Joint Supply and Planning Manual

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Abstract: This manual provides information for small and major customers connecting to, or altering, a connection, and requiring a negotiated connection agreement about their obligations in respect to connecting and interfacing with Energex and Ergon Energy Network's *Distribution System.* This manual has been developed to ensure the safe and stable operation of *electrical installations* connected to the *distribution network* without causing material degradation in the quality of supply to distribution network users, or burden existing distribution network users with unduly future costs.

Keywords: connection, negotiated connection, overhead, underground, commercial, industrial, agricultural, URD, subdivision, substation, ground mounted, padmount, indoor, chamber, HV, LV

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1 Overview

1.1 Purpose

This manual provides supplementary advice on certain technical information to be considered by Customers who seek to establish or vary a Connection and are connecting at Low Voltage.

All Customers, including Small Customers must comply with the applicable Connection process (and associated requirements) and the terms and conditions of their agreement(s) with the DNSP, before establishing or altering a Connection.

All Customers must comply with the requirements of the Queensland Electricity Connection Manual (QECM).

While Major Customers connecting to or coupling to the LV network must comply with the requirements specified for Major Customers, some of the information in this manual may also prove useful.

This includes Connection Applicants requiring to:

a) Establish a new Connection, or

b) Alter an existing Connection, including (but not limited to)

- additional demand
- addition of generation, or additional generation
- changes to the performance of the electrical connection.

c) Connect a subdivision

- Residential subdivision
  - Urban
  - Rural
- Commercial/Industrial subdivision

1.2 Scope

This Manual is intended for use by parties who;

a) are involved in connections designated as Small Customer and requiring or selecting a ‘negotiated’ connection in either the “Energex Connection Policy 2020-2025,” or the “Ergon Energy Connections Policy 2020-2025” and are connecting to or coupling to, the LV network.

b) are involved in connections designated as Major Customer and are connecting to or coupling to, the LV network

c) are involved in the connection of residential (urban and rural) subdivisions

d) are involved in the connection of commercial / industrial subdivisions.

This manual is intended to be used in conjunction with other Energex or Ergon Energy policies, procedures and documentation as listed in Section 2: References, and as listed on the respective Distributor’s internet site.

1.2.1 Subdivisions

While considered Major Customer Connections, this Manual may have variations that are covered in other DNSP policies and standards. The following documents are applicable within the DNSP's websites:

For Energex refer to:

- Commercial & residential subdivisions | Energex

For Ergon Energy refer to

- Commercial & residential subdivisions | Ergon Energy

The information in this manual supersedes the documents referred to in this sub-section 1.2.1 on planning matters. However, documents referenced in sub-section 2.1 relating to construction matters prevail.

In addition, where there is any inconsistency between this manual and the Queensland Electricity Connection Manual (QECM), the QECM prevails.

The design and construction of underground electrical reticulation and any associated street lighting by a real estate developer for the following real estate development categories shall need to be carried out in accordance with the DNSP requirements for:

- urban residential subdivisions
- rural residential subdivisions
- commercial & industrial subdivisions
- commercial developments within a residential subdivision
- street lighting.

1.3 Exclusions

This Manual does not apply to:

- Direct connections to the HV network
- Low voltage equipment that is owned or operated by the Connection Applicant (subject to the equipment meeting the necessary standards for interconnection with the Distribution Network)
- The removal or relocation of existing DNSP assets.

1.4 Contact information

Refer to Table 1 for contacts for various Customer connection types.

Table 1: DNSP contact details

Customer connection type	Contact
LV load Connections	qldconnections@energyq.com.au for Energex & Ergon Energy
EG systems capacity > 30kVA and less than <1500kVA	energexgeneration@energyq.com.au for Energex ergongeneration@energyq.com.au for Ergon Energy,
EG systems capacity > 1500kVA	majorcustomers@energyq.com.au for Energex and Ergon Energy
Subdivisions, major real estate developments	contestable@energyq.com.au for Energex, CCG.Contestable@ergon.com.au for Ergon Energy
HV Connections	majorcustomers@energyq.com.au for Energex and Ergon Energy

1.5 Terminology

In this Manual:

- the word “shall” indicates a mandatory requirement the Customer must comply with
- the word “should” indicates a recommended requirement that will not be mandatorily imposed on the Customer
- the word “may” indicates a requirement the DNSP may determine the Customer must comply with.

2 References

There are a range of applicable standards, reference materials and industry codes which define Connection types and requirements, and network standards as set out below. However, it should be noted that the details listed below may not be exhaustive or complete and additional laws and requirements may apply.

In the event of any inconsistency between;

- legislation and regulation; and
- this standard,

the legislation and regulation shall prevail.

Where an inconsistency is identified, we strongly recommend communicating with us as early as possible to ensure our interpretations are the same.

2.1 Legislation, Regulations, Rules, and Codes

Document	Type
Aboriginal Cultural Heritage Act 2003 (Qld)	Legislation
Construction and operation of solar farms – Code of Practice 2019	Code of Practice
Distribution Authority D07/98 Energex Limited	Legislation
Distribution Authority D01/99 Ergon Energy Corporation Limited	Legislation
Electricity Act 1994 (Qld)	Legislation
Electricity Regulation 2006 (Qld)	Regulation
Electrical Safety Act 2002 (Qld)	Legislation
Electrical Safety Regulation 2013 (Qld)	Regulation
Electricity – National Scheme (Queensland) Act 1997 (Qld)	Legislation
Environmental Protection and Biodiversity Conservation Act	Legislation
National Electricity (Queensland) Law, as defined in the *Electricity – National Scheme (Queensland) Act 1997* (Qld)	Legislation
Managing electrical risks in the workplace – Electrical Safety Code of Practice 2021	Code of Practice
National Energy Retail Law (Queensland) Act 2014 (Qld)	Legislation
National Energy Retail Law (Queensland), as defined in the *National Energy Retail Law (Queensland) Act 2014* (Qld)	Legislation
National Electricity Law	Legislation
National Electricity Rules	Regulation
Nature Conservation Act 2002	Legislation
Professional Engineers Act 2002 (Qld)	Legislation

Document	Type
Queensland Heritage Act 1992 (Qld)	Legislation
Queensland WH&S Regulation 2011	Legislation
Sustainable Planning Act 2009 (Qld) Legislation	Legislation
Torres Strait Islander Cultural Heritage Act 2003 (Qld)	Legislation
Works – Electrical Safety Code of Practice 2020	Code of Practice
Clean Energy Council – Embedded Generation Connection Guide	Reference
Distribution Determination Energex 2020-2025, 5 June 2020	Reference
Distribution Determination Ergon Energy 2020-2025, 5 June 2020	Reference
Energex Connection Policy	Reference
Ergon Energy Connection Policy	Reference
Energex Distribution Annual Planning Report (DAPR)	Reference
Ergon Energy Distribution Annual Planning Report (DAPR)	Reference
Energex Tariff Structure Statement	Reference
Ergon Energy Connection Policy	Reference

2.2 *DNSP* documents

Please note that this Manual reflects the relevant DNSP's policies and procedures and relevant regulatory arrangements at the time of publishing, and these may change from time to time.

A copy of the latest version of this Manual may be obtained searching for 'Joint supply and planning manual' on the Energex or Ergon Energy websites:

- https://www.energex.com.au/
- https://www.ergon.com.au/

Also note the following references for further details.

Energex technical documents available at:
https://swp.energex.com.au/service_providers/technical_docs/asp/technical_documents.asp

Ergon Energy Network - Design and Construction Standards, available at
https://www.ergon.com.au/network/contractors-and-industry

Document number	Document name	Document type
	Developer Handbook Developer Design and Construct	Reference
00305	Underground Construction Manual	Standard
	Underground Construction Manual	Standard
	Management of Disputes	Fact Sheet

	Security Requirements	Fact Sheet
	Tenure Requirements	Fact Sheet
01811	Queensland Electricity Connection Manual	Reference
STNW1174	Standard for Low Voltage Embedded Generating Connections	Standard
STNW1175	Standard for High Voltage Embedded Generating Connections	Standard
STNW3511	Dynamic Standard for Low Voltage Embedded Generation Connections	Standard
STNW3522	Standard for Major Customer Connections	Standard
STNW3369	Standard for Distribution Line Design Underground	Standard
STNW3389	Standard for Electrical Design and Construction Requirements for Chamber Substations	Standard
STNW3390	Standard for Site Selection and Construction Requirements for Chamber Substations	Reference
00293	Commercial and Industrial Substation Manual	Standard
00758	Standard for Distribution Earthing	Standard

2.3 Australian and international standards

Document number	Document name	Document type
AS 2067	Substations and high voltage installations exceeding 1kV a.c.	Australian Standard
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)	AU/NZ Joint Standard
AS/NZS 3835.1	Earth potential rise – Protection of telecommunications network users, personnel	AU/NZ Joint Standard
AS/NZS 3835.2	Earth potential rise – Protection of telecommunications network users, personnel	AU/NZ Joint Standard
AS/NZS 4777.1:2016	Grid connection of energy systems via inverters, Part 1: Installation requirements	AU/NZ Joint Standard
AS/NZS 4777.2:2020	Grid connection of energy systems via inverters, Part 2: Inverter requirements	AU/NZ Joint Standard
AS/NZS 4853	Electrical Hazards on metallic pipelines	AU/NZ Joint Standard
AS 60038	Standard Voltages	Australian Standard
AS/NZS 61000Series	Electromagnetic compatibility	AU/NZ Joint Standard
AS/NZS 7000	Overhead line design	AU/NZ Joint Standard
IEEE Std 519 – 2014	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems	International Standard

3 Definitions and abbreviations

3.1 Definitions

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

Term	Definition
After Diversity Maximum Demand (ADMD)	The equally apportioned contribution to maximum demand per customer of an aggregate of customers. This value takes into account the diversity of customer demands when they are grouped together in the network; e.g., downstream of a distribution transformer.
After Diversity Maximum Export (ADME)	The equally apportioned contribution to maximum export per customer of an aggregate of customers. This value takes into account any possibility of diversity between export of customers with generation capabilities.
Alternative Control Services (ACS)	A distribution service provided by the DNSP that the AER has classified as an Alternative Control Service under the NER.
Augmentation	Work to expand the distribution system or to increase its capacity to transmit or distribute electricity.
Australian Energy Market Operator (AEMO)	The entity responsible for the management of the NEM and who oversees the system security of the interconnected national electricity system in respect of which the NEM applies.
Australian Energy Regulator (AER)	Regulatory body established by section 44AE of the *Competition and Consumer Act 2010* (Cth) that regulates energy markets, and energy networks, under national energy legislation and regulations.
Build, own, and operate	Refers to either: • For Customer Assets, the Major Customer (or a contactor/consultant engaged by the Major Customer) designs and constructs the Customer Assets and retains ownership and operational control over those assets; or • For DNSP assets, the DNSP designs and constructs the Connection Assets and retains ownership and operational control over those assets.
Connection	A physical link between the Distribution System and a Premise to allow the flow of electricity across the Connection Point.
Connection alteration	An alteration to an existing Connection including an addition, upgrade, Extension, expansion, augmentation, or any other kind of alteration.
Major connection applicant	A Major Customer that has, or intends to, submit a Connection Application. For the avoidance of doubt, where another party submits a Connection Application on behalf of the Major Customer (for example, as described in the relevant definition in rule 5A.A.1 of the NER or a contractor or consultant engaged by the Major Customer) the Connection Applicant is the Major Customer, not the party submitting the Application.
Commercial / industrial customer (C&I)	A commercial/industrial premise requiring, or having, a negotiated connection offer, with a connection > 100 amps per phase and connected to the LV network
Connection application	An application to establish or alter a Connection in accordance with the process and requirements set out in Chapter 5 or Chapter 5A of the NER (as applicable).

Term	Definition
Connection assets	Those components of a Distribution System which are used to provide *connection services*. Connection Assets are all components used to connect a particular Customer's electrical installation to the shared Distribution Network. , which are not used by other Customers, (including a dedicated extension). The Connection Assets required to connect Customers to the Distribution Network may include: • High voltage overhead and/or underground mains • Low voltage overhead and/or underground mains and services • Distribution transformers • Protection systems.
Connection offer	Means an offer to establish a Connection or alter an existing Connection that is made in response to a Connection Application. For the avoidance of doubt, this encompasses a *connection offer* under Chapter 5A and offer to *connect* under Chapter 5 of the NER.
Connection Point (CP)	The physical point or link where the Connection Assets meet the Customer Assets so as to permit the flow of electricity between the Premises and Distribution System, being the agreed point of supply. Or An agreed point of supply established between the DNSP's *distribution system* and a *Customer's premises*.
Contestable	A service is contestable if the Energy Laws of the participating jurisdiction in which the service is to be provided permit the service to be provided by more than one supplier as a contestable service or on a competitive basis.
Current Transformer (CT)	Measurement transformer for current.
Customer	A person or entity who engages in the purchase of electricity supplied through a distribution system to a connection point.
Customer asset	Refers to the assets that are owned and/or operated by a Major Customer downstream of the Connection Point.
Defect	Refers to anything in relation to the Transferable Connection Assets that is, or is likely to: a) amount to a breach or non-compliance in respect of the NCEC b) amount to a non-compliance with a relevant law; or c) cause the Distribution System or the broader *power system* to operate in a manner inconsistent with the requirements of the applicable Energy Laws and regulations.
Detailed response	The detailed response to enquiry means the response to a connection enquiry prepared under rule 5.3A.8 of the NER, which must contain the information set out in S5.4B of the NER.
Developer	Developers are a Connection Applicant seeking to develop a site for future use by retail customers. (The Developer may be, but is unlikely to be, the end use Customer).
Distribution determination	The determination made by the AER at 5-yearly intervals concerning the economic regulation of a Distribution Network.
Distribution network	A *network* which is not a Transmission Network. This Manual refers to the Low Voltage or High Voltage portion of the Distribution Network.
Distribution Network Service Provider (DNSP)	Depending on the context means either Energex (who owns and operates the Distribution System in South East Queensland) or Ergon Energy

Term	Definition
	Network (who owns and operates the Distribution System in regional Queensland).
DNSP service point	The point the DNSP's distribution system terminates at the Customer's consumer's mains to provide a connection.
Distribution system	A Distribution Network, together with the Connection Assets associated with the Distribution Network, which is connected to another Transmission Network or Distribution System. Connection Assets on their own does not constitute a Distribution System.
Easement	A legal right to cross or otherwise use someone else's land for a specified purpose, where that right is registered on the title for the relevant land. An easement in favour of the DNSP must be on terms acceptable to the DNSP (known as an electrical services easement).
Embedded generating system(s)	One or more Embedded Generating Units and auxiliary equipment that are interconnected with a Distribution Network.
Embedded generating unit	A generating unit connected within a Distribution Network and not having direct access to the Transmission Network.
Embedded Generator (EG)	Broadly, an entity who is registered with AEMO in respect of the ownership, operation, or control of an Embedded Generating System.
Embedded network	A *distribution system*, connected at a *parent connection point* to either a Distribution System that forms part of the *national grid*, and which is owned, controlled, or operated by a person who is not a DNSP.
Energy laws	Has the meaning given to that term in the NERL, which, for the avoidance of doubt, includes the Electricity Distribution Network Code under the *Electricity Act 1994* (Qld). Relevant laws relating to the subject matter of this Manual at the date of publication are set out in Section 2 (NB this list may not be exhaustive or complete).
Energy storage system	A system comprising one or more components (e.g., batteries) that store electricity generated by distributed energy resources or directly from the grid, and that can discharge the electricity to *loads*.
Extension	An extension required to connect a power line or facility outside the present boundaries of the Distribution System to facilitate a new or altered Connection where there is a reasonable likelihood that the Extension will be used to supply another customer or customers within the planning horizon.
Financially responsible market participant	The entity that is financially responsible under the NER for a *market connection point*.
High Voltage	Voltages greater than 1kV RMS for a.c. systems.
Large centre	A large centre is considered a town with a population of 6,000 or more. Note: A suburb is not a large centre.
Load factor	The ratio of average demand to maximum demand
Locale	A locale is a location assigned to an electrical asset (e.g., ZSS) where it has no particular suburb reference but resides within a suburb or city/large centre/town.
Low Voltage (LV)	Voltages of 1kV RMS or less for a.c. systems.
Major Customer	A commercial/industrial premise coupled at high voltage and connected at low voltage where;

Term	Definition
	• the installed capacity is greater than 1,000kVA (1MVA) • the power usage is typically above 4GWh per annum • a residential or commercial/industrial subdivision.
Metering Coordinator	A person who is registered by AEMO and engages in the coordination and provision of metering services for a *connection point*.
Micro embedded generator	A *small customer*, *large customer* or *Market Small Generating Aggregator* who operates, or proposes to operate, an Embedded Generating Unit for which a *micro EG connection* is appropriate, that is, the kind contemplated by Australian Standard AS 4777 (Grid connection of energy systems via inverters).
National Electricity Law (NEL)	The *NEL* as it applies in Queensland under the National Electricity (Queensland) Law, as defined in the *Electricity - National Scheme (Queensland) Act 1997* (Qld), and under which the NER are established.
National Electricity Market (NEM)	The name of the wholesale electricity market in Australia and the associated interconnected *national grid*.
National Electricity Rules (NER)	The NER are made under the NEL. The NER governs the operation of the NEM.
National Energy Retail Law NERL)	The National Energy Retail Law (Queensland), as defined in the *National Energy Retail Law (Queensland) Act 2014* (Qld).
National Energy Retail Rules	The National Energy Retail Rules established under the NERL.
National Metering Identifier (NMI)	This is a unique identifier for each *metering installation* for a *connection point* within the NEM.
Negotiated connection Establishment contract	An agreement between the DNSP and a Major Customer under which the parties agree to carry out certain works to either establish or alter a Connection.
Negotiated Ongoing Connection Contract (NOCC)	An agreement between the DNSP and a Major Customer that describes the terms and conditions on which the DNSP agrees to provide Ongoing Services.
Network Coupling Point	The point at which Connection Assets join a Distribution Network, used to identify the distribution service price payable by a Major Customer.
Non-registered Embedded Generator	An *embedded generating unit operator* that is neither a Micro Embedded Generator nor a Registered Participant.
Ongoing services	Refers to the provision of ongoing connection services by the DNSP to the relevant Major Customer at the Connection Point. For the avoidance of doubt, this may cover *customer connection services*, *connection services* or *network services*.
Planning report	A high-level document that reviews the specific Major Customer requirements, examines the relevant Distribution Network conditions, and sets out available option(s) for the proposed Connection or Connection Alteration or modification.
Powerlink	Queensland Electricity Transmission Corporation Limited ABN 82 078 849 233 trading as Powerlink Queensland, being the relevant Transmission Network Service Provider in Queensland.
Premises	Means any land (whether a single block or multiple contiguous blocks), building(s) (whether whole or part), structure(s) (or adjuncts thereto) that are owned, occupied, controlled, or operated by the Customer in the vicinity of the proposed Connection, or are *connected* to the Distribution System,

Term	Definition
	and which can reasonably be considered to be part of a single overarching operation.
Project scope	A more detailed document prepared after a Planning Report, which considers one only of the options listed in that Planning Report and scopes out the works.
Project sponsor	Person/s within the DNSP that is responsible for liaising with the Customer and coordinating the Connection process on behalf of the DNSP.
Registered participant	A person who is registered by AEMO in any one or more of the categories described in Chapter 2 of the NER.
Real estate developer	A person who carries out a Real Estate Development.
Real estate development	The commercial development of land including its development in one or more of the following ways: • residential housing and commercial and / or industrial subdivisions • commercial and / or industrial multi-tenanted Premises, and • multi-residential Premises.
Retailer	Person who holds a retail authorisation issued under the *National Energy Retail Law* in respect of the sale of electricity.
Rural area	Rural or Rural areas have low population densities and are areas located outside towns, large centres, and cities Rural areas are not: • an Urban area • a large centre or • a Town (Rural areas are also referred to as an unbounded location). From an electrical network perspective, Rural and rural areas are typically those supplied by distribution feeders classified as either a “short rural feeder,” or a “long rural feeder”, as per the definitions in the respective DNSP’s Distribution Authorities. Note: This definition is only applicable to voltage drop calculations and considerations.
Shared distribution network	Those parts of the distribution network connecting more than one customer
Service line	an electric line that connects consumers terminals to the relevant supplier’s works or the works of another electricity entity. For clarity, this is the LV connection service linking the Customer assets to the DNSP’s assets. The DNSP’s HV and LV assets are considered network assets, not a service line.
Service Point	See DNSP Service Point
Small Customer	A residential dwelling or small commercial/industrial premise coupled and connected at low voltage or coupled at high voltage and connected at low voltage where the installed capacity is equal to or less than 1,000kVA (1MVA)
Standard Control Services (SCS)	A distribution service provided by the DNSP that the AER has classified as a standard control service.
Suburb	A suburb of a city, or large centre is a smaller area which is part of a city/large centre but is outside its centre.

Term	Definition
Town	A predominately urban area with some commercial areas, smaller than a large centre, with a name and defined boundaries. (Also referred to as a population centre with greater than 200, but less than 6000 people, or a bounded location).
Transferable connection assets	Refers to the assets constructed by, or on behalf of, a Major Customer in respect of a Major Customer Connection where, under the terms of the NCEC, the ownership of these assets is to be transferred to the DNSP upon completion.
Transmission network	In Queensland, the electricity network owned and operated by Powerlink.
Transmission Network Service Provider (TNSP)	A person who engages in the activity of owning, controlling, or operating a Transmission System.
Transmission system	Includes a Transmission Network together with any associated *connection assets*.
Urban area	The area surrounding a city or large centre where there is a density of human structures, such as houses, commercial buildings, roads etc.
Voltage transformer	Measurement transformer for voltage.
Works	Refers to the design, construction, testing, and commissioning works by either or both the DNSP and Major Customer under a NCEC.

3.2 Abbreviations

This list does not include well-known unambiguous abbreviations, or abbreviations defined at their first occurrence within the text.

Term	Definition
AC	Alternating Current
ACS	Alternative Control Services
ADLDD	After Diversity Lowest Daily Demand
ADMD	After Diversity Maximum Demand
ADME	After Diversity Maximum Export
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BESS	Battery Energy Storage System
BOO	Build, Own and Operate
CFS	Combined Fuse Switch unit
CBD	Central Business District
C&I	Commercial and/or industrial
CMEN	Common Multiple Earthed Neutral
CP	Connection Point
CT	Current Transformer
CTW	Consent To Work
DAPR	Distribution Annual Planning Report
DNSP	Distribution Network Service Provider
EDQ	Economic Development Queensland
EG System(s)	Embedded Generating System(s)
EG Unit	Embedded Generating Unit
EG	Embedded Generator
EMF	Electro Magnetic Fields
EQL	Energy Queensland Limited
ESS	Energy Storage System
FRMP	Financially Responsible Market Participant
GDD	Grid Disconnection Device
GEV	Generalised Extreme Value

Term	Definition
HV	High voltage
LR	Long Rural
LV	Low Voltage
MC	Metering Coordinator
MD	Maximum Demand
ME	Maximum Export
MEGU	Micro-Embedded Generating Unit
MEN	Multiple Earthed Neutral
N	The conditions under which all network elements are in service.
N - 1	The conditions under which all (or a certain percentage) of the electricity load will continue to be supplied under conditions whereby a critical system element is out of service. Also known as a credible contingency.
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NERL	National Energy Retail Law
NERR	National Energy Retail Rules
NMI	National Metering Identifier
NCEC	Negotiated Connection Establishment Contract
NOCC	Negotiated Ongoing Connection Contract
NCP	Network Coupling Point
NVD	Neutral Voltage Displacement
PLY	Paper Lead insulated multi core cable
PV	Photo Voltaic
QECM	Queensland Electricity Connection Manual
SCS	Standard Control Services
SD	Standard Deviation
SR	Short Rural
SWER	Single Wire Earth Return
TMU	Target Maximum Utilisation

Term	Definition
TNSP	Transmission Network Service Provider
UID	Underground Industrial Development
UR	Urban
URD	Underground Residential Development
VT	Voltage Transformer

4 Customer Connections

4.1 Connecting to the Energex or Ergon Energy networks

A connection is the physical link between a distribution system and a Customer's premises to allow the flow of electricity. All customers will require network connection services to connect their premises to the Energex or Ergon Energy distribution system. Typically, a meter is also required in order to measure the amount of electricity that flows through the connection.

The Connection Policy of both Energex and Ergon Energy describe two forms of connection, being:

- Basic
- Negotiated.

As mentioned in Section 1.2 above, this manual concerns itself with customers requiring a negotiated connection, and connecting at LV, or coupling to the HV network.

The provision of connection services may involve the establishment or modification of assets dedicated to the particular Customer (connection assets), as well as extensions to, or augmentations of, the shared distribution network. An extension of the distribution network is where the present boundaries of the distribution network need to be extended to include a new power line or facility. An augmentation of the distribution network is where work is required to enlarge the existing network or increase its capacity to distribute electricity, e.g., by installing a larger transformer.

Charges for connection services will typically depend upon the customer connection type and the classification of the customer connection service/s required to make the connection.

Refer to the relevant DNSP's Connection Policy for additional information.

4.2 Commercial / Industrial Customer classification

This manual uses the term "Commercial/industrial Customer" (C&I customer) to assist with describing the technical requirements for such connections.

A Commercial/industrial customer, for the purposes of this Manual, is defined as "A commercial/industrial premise requiring, or having, a negotiated connection offer, with a connection > 100 amps per phase and connected to the LV network."

This type of customer is typically a commercial, industrial, or agricultural property where their supply requirements will be met from either an LV service, LV connection point/s, or coupled at high voltage and connected at low voltage.

As previously stated, this Manual considers LV connected Customers only.

Table 2 summarises the connection types.

Table 2: Commercial/industrial Customer connection types

Connection Type - Load	Demand/Capacity	Connection Offer Type
Small commercial/industrial premise Small rural connected premises or equipment Multi tenancy residential premises	> 100 amps per phase and ≤ 1,000kVA (connected to the LV network)	Negotiated
Major commercial/industrial premise Major multi tenancy residency premises (other than real estate developments)	> 1,000kVA (connected to the LV network)	Negotiated

And from the major customer definition:

- Large commercial premises coupled at high voltage and connected at low voltage with
  - an installed capacity of greater than 1,000kVA (1MVA)
  - the power usage is typically above 4GWh per annum

Note: Major commercial/industrial properties connected at LV must comply with the requirements for Major Customers. These requirements are listed in the

- Major Customer Connection Manual
- The Standard for Major Customer Connections.

The maximum installed capacity of a low voltage connected customer in one indoor/chamber substation is 6,000kVA, comprising 4 x 1,500kVA transformers.

Where a negotiated connection offer is required, or where it is likely that a change to the existing connection assets, and/or augmentation of the LV network or HV network, including where HV coupling of a connection is required, then Distribution Planning shall be consulted where;

- **Energex network:**
  - Aggregate load to be connected is 500kVA or greater. This includes any residential, commercial, or industrial subdivision including contestable works, or
  - Authorised demand increases at an existing site by 500kVA or greater, or
  - Any Site where aggregate motor capacity to be installed at the site is greater than 50kW, or
  - All connections that require a load transfer or 11kV network reconfiguration, or
  - All EV charging stations ≥ 50kVA.
- **Ergon Energy network:**
  - LV connections where the Customer Connection Assessment Matrix (CCAM) indicates that a planning assessment is required, or
  - All connections that require a load transfer or a HV network reconfiguration, or
  - All EV charging stations ≥ 50kVA.

4.3 Customer classifications specifically excluded from this manual

This standard specifically excludes Customers connecting directly to the HV network.

i.e. customers connecting to voltages above 1kV.

Additional information on customers directly connecting to the HV network can be found in the

- Standard for Major Customer Connections, and
- Major Customer Connection Manual.

4.4 Temporary connections

- Temporary connections must comply with the requirements of the QECM.

4.5 Unmetered connections

- Unmetered connections must comply with the requirements of the QECM.

5 Supply arrangements

5.1 Charges for connection services

The AER regulates the charges that Energex and Ergon Energy may impose for specific services. The connection charges payable by a customer to Energex or Ergon Energy will (where applicable) be comprised of the following components:

- Connection charges for services classified as alternative control services
- Capital contributions for services classified as standard control services
- Connection charges for extension assets to which a pioneer scheme applies.

These connection charges are explained more fully in the Connection Policy of the relevant DNSP.

5.2 Connection alterations

Work initiated by a customer specific to an existing connection, including, but not limited to, supply abolishment (i.e. where the connection is no longer required), relocation of the point of attachment, re-arrangement of connection assets, replacement of an overhead service line, (e.g., as a result of a point of attachment relocation), supply enhancement, (e.g., upgrade from single phase to three phase) and upgrade from overhead to underground service are all considered connection alterations.

Information on connection alterations can be found in the QECM.

5.3 Service lines – Low Voltage

Overhead

Overhead service lines are to be in accordance with the QECM.

Underground

Underground LV connections to Customers premises are typically one of the following:

- From a pit or pillar located at the Customers property boundary. (The connection point being the terminals inside the pit or pillar)
- From the LV terminals of a substation located at the Customers property boundary.

Each DNSP will assess the least cost, technically appropriate connection taking into consideration the current network topology and any future known network requirements.

Charges shall be determined based on this assessment method. It should be noted that excessive cable lengths are likely to be charged.

Additional information on service lines (both overhead and underground) can be found in the QECM.

5.4 Enhanced connection services

Enhanced connection services are offered to Customers to balance Customer requests above and beyond the least cost, most technically appropriate connection & augmentation requirements in accordance with EQL standards and practices. Enhanced connection services will be offered to Customers on a “difference in cost” basis at the sole discretion of the DNSP. The considerations to determine the “least cost technically feasible” connection arrangement is detailed in Section 8.3.

5.4.1 Supply arrangements in excess of minimum technically appropriate

Customers or Applicants may request supply arrangements and/or load in excess of the least cost, most technically appropriate option according to the DNSP's policies, standards, and practices. These requests shall be accompanied by valid justification from the Applicant (e.g., enhanced reliability, future expansion, visual amenity) but are not justified by the immediate maximum demand and expected revenue from network tariff charges.

Examples of Supply Arrangements considered "Enhanced Connection Services" include (but are not limited to):

- Underground (UG) supply in an overhead (OH) area where the supply capacity can be serviced from the OH network
- Customer requested N-1 connection capacity and/or diverse feeder paths (where N – 1 network capability exists or is feasible to create)
- Surface / Chamber Substations located at a distance from the property boundary and/or proximity to the existing DNSP network
- Network augmentation or removal of network constraints for future embedded generation or battery storage systems.

5.4.2 High Voltage underground cable on Customer premises

To ensure the most technically appropriate placement of substations, Energex and Ergon Energy do not charge directly for excess HV cable on Customer premises. The total project cost is considered when calculating the proportion of the project costs to be paid by the Customer.

Customers need to be aware of all the physical and technical requirements of DNSP assets on their property to make a fully informed decision.

5.4.3 High Voltage overhead conductor on Customers premises

High voltage overhead lines may be considered for some types of customer installations. The DNSP is the sole determinant as to the suitability to supply premises with overhead HV line/s.

The maximum length of a HV overhead line from the point at which the cable crosses the Customers property will be determined as part of the Planning & Design process in accordance with the relevant DNSP's planning, design & construction requirements.

Customers need to note that easement requirements for overhead lines take into account the 'swing' and 'sag' of the overhead cables, as well as maintaining safe working clearances from structures. This means that easement requirements may be quite onerous in impacting land use within the easement and adjacent to the overhead line/s.

Refer section 16 for additional information on easements.

5.4.4 Additional Connection/s to Customer Premises

Customers requesting an additional service point at their premises must comply with the requirements in the QECM and be approved by the relevant DNSP.

All approvals for an additional connection point are at the sole discretion of the relevant DNSP and must be in writing.

5.5 Works on Customer premises

In addition to contractual and financial requirements, the physical requirements Customers are required to provide for works on their premises include (but may not be limited to:)

- Providing the respective DNSP with electrical load details
- Providing the respective DNSP with operation and usage details.
- Providing the correct property description, including associated building approvals, development approvals and proposed/final property titling arrangements
- Providing accurate and complete site details
- Providing wayleaves or easements (where required)
- Complying with the conditions of offer including any site clearing works (if required)
- Complying with the conditions of offer including any civil, and/or associated works (if required)
- Providing suitable accommodation for DNSP equipment such as cable pits and conduits on the property and appropriate civil works for ground and/or chamber substations
- Provide conduits across existing frontages to facilitate undergrounding of existing overhead electricity assets.

Additional details can be found in Section 6.4: Obligation of Customers.

5.6 Pioneer schemes

If a network extension asset ceases, within seven years after its installation and energisation, to be dedicated to the exclusive use of the customer occupying the premises, the customer may be entitled to a partial refund of connection charges under an Energex or Ergon Energy pioneer scheme.

Information on the treatment of Pioneer schemes can be found in the Energex Connection Policy or the Ergon Energy Connections Policy.

6 Connection requirements

6.1 General requirements

This Manual applies to Connections that come within the scope defined in Section 1.2. The connection and technical requirements set out in this section are applicable for all new Customer connections.

Existing Customers proposing to undertake a change to their connection, for example but not limited to, additional demand that necessitates augmentation, addition of generation, or changes to the performance of the Premises require a review of existing arrangements to align to this Manual.

This manual has specific regard for load growth, generation growth and customers who are either new connections or proposing to alter their existing connection and are connecting/connected to, the LV network.

From a customer classification perspective, this applies to small customers and major customers connecting to the LV network.

In addition, developers coupling to the HV and/or LV system will find additional information throughout this document and Customer connection specific information in Sections 8, 10, 11, 12 and 13.

6.2 Maximum Customer connection capacity (aggregated considerations)

The maximum capacity for any Connection Point in respect of a Premise is based on the aggregate of all the maximum demand or connected capacity of the EG Systems authorised to be connected within that Premise.

For Premises with multiple Connection Points, or EG System(s) within a Premises being connected to multiple Connection Points:

i. The maximum capacity for any Connection Point in respect of a Premises is based on the aggregate of all the maximum demand or connected capacity of the EG Systems authorised to be connected within that Premises.

ii. The requirements set out in this manual and any technical study will be applied and determined based on the aggregate maximum capacity of all the EG Units connected and the maximum aggregate demand, or proposed aggregate to be connected, within the Premise.

This aggregate capacity consideration is irrespective of any interlocking or electrical separation of the multiple supplies at the Premises.

6.3 Summary of the Connection process

Details or connection processes can be found on the respective DNSP's websites:

- Energex
- Ergon Energy

More specifically, the connection process for connection at LV involves (but is not limited to):

- Assessment of the current network capacity, including substation, HV feeder and LV circuit capacities. Refer to Distribution when required and as necessary

- Assessment of the After Diversity Maximum Demand (ADMD) and/or After Diversity Maximum Export (ADME)
- Calculation of voltage drop and/or voltage rise to ensure voltage remains within the planning and design limits
- Ensure the connection requirements can be accommodated within standard protection arrangements.

6.4 Obligation of Customers

In addition to Section 5.5: Works on Customer premises above, where a Customers load or generation capacity is deemed sufficient to require a substation on the Customers premises, the Customer will be required to:

- Provide an appropriately sized and specified;
    - room/building for an indoor or free-standing chamber substation or
    - ground mounted substation (either ground mounted or padmount)
- Provide suitable accommodation for Energex or Ergon Energy equipment such as cable pits and conduits on the property and appropriate civil works for ground substations.
- Provide easements for all areas;
    - containing HV and LV equipment/cables
    - containing earthing conductors including remote earthing and separately earthed equipment
    - containing communication cables
    - providing vehicular and pedestrian access and egress
- Comply with the conditions of offer including clearing (if required)
- Provide conduits across existing frontages to facilitate installation of underground assets
- Comply with all DNSP and building code regulations and requirements.

6.5 Requirements for substation on Customer Premises

In accordance with the provisions of the Electricity Regulation 2006, customers are required to provide space on their premises for the purpose of establishing a distribution substation should the total maximum demand be more than, or is reasonably estimated to be more than, 100kVA.

Specifically, Clause 57 (1) states;

> *"This division applies if the supply of electricity required by customers in premises is more than, or is reasonably estimated by the distribution entity to be more than, a total maximum demand of 100kV.A worked out under the wiring rules."*

For the purposes of this clause, both Energex and Ergon Energy consider maximum demand load and generation capacity as demand. (Representing the maximum current flow either into, or out of, the Premises).

All of the costs incurred in establishing the site/building to the DNSP's specification are to be borne by the customer, with the exception of those costs outlined in the relevant DNSP's Connection Policy, to which the relevant DNSP may contribute.

6.5.1 Substation site selection

The selection of the site for a ground mounted, padmount or indoor chamber substations should be as close as practical to the optimal position for electricity supply distribution. The selection of the site for all substation sites shall be approved by the relevant DNSP.

Substation sites that may restrict future development of the premises should be avoided, as relocation of the substation and associated electrical equipment would be charged to the Customer and likely prove to be costly. In addition, future development of the premises must not encroach upon the agreed access route of the substation or other required clearances.

Ground mounted or indoor/chamber substations designed for future assets should be favoured over padmount substations where the nature of the premises and future occupants could feasibly require future load growth. e.g., > 1MVA (C&I vs. Retail / Residential developments).

Additional consideration should be given to the substation sizing and layout to accommodate conversion to a HV supply arrangements where future load growth could exceed 4.5MVA. This is particularly pertinent in areas of high load growth such as CBD Fringe, and CBD Fringe Equivalent areas.

Substation site requirements are listed in the relevant DNSP's design and construction manuals and shall be referred to by consultants and developers. The following is a summary of general requirements that must be taken into account when assessing a site or location for a substation:

- Be sensitive to the local environment
- Be secure from likely third party and environmental damage
- Be relatively flat and structurally sound
- Be clear of other structures, both vertically and horizontally, including the maintenance of statutory clearances
- Not be subject to tidal inundation, storm surge, or flooding
- Provide secure and safe access for operational purposes
- Provide for road safety
- Not be an obstruction or public nuisance.
- Limit EMFs on surrounding buildings
- Not cause a fire risk
- Be free of, and unencumbered by, any other services
- Be located within a registered easement. (Refer sections 10.7 and 16)
- The substation, the required access ways, conduit routes, ventilation ducts, and cable risers as appropriate must be located in areas which are free of any other building, structure or services excluding services or conduits directly related and, required for the indoor/chamber substation.

- The selected site is required to be geotechnically stable and RPEQ certified by a geotechnical engineer as having sufficient capacity for the intended loadings by the substation building, substation equipment and any underground conduits, pits or culverts servicing the substation
- The structure of the substation or chamber must be RPEQ certified, as being designed at least by a practicing RPEQ structural engineer to Australian Standards prior to supply being made available to the substation
- The structure of the substation is to be designed to have a design life matching that of the building structure but shall be no less than 50 years
- The selected site/location shall be clear of all obstructions which may interfere with the installation of any part of the substation earthing system

CAUTION
Electrodes for the earthing system may extend up to ten (10) metres into the ground below the substation/s and/or the ground level near the substation/s.

- Any services including, but not limited to, stormwater or subsoil drains, sewers, gas, water, fire services, air-conditioning installations, electrical or communications cables, conduits or pipe work other than those specified by the relevant DNSP, must not pass through or encroach into the substation site area or its required or associated access, services passageways, ventilation duct or cable riser clearances
- Columns, beams, footings or any part of any other building or structure shall not encroach on the clearances referred to in the relevant DNSP's design and construction manuals, within any portion of the substation or associated access or services passageways area or any space required for ventilation ducts
- Care should be considered to locate services sensitive to high voltage and strong electromagnetic fields with sufficient separation to the chamber substation. This is to ensure that they are not adversely affected by the installation of the chamber substation. e.g., separation of gas/metallic pipelines from the earthing installation.
- Separation of electronics/computer systems from the LV bus magnetic fields.

In addition, the site must not be within an area which is;

- classified as a hazardous area as defined in AS/NZS 3000
- deemed to be a confined space according to the Queensland WH&S Regulation 2011
- utilized as a possible storage or collection area for combustible or dangerous materials or goods
- likely to be used for such purposes or in a manner that would significantly increase the risk of fire or cause access difficulties.

The local government authority, in its role as a planning authority, may have preferences for these sites, which need to be taken into account.

This list is indicative only, and not exhaustive.

6.5.2 Substation types explained

There are a number of substation types suitable for use on customers' premises provided they are consistent with the local network topology and suitable for the customers current and prospective future needs. They are:

i. Ground mounted (surface) outdoor substation
ii. Padmount substation
iii. Dual padmount substation
iv. Indoor/chamber substation
v. Pole mounted transformer

A surface mounted substation (padmount, ground mounted) is a reference to a substation where the highest point of the floor of the substation is not more than 2000mm above the lowest finished surface level of the roadway or footpath from where personnel and equipment access is gained.

6.5.2.1 Ground mounted (surface) outdoor substation

The basic design comprises a transformer sitting on a concrete slab surrounded by a suitable enclosure. Variations to the basic design are available to accommodate additional transformers, ring main units and an outdoor weather-proof or weather protected low voltage switchboard.

Outdoor substations consist of up to four transformers rated up to 6,000kVA (4 x 1,500kVA) and associated switchgear mounted within a secure enclosure (open to the weather). The transformers may be located with, or remotely from, the associated HV switchgear.

The switchgear is connected to the distribution network via underground cables. Outdoor type ring main units are used to switch and protect the transformers.

Details of these substations can be found in the Energex Commercial & Industrial Substations Manual.

6.5.2.2 Padmount (kiosk) substation (surface located)

This arrangement consists of a transformer and its integral high voltage and low voltage switching equipment enclosed in a metal cabinet. The enclosure and internal components are mounted on a plinth. The design is appealing as the equipment is located on a single frame and additional site works are limited.

Padmount substations on both the Energex and Ergon Energy 11kV networks can accommodate 315kVA, 500kVA, 750kVA and 1000kVA transformers.

There is also a 1500kVA option available on the Ergon Energy 11kV network.

Padmount substations on the Ergon Energy 22kV networks can accommodate 315kVA, 500kVA, and 1000kVA transformers.

The associated indoor type of switchgear is connected to the distribution network via underground cables.

It should be noted that padmount substations may not be suitable for use in rural and remote areas due to a number of considerations, including, but not limited to:

- Protection requirements
- Unacceptable repair/replace times. (i.e., exceeding Safety Net limitations).

On the Energex network, these substations are detailed in the:

- Energex Underground Distribution Construction Manual.

On the Ergon Energy network, these substations are detailed in the:

- Ergon Energy Underground Construction Manual, PADMOUNTED SUBSTATIONS.

6.5.2.3 Dual Padmount Substation (surface located)

The dual padmount arrangement is only applicable for commercial/industrial Customers having a load requirement of 1000kVA to 1600kVA.

While the current maximum dual padmount substation size is limited to 2MVA (2 x 1000kVA), each DNSP retains reserve capacity to protect against future load growth. Due to this limitation, the dual padmount transformer arrangement shall only be utilised where the likelihood of future load increase is very low.

Padmount substations shall be situated side by side facing a road reserve or open area. Horizontal separation between padmount substations is required to facilitate safe construction, operation, and maintenance of the substations.

Parallel connection and operation of LV circuits is not permitted. Parallel interlocking requirements apply. Refer to the QECM for additional details.

Customer switchboard locations and electrical arrangements must comply with the QECM.

On the Energex network, these substations are detailed in the:

- Energex Underground Distribution Construction Manual.

On the Ergon Energy network, these substations are detailed in the:

- Ergon Energy Underground Construction Manual, PADMOUNTED SUBSTATIONS.

6.5.2.4 Indoor / Chamber Substation (surface located)

Indoor/chamber substations are normally contained within buildings but may be constructed as a free-standing structure, in which the substation equipment, such as transformers, high voltage switchgear, low voltage switchboard, cabling, protection schemes, SCADA equipment, etc., are housed.

Indoor /chamber substations may be rated up to 6,000kVA (4 x 1500kVA transformers) and are used to supply commercial and/or industrial loads. In some instances, the DNSP may also need to run an LV circuit into the street for their own purposes.

Where customers are requiring a capacity serviced by a 1,500kVA transformer, the DNSP may recommend the use of 2 x 750kVA transformers rather than 1 x 1,500kVA for improved reliability as the most technically appropriate option.

Variations to indoor/chamber substations

Other variants of indoor/substations may be considered in addition to the guidelines in sub-section 6.5.1. These include:

- Elevated indoor/chamber substations
- Upper level indoor/chamber substations
- Basement indoor/chamber substations

- Switching stations
- Chamber for control of high voltage connections

Critical loads

For critical loads such as the Gold Coast, Sunshine Coast & Ipswich CBDs, shopping centres, hospitals, prisons, water and wastewater infrastructure, an increased security of supply is recommended. This can be achieved by Customers who choose an N – 1, or duplicate supply, either at the LV level or both the HV and LV level where the configuration of the local network can provide for this. The relevant DNSP is the sole determinant as to the suitability of the local network for such configuration and whether additional charges for “Enhanced Connection Services” may be applicable. (As detailed in sub-section 5.4).

The Brisbane CBD uses a three feeder 11 kV mesh network. CBD Fringe and CBD Fringe Equivalent areas may use remotely operated interconnected feeders or three feeder mesh networks. A mesh point substation is used to tie the three feeders together.

Loads on three feeder meshes vary depending on the rating of the underground cables. The Targeted Maximum Utilisation (TMU) on these cables is 0.67 of the assessed cable ratings to maintain the integrity and reliability of these networks. Site specific cable rating assessments are conducted by Distribution Planning. Refer 6.5.3.1: Geographic Locations below for additional information on CBD, CBD Fringe and CBD Fringe Equivalent Areas.

Dry type transformers

Energex utilizes both oil filled and dry type transformers within indoor / chamber substations, depending on the substation location. Refer to the Energex Commercial and Industrial Substation Manual for selection requirements in areas frequented by the public, or areas of high fire risk.

Ergon Energy uses oil filled transformers only at this time.

To allow for load growth and contingency events, Energex only allow dry transformers to be loaded to 85% of their nameplate rating for new installations.

Additional information on indoor/chamber substations

Additional information on chamber substations can be found in the:

- Energex Commercial and Industrial Substation Manual
- Ergon Energy Standard for Electrical Design and Construction Requirements for Chamber Substations
- Ergon Energy Standard for Site Selection and Construction Requirements for Chamber Substations.

6.5.2.5 Pole transformer substation

This arrangement consists of a transformer, and associated fuses mounted on a pole.

It is mainly used in existing overhead reticulated areas, rural areas, quarries, agriculture, sewerage, and water treatment plants, and in some industrial situations where overhead lines exist.

Pole transformers will only be considered in predominantly underground areas with the support of the Local Government Authority (LGA) and where underground HV assets would be unsuitable due to environmental factors. (e.g., hazardous areas or areas prone to flooding).

6.5.3 Considerations when choosing a substation type

The choice of substation type available to customers is firstly determined by:

i. Geographic Location (including planning authority/ies requirements)
ii. Electricity network topology at the location. (i.e., underground, or overhead)
iii. Load or generation capacity required, both current and projected future requirements
iv. Premise type
v. Substation Site Location
vi. Environmental factors
vii. Site Access
viii. Cable Routes on the Premise
ix. Future Developments
x. Tidal inundation, storm surge and flood levels
xi. Clearance from Other Services

The above list represents some factors to be considered when choosing a substation site and is not exhaustive. Only experience with the special requirements of different substations in various locations will determine the most appropriate list of factors to be considered in each individual situation.

6.5.3.1 Geographic locations

Brisbane CBD

Brisbane CBD is the area defined in the Brisbane City Council's City Plan 2014, and typically defined as the area represented by the postcode 4000, excluding the suburbs of Spring Hill and Petrie Terrace

Information on the electrical requirements for the Brisbane CBD can be found in sub-section 9.1: Brisbane CBD.

Brisbane CBD Fringe and CBD Fringe Equivalent areas

With the continuing growth and Development of Queensland, especially in the South-East of the State, to continue the sustained capability of the Energex and Ergon Energy distribution networks, two new categories of planning consideration have been added. They are CBD Fringe and CBD Fringe Equivalent Areas, and they have similar electrical planning requirements to the Brisbane CBD.

Brisbane CBD Fringe areas

CBD Fringe areas have been labelled Emerging CBD in the past. With the significant growth of high-density developments including high rise buildings, in accordance with the most recent Brisbane City Council City Plan, the establishment of the Woolloongabba Priority Development Area, and prudent forward planning for the 2032 Olympics being held in Brisbane, the areas designated requiring distribution networks capable of being remotely switched and operated is expanding beyond the Brisbane CBD to include a new category, called the CBD Fringe Areas.

For simplicity, these areas are defined by suburbs and are listed in Appendix C.

More specific details are listed in sub-sections 9.1 and 9.2.

CBD Fringe Equivalent areas

In addition to the growth in and around central Brisbane, there is also continuing growth in regional areas. Growth remains strong on both the Gold Coast and Sunshine Coast.

For simplicity, these areas are defined by suburbs and are listed in Appendix C.

More specific details are listed in sub-sections 9.1 and 9.2.

Urban areas

Urban areas service the largest percentage of Queenslanders and the associated businesses servicing them. The continuing growth in roof top solar generation, the electrification of the transport industry, and the increased use of batteries, (both behind the meter and on the distribution networks), all have a significant influence on how we plan our urban electricity networks now and into the future.

Details on the specific requirements for planning and designing electricity networks in urban areas can be found in the relevant sections of this document, and specifically:

- Sub-section 9.4: Urban areas
- Sub-section 7.6: Low Voltage levels when planning and designing the Low Voltage network
- Section 8: Commercial / industrial Customers
- Section 11: Urban Residential Subdivisions
- Section13: Commercial / industrial subdivisions.

Regional areas

Regional areas are commonly a mix of urban and rural areas, with geographically smaller urban areas than larger cities, and closer abutting rural areas.

(Note: A ‘Regional Centre’ is defined in this manual as “a larger centre with at least one urban feeder.” A larger centre is a town/city with a population of 6,000 or more people).

For regional area planning and design, it is necessary to be specific in the geographic location and the feeder classification to determine which of an urban or rural environment is best suited to the connection in question.

Rural and Remote areas

Rural, rural areas and remote areas are typically those supplied by distribution feeders classified as either a “short rural feeder,” or a “long rural feeder.

Electricity networks servicing the rural and remote parts of the State require careful consideration, not only with the impacts of changing technology, but also with the limitations on load and/or generation that some areas are experiencing.

Details on the specific requirements for planning and designing electricity networks in rural and remote areas can be found in the relevant sections of this document, and specifically:

- Sub-section 9.6: Rural and remote areas
- Sub-section 7.6: Low Voltage levels when planning and designing the Low Voltage network
- Sub-section 11.8: Preferred overhead conductor sizes
- Section 12: Rural residential subdivisions

- Sub-section 13.8: Industrial and commercial subdivisions in rural environments

6.5.3.2 Electricity network topology

The network topology at the location may be overhead, underground or a combination of the two. Where the topology is underground, the Customer connection is required to be underground.

Where the topology is overhead, or both overhead and underground, the choice of substation will typically define the connection arrangement. However, the DNSP reserves the right to make the final decision in this situation.

The DNSP decision will be based on the technical assessment of the connection and future known network requirements.

6.5.3.3 Constrained and non-standard networks

The DNSP may require additional electrical installation requirements where connections are made in network areas that are considered constrained. This may include non-standard networks. e.g., CBD, SWER and isolated networks.

The areas of Fortitude Valley, Ipswich, Gold Coast and Sunshine Coast, commercial areas may also have limitations. Refer to sub-section 9.3 for additional information.

The DNSP is the sole determinant of whether a network is constrained.

6.5.3.4 Load and generation capacity

As previously mentioned, Energex and Ergon Energy consider both maximum demand (load) and generation capacity as demand measures. i.e., the largest possible current flow regardless of the direction of flow determines the maximum demand at the site.

6.5.3.5 Premise type

The premise type often dictates the type of connection. For example, highly frequented buildings such as shopping centres and hospitals will require an underground electricity supply.

Industries such as quarries, mines, farms are more suited to overhead electricity supply.

For example, when making a choice of substation type with environmental concerns;

- a pole type substation may not be acceptable at a cement plant. The build-up of dust, fly ash etc. on insulators may lead to a disproportionately high level of maintenance in future years. In such a case it may be more cost effective to adopt an alternative design initially - one that will not require a high level of maintenance in the future. e.g., an indoor/chamber substation
- similar situations can occur in marine environments where salt spray can cause corrosion problems, quarries where flying rocks from blasting could cause insulator damage, chemical plants, and oil refineries where hazardous build-up of fumes may require the substation building to be pressurised. Each environment will need to be considered carefully to determine the most suitable type of substation for that location.

Whilst the adoption of an alternative or improved design of substation may solve most problems likely to be experienced from the environment, a more appropriate choice of location within the property may prove to be a more cost-effective solution to the problem. i.e., move the substation away from the immediate environment that is causing problems.

6.5.3.6 Substation siting in proximity to load and/or generation

Ideally the substation and main low voltage switchboard should be located as close as possible to the electrical centre of the load and/or generation to minimise the extent of low voltage cabling required as well as the voltage drop at the extremity of the load. Another advantage of locating the station at or near the centre of the load is that the number of additional low voltage switchboards and sub-mains is minimised.

Note: The siting of a padmount or ground/chamber substation near the load centre does not preclude the DNSP classifying the connection as an “Enhanced network Connection” in accordance with Section 5.4.

Refer to 6.5.3.8: Site access below for additional requirements impacting this consideration.

6.5.3.7 Substation siting in sensitive environment areas

The site should, if possible, be chosen so that the substation has minimal impact on the immediate environment. The installation of transformers near environmentally sensitive areas should be avoided wherever practicable.

Transformers (excluding dry type transformers) typically contain oil, and such sites must comply with current environmental laws. This will require a substation containing an oil filled transformer/s to provide containment against egress or ingress of contaminants. This includes the sealing of conduit terminations.

An example of a transformer located in a sensitive environmental area would be one where the transformer is located on the top of a creek bank, up slope from the water flow path and in a position where a motor vehicle could collide with it causing tank rupture.

6.5.3.8 Site access

Each DNSP needs to be able to install, operate, maintain, and repair all of their equipment on the premises.

Installation consideration includes cable routes (bending radii), transformer and switchgear handling etc.

Operation, maintenance, and repair/replacement work requires 24/7 access to the premises.

This includes access to the site for DNSP personnel and equipment 24 hours a day in such a way that there is no need to enter the customers' secure areas.

For landlocked substations located beyond the property boundary or within a Customer’s building a suitable means of secure access shall be maintained by the Customer in the form of series padlocks / dual barrel door locks / key exchange box.

If fencing is installed around the site, gate access to the rear of the substation may be required. Sites must be accessible when there is an electrical outage (i.e., no electric gates to restrict access to DNSP equipment).

Vehicle and pedestrian access routes must be included on easements associated with the substation and DNSP equipment.

The DNSP will not accept responsibility for ownership of the future maintenance of the gates. The gates are required either by the local council or by the developer and therefore the council or the CTS Body Corporate accepts ownership and maintenance responsibility for the gates.

6.5.3.9 Cable routes on the premises

The substation site should be selected such that the route of the incoming and outgoing HV feeders and any associated LV feeders are not compromised by excessive directional changes or future site developments. If cable pulling tensions are excessive, a concrete pulling pit on the directional change must be installed.

6.5.3.10 Future developments

Development plans by the customer should be considered for optimal placement of the substation initially as well as any future cable routes and easement requirements.

6.5.3.11 Flood levels

The substation site level shall comply with the most stringent of the inundation requirements.

Where indirect inundation is possible due to seepage or localised storm run-off, drainage pits complete with automatic stop/start sump pumps are to be provided within the substation, with a generator connection point at ground level.

Refer to the relevant DNSP’s design and construction manuals for additional information.

6.5.3.12 Clearance from other services

No other services such as water pipes, storm water pipes, sewerage pipes etc. are permitted within the substation boundary and earthing systems. The site should be chosen so that it is clear of all such services. Clearance requirements include both horizontal and vertical clearances.

Refer to the relevant DNSP’s design and construction manuals for additional information.

6.5.3.13 Third party use of conduits supplied for DNSP use

Each DNSP reserves the right to allow third parties to access and use any conduits provided for the DNSP’s requirements. Such use is usually restricted to communications cables.

6.6 Standard clearances

For overhead networks, Clearance to Ground (CTG), Clearance to Structure (CTS) and inter-circuit clearances shall be maintained to Energex and Ergon Energy standards. If no documented Energex or Ergon standard on clearance exists for a particular scenario, the Electricity Safety regulation 2013 clearances shall be applied and maintained. Refer to the relevant DNSP for guidance. Any construction work by a developer or builder must be outside of the standard clearance distances, both during and after construction.

Any existing clearance issues are to be brought to Energex or Ergon Energy’s attention prior to commencement of the detailed design of the project.

Any queries should be directed to the relevant DNSP contact shown in Table 1.

6.7 Vegetation clearing

It is the developer’s responsibility to obtain any required approvals for vegetation works such as tree trimming and to arrange for the required works to be completed so that Energex or Ergon Energy will be able to erect the proposed overhead line or service line (as per the consultant’s proposed method of supply) when the future customer requests connection.

Energex or Ergon Energy do not undertake vegetation works for Developer Design and Construct subdivision projects. The developer is responsible for organising all required approvals and completing all vegetation works prior to receiving the Certificate of Supply.

For HV distribution networks, overhead lines remain as the preference in rural and remote areas. However, in more densely populated areas and sensitive vegetation areas, insulated or covered conductors may be utilised to avoid EMF exposure, minimise vegetation clearing, and minimise the visual impact.

Additionally, it is both Energex and Ergon Energy's strong preference to have overhead lines located in the road reserve.

However, where the cost of clearing on the road reserve is substantial or may cause issues with the local community and/or council, then Energex or Ergon Energy will give consideration to installing the new line inside the property boundary, depending on the property owner's approval and the DNSP's ability to install the assets and then maintain the assets into the future.

Strict conditions apply to overhead lines on private property, and liaison must occur with the relevant DNSP as early as practicable in the design phase of a project.

6.8 Liaison with other authorities

The design consultant is responsible for ensuring third parties utilising Energex or Ergon Energy assets are advised during the consultant's planning phase of the project.

Any queries should be directed to the relevant DNSP contact shown in Table 1 in conjunction with EQL's Facility Access Team.

Clearances between the DNSP assets and third-party assets installed within private property or in road reserve along the development frontage are the responsibility of the design consultant. The relocation of these assets to facilitate the installation of DNSP assets to supply the customer are the responsibility of the Customer.

Should alterations to their assets be identified as part of the project, the third party should be advised as soon as possible. e.g., Telstra, NBN, unmetered supply consumer's mains, 5G micro cells, etc.

6.9 Low Voltage (LV) servicing

For full details on low voltage servicing, refer to the Queensland Electricity Connection Manual. (QECM).

6.9.1 Low Voltage services property crossings

Energex or Ergon Energy will not approve service line property crossings where the purpose of the crossing is to supply one or more of the lots within a subdivision.

Supplying established lots via an overhead service through or crossing an adjacent property shall be at the sole discretion of the DNSP where there is a clear network or maintenance benefit. Mid span services, service crossings or flying fox services will not be considered for the sole purpose of avoiding a property pole installation on a greenfield connection.

All LV servicing must comply with the QECM.

7 Technical requirements

7.1 General network configuration

7.1.1 The High Voltage (HV) network

The Energex distribution system comprises overhead and underground 11kV feeders throughout South-East Queensland. These 11kV feeders supply both urban and rural areas with the majority being 3 phase feeders.

The Ergon Energy distribution system comprises overhead and underground 11kV, 22kV and in some instances, 33kV feeders throughout all other areas of Queensland. In urban areas, the majority of these feeders are 3 phase feeders. In urban areas, feeders have more inter-connections than rural areas. In many rural areas, feeders are radial, without any significant inter-connection with other feeders. There are also large remote areas of the State supplied by 19.1kV and 12.7kV SWER systems.

On the HV network, urban feeders are typically rated to:

- 11kV 6MVA and loaded to 4.5MVA representing a utilization factor of 75%
- 22kV 12MVA and loaded to 9MVA representing a utilization factor of 75%
- 33kV 18MVA (loading being location specific).

Adopting a utilization factor of 75% provides each DNSP with the flexibility to meet its reliability requirements without additional investment in the respective network.

In CBD, CBD Fringe and CBD Fringe equivalent areas where 3 feeder mesh networks are incorporated, the feeder utilization factor is 67%.

On rural feeders, the feeder utilization factor is 80%.

The recommended switch placement for urban and shorter rural feeders is one switch for approximately every 650kVA of installed transformer capacity. (Based on the nameplate rating).

7.1.2 The Low Voltage (LV) network

Distribution transformers are connected to the 11kV, 22kV and 33kV feeders and reduce the voltage to 400/230V, on the LV network. The 400/230V is then fed from the distribution transformer to individual customers. The LV network is typically a 4-wire system, comprising 3 phases and a neutral.

A Low Voltage (LV) circuit is any electrical circuit usually emanating from a distribution substation that delivers power to customers at a nominal 400/230V. The low voltage circuit may be dedicated to supply one customer or to provide supply to a number of customers that are distributed along the low voltage circuit. In URD subdivisions, customers are distributed along the LV circuit.

Distribution substations and low voltage networks form the final physical link in the electricity supply network. They typically have no real-time voltage management capability, with fixed tapping transformers and voltage drop (or voltage rise) in the distribution network determined by the conductor impedance, circuit load and circuit generation.

Despite the relative technical simplicity of this part of the network, it must be engineered carefully to ensure that voltage and power quality remain within statutory limits.

The LV network design is constrained by:

- Regulated voltage limits that must be maintained at the customers terminals
- The range of standard conductor sizes.

This makes the primary consideration when planning an LV distribution network is to ensure that adequate voltage levels are maintained for all customers along an LV circuit at all times throughout the life of the LV network. In order to achieve this, accurate voltage drop, and voltage rise (with solar PV) calculations should be considered at the planning stage, and must be carried out at the design stage, on the LV circuit.

Both Energex and Ergon Energy plan their LV networks to avoid costly augmentation of underground networks, including LV networks. This requires the planning of these networks or take into consideration expansion, demand, and generation growth at the time of initial design.

While the existing LV network may consist of wholly overhead, wholly underground circuits, or a mix of both, LV circuits in new URD subdivisions are typically underground. Where a developer installs new underground network where there is existing overhead network, they are required to relocate the overhead network to underground for the particular voltage they are installing. Where the LGA requires undergrounding of the existing overhead, the developer is required to underground all the overhead mains along the frontage per the LGA Decision Notice. In all instances, the development must be in compliance with local government planning requirements.

7.2 Connection control

Refer to the Standard for Major Customer Connections for details on connection control.

7.3 Dynamic connections

Each DNSP has enabled dynamic Connection capability for LV Connections. This offers Customers a real time, variable active power import / export limit from the DNSP with capacity limits forecasted ahead.

Refer to STNW3511, Dynamic Standard for LV EG Connections for additional information.

7.4 Network connection and isolation

Refer to the Standard for Major Customer Connections for details on network connection and isolation.

7.5 Operating voltages on the Low Voltage network

Each DNSP is required to maintain voltage operating envelopes at the Customers connection point as shown in Table 3.

Table 3: Low Voltage nominal voltage range

Nominal voltage	Maximum allowable variance
<1000V (230V Phase to Neutral 400V Phase to Phase (3 phase) 460V Phase to Phase (2 Phase)	Nominal voltage ±10%

And more specifically shown as voltage in Table 4.

Table 4: Voltage supply requirements - Low Voltage Customers

System	Highest supply voltage (V)	Nominal voltage (V)	Preferred voltage range (V)	Lowest supply voltage (V)
LV three phase four-wire or three-wire	253/440	230/400	225 – 244 390 – 424	207 360
LV single phase two-wire systems	253	230	225 – 244	207

While the above voltage ranges are utilized by both Energex and Ergon Energy for the day-to-day operation of their respective networks, both DNSP's plan and design their respective networks (where practicable), to operate in the preferred operation range of 225V – 244V. Refer section 7.6.

7.6 Low Voltage levels when planning and designing the Low Voltage network

The *Queensland Electricity Regulation 2006* refers to AS60038 with regard to voltage levels. AS60038 defines voltage requirements for steady state conditions, which are, for LV customers, 230V ± 10%, with a preferred range 225V to 244V.

Energex and Ergon Energy currently and continue to, plan and design their distribution networks to operate within the preferred range, to the extent that it is reasonably practicable. Developers and consultants are required to do the same.

Energex and Ergon Energy use voltage drop calculations and voltage rise calculations to determine the voltage when planning and designing new LV networks or augmenting existing LV networks.

7.6.1 Explaining the voltage interaction between the HV and LV networks

The intention of voltage management is to ensure that Customers' supply voltages are within statutory limits in all anticipated network configurations; (peak load, low load, reverse power flows).

Targeted voltage levels on distribution feeders are set at the 11kV or 22kV bus of the relevant zone substation using either Line Drop Compensation (LDC) with a fixed voltage reference or Automatic Voltage Regulator (AVR) setpoints. Where voltage regulators are connected downstream of the zone substation, they may also have voltage setpoints with LDC or a flat setpoint.

Setpoints on distribution feeders typically vary with the type of feeder, being urban, rural, long rural or SWER.

With the significant increase in power electronics interfaced loads and inverter based embedded generation, the Energex and Ergon Energy networks are experiencing a shift from lagging power factor towards a unity power factor. (In some residential areas, there is now a capacitive or leading power factor). Due to the change in power factor, combined with voltage rise due to increasing levels of embedded generation, it is generally recommended that across the Energex and Ergon Energy networks that distribution transformers have the tap setting at 2.5% buck.

This results in less available voltage drop for some distribution network configurations, and particularly for rural feeders.

The maximum allowable voltage drop on the LV network (by feeder type) is listed in sub-section 7.6.2 below and the maximum voltage rise on the LV network (by feeder type) is listed in sub-section 7.6.3.

Note: The allowable voltage drop on some feeder types has been reduced from historical levels.

7.6.2 Allowable Voltage drops on Low Voltage networks

Table 5: Maximum LV drop by feeder type

Distribution feeder type	Revised maximum LV drop	Description
Urban	6.0%	5% LV mains 1% service
Short Rural[1]	3.0%	2% mains 1% service
Long Rural	1.6%	Mains and service. Minimum mains
SWER	1.6%	Mains and service Minimum mains

Note 1: Revised down from 6.0% to 3.0% to ensure maximum voltage levels at low load and at times of reverse power flow are not exceeded.

Note 2: The DNSP may revise the feeder classification at the concept enquiry stage of a subdivision development as per section 11 of this manual for voltage drop calculations only. A reclassification request must be submitted for each stage of the development.

To assist with the determination of voltage drop, zone substations for both Energex and Ergon Energy are listed by location classification in Appendix F, (Energex) and Appendix G (Ergon Energy) respectively. The HV feeder categories connected to each ZSS are also listed by quantity.

A visual representation of the location of the Zone Substations can be found from the DAPR maps for each respective DNSP.

DAPR maps information can be found on the following links:

- Energex DAPR
- Ergon Energy DAPR

7.6.3 Voltage rise on Low Voltage networks

With the proliferation of roof top solar, summated Micro-Embedded Generator Unit (MEGU) export is now having a significant impact on LV networks, with many circuits experiencing reverse power flows, especially at times of high solar penetration and low load.

Similar to the consideration for voltage drop, voltage rise must now be considered. Voltage rise should be limited to the levels shown in Table 6 below.

Table 6: Acceptable voltage rise levels on LV and HV networks

	Maximum voltage rise on LV	Maximum voltage rise on HV all cases
Energex network		
Brisbane CBD	1%	0.5%
Energex Urban Feeders	2%	2%
Energex Rural Feeders	2%	2%
SWER	2%	2%
Ergon Energy network		
Ergon Energy Urban feeders	2%	2%
Ergon Energy Rural feeders	2%	2%
Ergon Energy SWER	2%	2%

Note: A maximum of 0.5% voltage rise over existing voltage levels shall be allowed anywhere on the HV distribution network due to the export of a single generating system.

7.7 Fault levels on the High Voltage (HV) Network

The Customer shall be responsible for ensuring the fault level withstand capability of their plant is sufficient and maintained. It is recommended to specify plant to equal or greater fault withstand than the fault ratings in Table 7 at the Connection Point and an appropriate scaled level within the Premises, depending on impedances and applicable fault current sources.

In the context of Table 7;

- primary plant is plant that is directly associated with a bulk supply or zone substation of DNSP
- secondary plant is plant on the Distribution System downstream of a bulk supply or zone substation circuit breaker.

In some circumstances, higher withstand will be required, which will be advised as part of a technical study should the need for one be identified or specified.

Table 7: Fault withstand capability levels for equipment related to system voltage

Voltage	Primary plant	Secondary plant
33 kV	31.5kA / 3s	25kA / 3s
22 kV	25kA / 3s	20kA / 3s
11 kV	25kA / 3s	20kA / 3s

An infinite HV bus methodology with the voltage at 1.0 p.u. must be applied when calculating fault levels.

7.8 Fault Levels on the Low Voltage (LV) network

The maximum single phase and three-phase fault currents that can be expected on the Low Voltage (LV) terminals of a distribution transformer are set out in Table 8 and Table 9 respectively, below.

Table 8: Maximum single-phase prospective fault currents on LV terminals of a distribution transformer

Nameplate Rating (kVA)	Transformer Type	Transformer Nominal Impedance (%)	Maximum LV Phase - Ground Fault Current (kA)
10	Pole Mount	3.30%	1.35
25	Pole Mount	3.30%	3.37
50	Pole Mount	3.30%	6.73

Table 9: Maximum three-phase prospective fault currents on LV terminals of a distribution transformer

Nameplate Rating (kVA)	Transformer Type	Transformer Nominal Impedance (%)	Maximum LV Three-Phase Fault Current (kA)
25	Pole Mount	3.30%	1.1
63	Pole Mount	4.00%	2.3
100	Pole Mount	4.00%	3.7
200	Pole Mount	4.00%	7.4
315	Pole Mount and Padmount	4.00%	11.7
500	Pole Mount and Padmount	4.00%	18.5
750	Padmount	5.00%	22.2
1000	Padmount	5.00%	29.6
1500	Padmount	6.25%	35.6

The fault currents shown correspond to a worst-case transformer impedance of 90% of nominal, as transformer standards allow for a ± 10% tolerance on nominal impedance.

These values also assume an infinite HV bus is applied at the transformer at 1.0p.u. voltage.

Site specific fault currents will be provided in a planning report for multiple transformer installations.

Customers are responsible for ensuring the fault level withstand capability of their plant is sufficient and maintained. It is recommended to specify plant equal to, or greater than the fault withstand levels in Table 8 and Table 9. Refer also sub-section 13.1.1: Distribution substation sizing and provision for LV ties.

Note: Embedded generators connecting to the LV network must comply with the fault level requirements listed in the relevant DNSP connections standard.

The QECM also provides information on fault levels.

For inquiries regarding fault levels on the Energex network, refer:

- Energex fault levels

For inquiries regarding fault levels on the Ergon Energy network, refer;

- Ergon Energy fault levels.

7.9 Earthing

Standard Earthing of DNSP substation sites are detailed in:

- Energex Standard for Distribution Earthing

and supported by the relevant Energex and Ergon Energy Construction manuals and the QECM.

Special locations and Frequented locations as defined in the Energex Distribution Earthing Manual, or the Ergon Energy Standard for Substation Earthing Devices may not be suitable for all standard earthing designs. These locations shall be assessed by the relevant DNSP, and the design consultant advised where a non-standard earthing study or design may be required. Earthing designs shall follow a risk-based approach as per ENA Power System Earthing Guide (EG-0) Part 1: Management Principles (ENA DOC 025-2022) to assess and suitably control risks associated with prospective step and touch voltages as required by the ESCOP Works 2020 sections 3.5.1 and 3.5.2.

Non-standard earthing designs shall comply with the requirements set out in AS/NZS 7000, AS 2067 and AS/NZS 3000 as relevant. Earthing designs may also need to comply with other relevant standards including AS/NZS 3835.1, AS/NZS 3835.2 and AS/NZS 4853.

The applicable requirements in respect of the earthing of the Customer's installation and the earthing of the distribution system must be documented in the Connection Agreement, including whether these must be separated (i.e., isolated) from one another or can be interconnected together. (i.e., bonded). Consideration should be made for bonding the Customer's installation and the distribution system where secondary systems cross ownership boundaries, or where the two earthing systems cannot be effectively isolated from one another.

7.10 Power factor

The permissible power factor range at the Connection Point for when the Premises is taking electricity from the Distribution System at the Connection Point, such that the *load* is equal to or greater than 30% of the authorised demand for importing electricity from the Distribution Network shall be in accordance with Table 10 below. This is consistent with the automatic access standard set out in Table S5.3.1 of the *NER* and the requirements in the *Electricity Regulations 2006 (Qld).*

Table 10: Power factor applications

Supply voltage (nominal)	Power factor range
1kV < 50kV	0.90 lagging to 0.9 leading
< 1kV	> 0.8 lagging to unity (but not leading) unless agreed to in writing by the DNSP

When the Premises are taking electricity from the Distribution Network at the Connection Point such that the load is less than 30% of the authorised demand for importing electricity, the DNSP at its discretion may accept a power factor outside the range stipulated in Table 10, provided this does not cause the system standards to be violated, or for any other customers to be adversely impacted.

In some cases, site-specific requirements may necessitate a negotiated requirement, such as significant inverter-based resources to ensure suitable voltage regulation, or connections in weak areas.

Sites that incorporate loads and Generating Units operating together shall require a negotiated outcome on the power factor performance.

A Customer who installs shunt capacitors to comply with power factor requirements must comply with the DNSP's requirements to ensure that the design does not severely attenuate audio frequency signals used for load control or operations, or adversely impact on harmonic voltage levels at the Connection Point.

Customers are required to monitor the Connection Point to maintain their continual compliance with the power quality limits set out in the Connection Agreement

7.11 Power quality

7.11.1 Introduction

Power quality is broadly defined in terms of the degree to which the electricity system is free from major distortions and fluctuations in supply voltage and frequency, and free from interruptions to supply.

The electricity distribution network is a shared community resource and power quality on this network is an important issue for a wide range of customers, as well as for Energex and Ergon Energy. This importance continues to grow, due largely to advances in equipment technology, and the accompanying increase in the sensitivity of this equipment to disturbances present on the power system.

Power quality is an issue which must be approached in a cooperative manner between customers, equipment suppliers, manufacturers, and utilities to manage it, as it is not possible to guarantee a disturbance-free supply.

Studies actually show that the majority of disturbances originate in the customer's own installation due to the normal operational effect of their equipment on the voltage waveform. This can not only expose sensitive equipment on the customers' site to disturbances but can also cause unacceptable levels of interference to other adjacent customers on the shared electricity network.

It is therefore necessary to set out connection requirements on individual customer's Connection Agreements to ensure an acceptable power quality is maintained for the benefit of all customers.

7.11.2 Obligation of Customers – non-interference with supply of electricity to other Customers

All power quality measurements, allocations and limits are with reference to the Connection Point.

The Customer is responsible for ensuring electrical equipment selection meets requirements for safety, reliability, power quality.

Customers shall design and install electrical installations to prevent any connected device or system interfering with supply of electricity to any other user of the distribution network. A Customer shall consider the impact of particular loads such as transformer arc welding machines, motor starting, fluorescent lighting as well as EG system connections.

All Customers shall comply with:

- The performance standards set out in their Connection Agreement

- The requirements of AS/NZS 61000 series standards "Electromagnetic Compatibility (EMC)"
- Applicable energy and safety laws that are associated with power quality parameters.

This may include, but not be limited to voltage fluctuation, voltage unbalance, harmonic emission limits or power factor requirements to assist the DNSP in maintaining network capability, power system security, quality, and reliability of supply.

In situations where the DNSP may have connected the equipment or device causing the interference, the Customer is not exempt from this clause.

Where requested, the Customer shall provide the DNSP with an RPEQ certified power quality report presenting the power quality limits and the recorded results in accordance with the requirements set out in the Connection Agreement, in order to demonstrate compliance with the performance standards referred to in the Connection Agreement. The DNSP may at any time during the term of the Connection Agreement require the Customer to retest the performance requirements and provide evidence that the Customer's connection is still compliant at the Connection Point.

Customers are required to monitor the Connection Point to maintain their continual compliance with the power quality limits set out in the Connection Agreement

Note: Customers with an electrical installation or equipment which may be sensitive to voltage variation, transients, loss of one or more phases of supply or due to leakage current are advised to install protective equipment to limit possible damage.

7.11.3 Limitations on starting currents of AC motors

7.11.3.1 General requirements

The requirements for motor starts are:

a) The motor rating in kW is the continuous rating of the largest motor in the installation

b) Motor installations and any associated starting devices shall be designed and installed so that they can be operated to comply with Table 11 below

c) A Customer requires approval from the DNSP to install motors in SWER areas of supply. (Note: Approval required prior to installation)

d) No limitation may be placed on the starting current of any motor that is not frequently started and the rated output does not exceed 10% of the total motor load connected for a Customer to the one DNSP service point. (i.e., This is an exception)

e) Motors should not be started simultaneously, and the starting current of the motors should be limited to 2 to 3 times full rated current by fitting with an appropriate starter.

Table 11: Motor size ratings and allowable start currents

Phase	Voltage (V)	Motor size (kW)	Allowable starting current (A)
single-phase	230V	All sizes	45A
split phase	460V	≤ 7.5kW	I = (17.5 x motor rating in kW) A
		≤ 1.5kW	26A
		> 1.5kW to ≤ 3.5kW	I = (17.5 x motor rating in kW) A

Phase	Voltage (V)	Motor size (kW)	Allowable starting current (A)
three-phase	400V	> 3.5kW to ≤ 10kW	= (53 + 3.3 x motor rating in kW) A
		> 10kW	Contact DNSP for limits

7.11.3.2 Fall in Voltage

The starting current shall not cause a fall in voltage of more than 5% of the nominal voltage at the DNSP service point for more than 0.02 seconds when connected to a typical 400/230V, three-phase, 50Hz supply system which for this purpose shall be considered to have the following impedance:

$$Z = 0.2 + j0.2 \text{ Ohms (phase - neutral).}$$

$$Z = 0.1 + j0.1 \text{ ohms (line impedance per phase).}$$

Additional details may be found in the QECM.

7.11.3.3 Test methods

Test methods for determining falls in voltage and starting currents can be found in the QECM.

7.11.3.4 Special provisions

For both three-phase and single-phase motors, where it is necessary for a DNSP to prevent interference with supply to other Customers, the DNSP may require the Customer to:

i. Require maximum starting currents lower than those set out; or
ii. Limit the rating of any motor to be connected.

7.11.4 Equipment with fluctuating loads (voltage fluctuation and flicker)

Voltage fluctuations are random or continuous variations of the Root-Mean-Square (RMS) voltage. Voltage fluctuations may be caused by rapid current changes by customer load switching and equipment starting.

This includes (but is not limited to):

- Motor starts (see 7.11.3 above)
- Arc furnaces
- Generators
- Welding Equipment.

The DNSP reserves the right to specify the conditions under which an electricity supply will be given for equipment having rapidly fluctuating loads such as welding machines, (other than welding machines complying with AS 60974.6), or previous standards superseded by this standard, and marked "Limited Input", X-ray equipment and furnaces.

No work should be carried out by a customer to connect equipment with fluctuating load until advice has been received on the terms on which supply will be given as per clause 7.11.1.

7.11.5 Voltage fluctuation and flicker

Voltage fluctuations are random or continuous variations of the RMS voltage. They are generally caused by customer load switching, equipment starting, maloperation of generation or may be caused by network switching. Flicker is the impression of fluctuating luminance resulting from voltage fluctuations on the supply systems and is defined as follows:

- **Pst** - the short-term flicker severity index where a value is obtained for each ten (10) minute period
- **Plt** - the long-term flicker severity index where a value is obtained for each two (2) hour period.

AS2279.4 and IEC 61000.3.7 are the two Australian Standards relevant to voltage flicker, with the NER still referencing AS2279.4 (refer Section 8.2 – derogation) as the relevant standard to be used for assessment of new and existing flicker producing loads in Queensland.

The planning levels for voltage flicker on the electricity supply system are shown in Table 12

Table 12: Planning Levels for Pst and Plt in LV and MV Power Systems

	Compatibility Levels	
	LV	MV
Pst	1.0	1.0
Plt	0.8	0.8

Note: MV is voltage > 1kV and < 35kV

The minimum Flicker emission limits for LV connections are as per Table 13. When a Flicker emission limit is calculated, the values must be greater than the values in Table 13 or the minimum value is the allocation.

Table 13: Minimum emission limits at LV

E_{Psti}	E_{Plti}
0.30	0.25

7.11.6 Harmonic distortion

Harmonic distortion of the voltage waveform is the result of non-linear currents caused by non-linear *loads* and Generating Systems connected to the Distribution Network. Common sources of harmonic distortion include switched mode power supplies, inverter-based technologies, arc furnaces and motors with variable speed drives or variable frequency drives.

Energex and Ergon Energy have an obligation to maintain network harmonic voltage distortion levels within permissible limits to ensure that the compounded side effects of harmonics do not become problematic to the network and the customers alike. To ensure acceptable harmonic voltage distortion levels, harmonic assessments are likely to be undertaken as part of the technical assessment associated with the connection of distorting installations to the distribution system.

Customers shall meet the harmonic emission limits specified for their *electrical installation,* even under resonant conditions due to any Customer capacitor bank.

The DNSP reserves the right to specify the conditions under which an electricity supply will be given for equipment which would cause excessive distortion to the wave form of the supply system voltage for electrical equipment including but not limited to rectifiers, frequency converters, load control devices using thyristors or saturable reactors.

Harmonic emission limits will be determined in accordance with Table 2 of IEEE 519 for Small Customers and Major Customers up to and including 1.5MVA connected at LV, and in accordance with AS/NZS 61000.3.6:2001 for all other Major Customer Connections.

In the event a Customer needs to install a harmonic filter to reduce harmonics to meet the allocated harmonic emission limits, filter costs, construction footprints and delivery timescales can be significant. Therefore, it is important that developers and consultants are aware of the harmonic emission compliance as required by relevant Australian Standards and the NER during the planning for the project. The Customer should become familiar with the assessment process, technical specification, possible interactions with the DNSP's Audio Frequency Load Control (AFLC) and any review of the filter design.

It should be noted that lack of timely consideration of power quality parameters like harmonics can delay connection or result in network or operational constraints if a filter is not available on time or a construction footprint has not been allowed for.

7.12 Ferroresonance

The phenomenon of ferroresonance is the occurrence of high voltages which may occur when a modest size capacitance is either in series or in parallel with nonlinear inductance, such as an iron cored transformer.

The common and increasing use of underground assets has resulted in a higher incidence of situations where single phase switching of the cable connecting the transformer could result in dangerous overvoltage due to ferroresonance.

Ferroresonance may be considered at the planning stage (when determining cable lengths and must be calculated at the design stage of a project.

Additional information can be found in Appendix D.

7.13 Audio Frequency Load Control (AFLC) explained

Customer installations must not interfere with the DNSP's AFLC system.

The ripple Audio Frequency Load Control (AFLC) system operates by the injection of a high frequency (167-1042 Hz) coded signal onto the high voltage network at Energex Zone Substations and Ergon Bulk Supply Points to send signals to customer premises. Through AFLC, loads at the customers' premises are controlled (turned off and on, or their consumption reduced).

The current Energex and Ergon AFLC configuration has two important attributes:

- providing a signal of when appliances can consume electricity
- staggering these signals, so that load is turned off and on in a staged manner and doesn't create new peaks. The latter is achieved by channels. When an AFLC receiver is installed in a home it is randomly allocated to a channel to achieve an even distribution of connected loads across channels.

This AFLC system has been used to control hot water load since 1956 and more recently to control pool pumps and air-conditioners. The load control system is integrated with the distribution management system and can deliver scheduled and ad hoc control signals on the Energex network and threshold control on the Ergon network to manage demand. Configurations are being implemented across Energex and Ergon Energy to not only reduce peak demand but to shift hot water load to the middle of the day and soak up excess solar generation in response to minimum demand. Any reduction in peak demand benefits all customers.

8 Commercial / industrial Customers

8.1 Connection arrangements

The provision of electricity supply to commercial/industrial premises is dependent on

- The maximum demand of the load and/or generation required
- The voltage at which the customer is connecting
- The nature (characteristics) of the customers connection
- The topology of the electricity network in the vicinity of the customers connection
- Any additional requirements identified by the DNSP, including future requirements.

As previously mentioned, this manual concerns itself with customer connections at low voltage.

For commercial/industrial customers requiring ≤ 100A per phase connection, these are dealt with through the connection assessment process.

All basic and negotiated connections must also comply with the requirements of the QECM.

8.1.1 A Negotiated connection from the Overhead LV network to individual Customers

Where a connection to the overhead network is available, and the DNSP agrees to an overhead connection, there are two primary connection sizes to be considered for a negotiated connection to the overhead LV network:

1. A connection with an LV service > 100A/phase and ≤ 200A/phase supplied from the existing LV network via an overhead conductor
2. A connection > 200A/phase are typically supplied by the DNSP with an underground service line. See section 8.1.2.

Note: The DNSP may agree to an overhead service line ≤ 315A/phase (by paralleling two conductors). The DNSP is the sole determinant as to the suitability of increasing an overhead service capacity beyond 200A/phase.

8.1.2 A Negotiated connection from the underground LV network to individual Customers

Where the preferred or only connection arrangement is underground, there are five primary connection sizes to be considered for a negotiated connection to the LV network:

1. A connection with an LV service > 100A/phase and ≤ 160A/phase supplied from the existing LV network via a pillar
2. A connection of ≤ 315A supplied via a supapillar
3. A connection with an LV service ≤ 400A/phase supplied from an LV distribution cabinet
4. A connection supplied from the LV switchgear, busbar, or terminals of a distribution transformer
5. Other standard underground pillar types with ratings specified in the Underground Construction Manual.

Should the existing network at the premise location have capacity, and no growth is expected in the electrical requirements of the premises, an LV circuit connection may be available. However, the DNSP may require allowance to be made for a future substation on the premises to allow for unforeseen load growth, either on the premises or within the surrounding environment.

With the electrification of the transport industry, and the increasing requirement for EV charging, no growth scenarios are deemed to be highly unlikely.

In all these situations, the C&I pillar, the distribution cabinet, or the distribution substation shall share a common boundary with the property being supplied. Where a common boundary is not shared, the DNSP's calls this "supply beyond the property boundary." See section 8.6 for additional information on "supply beyond the property boundary."

Where the C&I pillar, the distribution cabinet or the distribution substation are within the freehold property boundary, the DNSP assets shall be in a registered easement.

8.1.3 A Negotiated connection requiring an on-site substation

Commercial/industrial customers requiring, or likely to require a supply of 100kVA or more (or generation capacity of 100kVA or more) may be required to have a substation on their premises. Where the supply or generation requirement is for > 400A/phase, then this requirement becomes highly likely.

As previously mentioned, the considerations for a substation on the premises are listed in;

- Section 5.5: Works on Customer Premises
- Section 6.4: Obligation of Customers and
- Section 6.5: Substation Types of Customer Premises.

Refer to Appendix A of STNW3522, The Standard for Major Customer Connections, and in particular, the low voltage connection arrangements.

8.2 Provision of additional service points

Additional points of supply must comply with the requirement in the QECM and be agreed by the relevant DNSP. The DNSP is the sole determinant of the suitability of an additional supply point.

Designers and connection officers must consult with the Distribution Planning to determine any network requirements for a HV ring feed in to, and out of the premises where the connection size is ≥ 500kVA. The consideration for establishing a ring feed is most often determined by (but not limited to) HV sectionalising, network reliability and operational flexibility.

Note: Where Distribution Planning determine that a HV Ring feeds in to and out of premises is the minimum technically appropriate outcome, then the ring is not considered an additional supply point.

See sub-section 8.3 below for additional information.

8.3 Least cost, minimum technically feasible connection arrangements

The term "least cost, technically appropriate" is a principle used within both Energex and Ergon Energy to guide decision-making processes. It refers to the approach of selecting the most cost-effective solution that meets the required network technical specifications and project objectives.

Energex or Ergon Energy assess each connection based on "least cost, technically appropriate" consideration. While there are a large range of considerations and inputs that go into making such assessments, some (but not all) of the considerations are:

- State and Federal Government legislation and regulations
- Planning authorities' requirements. (e.g., local municipalities)
- DNSP planning, design and construction standards

- Local network topology and technical characteristics
- Customer requirements, both current and projected
- Future network requirements
- The impact of emerging and disruptive technologies
- Lowest life cycle costs.

Electricity infrastructure has a practical life of typically 40 to 70 years depending on the asset class. Least cost consideration includes the total life cycle costs of any new assets installed into the DNSP's network.

Sound engineering judgement is applied to the above considerations to provide the minimum technically feasible, and preferred outcome.

It should be noted that:

- Government legislation, regulation and planning requirements must be met
- The requirements of the NER must be met, and
- DNSP standards are required to be adhered to.

The DNSP is the sole determinant of the most appropriate least cost, minimum technically feasible connection arrangement.

Where a Customer or the DNSP requests connection or assets above the least cost, minimum technically feasible connection arrangement, the party requesting or benefiting from these requirements will fund them on a "difference in cost" basis. Note this principle is built into the SCS cost assessment tools and Connection Policy for ACS "Enhanced Connection Services".

8.4 Determining load and generator requirements

8.4.1 Determining load requirements

Estimation of the maximum demand of a large installation is an important part of the distribution planning and design process. To ensure effective utilization of transformers, the distribution planner/designer must be decisive in optimising the transformer assets used to supply a large installation. However, it is also necessary to consider the future requirements of the site and surrounds to avoid unnecessary augmentation/replacement of the transformers in the short and medium terms.

The Customer needs to determine an appropriate method for the calculation of load.

There are a number of ways for commercial/industrial customers to determine their load requirements. Refer to Appendix A for additional information.

8.4.1.1 Electric Vehicle (EV) charging (load consideration)

For onsite charging of electric vehicles, there are two primary considerations:

- Slow Charging
- Fast Charging

The impact of EV charging on ADMD is included in section 18.

For fast charging, developers should add the maximum charge rate of each fast-charging station to the maximum demand.

For fast charging stations connections ≥ 50kVA, Distribution Planning must be consulted.

Where a charge management system is installed as part of multiple EV charging installations the design consultant shall provide the DNSP with the aggregate maximum demand of all connected EV charges and the 24/7 curtailed demand profile of the management system. It is the Customer's responsibility to service and maintain their EV charging and management systems in coordination with total site load within the authorised demand of their connection point.

Note: Connection asset transformer loadings for charge management systems that would theoretically allow for a near unity load factor shall be assessed as Commercial as per Table 14: Distribution transformers - assigned loading limit factor for well-ventilated situations

Superfast charging has not been considered for this type of environment at this time. Any consideration for superfast charging must be carried out by Distribution Planning.

8.4.1.2 Electric Vehicle (EV) to grid connections (generation consideration)

Where an electric vehicle is capable of both charging as an electric vehicle, and operating the vehicle as an energy source and ESS that can supply an electrical installation connected to the Distribution Network, it shall be considered part of an EG connection and must meet the connection requirements for an EG.

Additional information can be found in the QECM.

8.4.2 Determining generation requirements

Generation export capacity affects the connection and is a negotiated capacity. The agreed limit with the DNSP is then the maximum export capacity and the value is included in the Connection Agreement.

From a practical perspective, the maximum export capacity is the summated inverter capacity (without consideration for any on-site load).

The larger of load or generation export capacity is considered the maximum demand of the premises, and the connection size is determined by this.

8.4.3 Load factor

Load Factor is the ratio which indicates the average level of usage for any period of time compared with the highest level of usage averaged over 30 minutes i.e., the maximum demand during that period. It may be estimated by:

$$Load\ Factor = \frac{kWh\ in\ period}{maximum\ demand\ (kW) x\ No. of\ hours\ in\ period}$$

Equation 1: Load factor

The higher the load factor, the more efficient the overall electrical usage is likely to be. One method to achieve this is to lower the peak demand. e.g., shifting some energy usage away from peak times.

8.5 Additional substation site and type considerations

In existing overhead electricity areas in urban areas, the Customer has the choice of a ground mounted substation or a padmount substation. Network arrangements must comply with HV switching parameters.

In existing underground electricity network areas, a padmount substation is preferred.

8.5.1 Distribution Transformer types and assigned loading limits

Energex and Ergon Energy use predominately oiled filled transformers. The assigned loading limit for distribution transformers varies according to the size, configuration, type, and their locality. Table 14 lists the assigned loading limit factors for these transformers. Values shown are in percentage per unit of the nameplate rating.

The assigned loading limit factors are for customer connections and are generally below the standard cyclic rating of the transformer to provide for future load growth without the need for near term augmentation.

Table 14: Distribution transformers - assigned loading limit factor for well-ventilated situations

Distribution transformer type	Assigned loading limit factor		
	Normal cyclic	**Emergency cyclic**	**Reverse power (Generation)**
Domestic outdoor all sizes	1.25	1.45	1.1
Industrial outdoor 200kVA to 1500kVA	1.0	1.2	1.0
Commercial outdoor all single sizes	1.15	1.3	1.1
Commercial indoor			
1 transformer 300kVA to 500kVA	1.0	1.25	1.0
1 transformer 750kVA to 1500kVA	1.0	1.25	1.0
Substation Configurations			
Commercial outdoor Dual 1000kVA padmount	0.8	0.8	0.8
Commercial indoor			
2 transformers up to 1500kVA each	1.0	1.25	1.0
3 transformers up to 1000kVA each	1.0	1.2	1.0
3 transformers up to 1500kVA each	0.95	1.15	0.95
Dry type transformers all sizes	0.85	0.85	0.85
SWER Isolation transformers all sizes	1.25	1.45	1.1

Note 1: Assigned loading limit = nameplate rating x an assigned loading limit factor

Note 2: Where there is any concern raised by the relevant DNSP over ventilation, the assigned loading limit will be de-rated by a further 5%.

Note 3: Assigned loading limits are intentionally lower than plant rating factors to allow for load and/or generation growth without the need to augment over the planning horizon timelines.

Note 4: The emergency cyclic loading is listed to assist in the evaluation of the effectiveness of LV circuit ties.

8.5.1.1 Dry type transformers

Dry type transformers are required to be installed in major buildings (e.g., convention centres) and high-rise buildings. Dry type transformers are limited to 85% of their nameplate rating for load and generation purposes to allow for future growth.

8.5.2 Use of Ring Main Units (RMU’s)

It is standard practice to require RMU's in existing underground areas.

Ground mounted substation shall have provision for an RMU to be installed, including where one is not required at initial installation.

In these situations, RMU’s may be contained within their own enclosure, or included within the ground mounted substation enclosure.

HV tee-offs in underground areas via cable joints are not acceptable. Where a new substation/transformer is installed or upgraded on a HV feeder in the vicinity of an existing underground tee-off, RMUs should be installed to replace the cable joint where practical.

8.5.3 Grid Disconnection Device (GDD)

To enable rapid disconnection and minimise distribution system impact at the Connection Point, a Grid Disconnection Device (GDD) may be installed at or near the Connection Point.

A GDD consists of a HV Automatic Circuit Recloser (ACR) or a HV circuit breaker supported by a protection scheme for automatic operation.

For Customers with an LV Connection Point/s, the GDD would be installed at or on the distribution network side of the HV Network Coupling Point. Where a GDD is not required for a new Customer connection (e.g. on LV load Connections), the Customer should consider allowing provision for plant space for a GDD enablement in a future scenario of a Connection alteration. (i.e., future EG additions).

8.5.4 Customer LV switchboard interlocking requirements

Customers with multiple transformers are required to follow strict requirements in regard to paralleling and LV interlocking.

Refer to the QECM and the Standard for Major Customer Connections for the requirements.

8.5.5 Conversion to a HV connected customer

If there is any likelihood that the Customer will progress to a future HV connection, then an indoor/chamber substation with spatial provision for all future equipment (switchgear, protection devices, control equipment etc) is recommended as the preferred substation type.

8.6 Supply beyond the property boundary

Where a customer requests supply beyond the property boundary, they must:

- Have written permission from the relevant DNSP, and
- Have written permission from the relevant LGA or property owner, and

- Consumer's mains or private assets required to facilitate supply beyond the property boundary shall be protected by a Services and Access Easement, and
- Any other requirements under the QECM.

8.7 Brisbane CBD, Brisbane CBD Fringe areas, and CBD Fringe Equivalent areas

As mentioned in section 6.5.3.1: Geographic locations, substations on customer premises in these locations require an indoor/chamber substation suitable for housing relay operated (remotely operated) switchgear. From a size perspective, these substations have a larger footprint than other types of indoor/chamber substations. Specific requirements are (but not limited to):

- Sufficient space to house all the necessary equipment for remote operated switchgear
- Increased earthing requirements (greater fault withstand capability)
- Increased number of conduits
- Communications infrastructure

Refer Appendix B for a list of suburbs where this requirement prevails.

9 Geographic considerations

9.1 Brisbane CBD

In the Brisbane CBD area, all electrical cabling (HV and LV) is underground, with distribution substations being indoor or chamber substations, capable of housing the necessary equipment to support relay operated (remotely operated) switchgear.

All developer/consultant projects within the Brisbane CBD require a concept plan to be submitted to the relevant DNSP contact shown in Table 1 for approval.

Specific attention should be paid to (but is not limited to):

- The development/client site is within 1.5 kilometres radius of an existing or proposed zone substation.
- The requirement for a concrete cable pit and duct network.
- Limitations caused by a full concrete verge from kerb to property boundary
- Developments containing narrow footpaths, narrow laneways, or restricted width verge.
- Cable routes into, within, and out of the property
- The chamber substation location, including ventilation requirements
- The Customer connection will maintain, and where possible improve, the rating of the network in and around the connection point
- The customer connection will not effectively contribute to a rise in the fault level at the DNSP service point.

See also

- Sub-section 6.5: Requirements for substation on Customer Premises
- sub-section 6.5.2.4: Indoor / Chamber Substation (surface located)

Cables are installed in PVC ducts, or, in older installations are installed in fibre reinforced cement ducts. All new ducts for power cables to be 125mm diameter.

11kV networks are loop in/loop out. No HV tee-offs are allowed.

Legacy LV services to consumers are tee-jointed off the main LV cable and generally terminate on indoor CFS units located on the consumers' premises. The service tee-joints may be located in a nearby concrete pit or direct buried.

For legacy loads in excess of 300 A/phase supplied at LV, dedicated circuits shall be run from the LV switchboard of the distribution substation. These terminate directly on the main switch or incoming circuit breaker of the consumer's switchboard. In some cases, two cables will need to be paralleled to achieve the required current capacities.

New LV services with CBD areas or locations where street furniture is constrained by the LGA shall be supplied by a distribution cabinet or C&I pillar located within the Customer's property adjacent to the road reserve. The DNSP assets shall be suitably recessed within any building or structure to suite the LGA's development requirements and maintain all relevant access and signage required by the DNSP.

LV cable connections and tie capacity to a distribution board in CBD areas will be subject to the network capacity in the local area, and in accordance with the relevant DNSP's planning, design, and construction requirements.

Customers loads supplied by a distribution substation in the CBD area should be via multiple transformers to provide higher reliability of supply. Where a multiple transformer substation site cannot be accommodated due to site constraints, transformers in adjacent substations shall be uprated as required to supply suitable tie capacity to the single transformer substation. All LV connected substations in the CBD shall allow for a minimum of 2 x LV circuit tie capacity to the local area.

LV tie capacity to adjacent single transformer substations shall be made available by means of disconnect boxes within pits.

The rating of underground cables within highly urbanised areas is dependent on a number of factors, including (but not limited to):

- The whole of the cable route
- Cable type
- Depth of installation
- Type of soil/fill
- Trench configuration
- Duct configuration
- Proximity of other cables
- Proximity of other services

Consideration also needs to be given to fibre optic and pilot cables for communications and protection purposes. These are also installed in conduits.

Distribution Planning shall advise on cable ratings where cables are installed in ducts. This becomes a critical consideration in highly urbanised areas such as the CBD, CBD Fringe and CBD Fringe Equivalent areas.

9.1.1 Concrete cable pit and duct reticulation

A pit and duct system is utilised within highly urbanised areas, such as the Brisbane CBD, Fortitude Valley, South Brisbane, and commercial centres of the Gold Coast and Sunshine Coast. They may also be utilised in high prestige, and high security areas.

This system shall be used where:

- footpaths are sealed and carry significant pedestrian traffic (e.g.: shopping malls & busy commercial centres)
- pillars on footpaths are undesirable
- loads of up to 200A per phase are not able to be supplied from adjacent substation switchboards.

This type of installation facilitates easier access for future network augmentation, reduces re-excavation and reinstatement costs and reduces impacts on the local community during future works. This system also provides greater flexibility in network augmentation than the conduit system used for C&I subdivisions. Pits are of cast in-situ reinforced concrete construction and are generally located on corners of city blocks.

Civil works for CBD or highly urbanised locations may differ from those for URD or UID in a number of ways, such as:

- A larger number of conduits are installed in a duct bank. This will be determined by the DNSP at concept enquiry stage.
- C&I areas may require pit and duct system. This will be determined by the DNSP at concept enquiry stage.
- When there is a high probability that access to HV joints or conduits will be required, the pits shall be installed in accordance with the cable supply length, and if required an additional pit is to be installed for a joint bay to allow for future growth and joint spacing requirements.
- Conduits are 100mm diameter or 125mm diameter PVC (to integrate with old fibre reinforced cement conduits) for existing areas
- All new conduits installed within a pit and duct network area shall be 125mm diameter, except for the communications conduits which are 100mm diameter, and
- A larger number of cables in closer proximity
- Shared trenching is generally not used, although space in Energex ducts may be leased to external users. e.g., communications companies.

Conduits with duct banks should have sufficient horizontal and vertical separation to achieve the maximum cable rating possible. Where this is not possible, approval must be obtained from Distribution Planning.

Service pillars, Ring Main Units and substations shall not be installed over cable pits unless approved by the relevant DNSP contact shown in Table 1.

The installation and layout of cables and joints within the cable pit should be in accordance with the DNSP Underground Distribution Construction Manual.

The following criteria provide guidelines in order to justify the installation of a cable pit in a location where they are optional.

- there is a high probability that access to the joint or conduit end will be required within the next 3 years
- the surface is sealed with decorative concrete pavers or similar, and will be expensive and disruptive to pedestrian traffic to excavate, and
- HV cables are involved.

9.1.2 HV cables used in Brisbane CBD

Pit and duct networks in CBD, CBD Fringe and frequently augmented areas require HV cables and LV cables with armoured protection. This is considered the standard for concrete cable pit and duct systems.

Within underground pit and duct systems, HV cables shall be installed in conduits.

There will be no mixing of XLPE and PLY cables in new installations. This ensures that XLPE can be operated at maximum rating. Where the existing civil infrastructure cannot accommodate XLPE cables, Distribution Planning shall be consulted to assess the cost-benefit of civil refurbishment versus reduced feeder ratings.

Augmentation of sections of existing network in CBD/urban areas that are already reticulated with PLY cables may best be accomplished by continued use of PLY cables especially where XLPE cables of the required rating cannot be installed due to the size of existing ducts.

However, the preferred choice is to use XLPE cables for new applications wherever practicable.

The preferred 11kV cables to be used in the Brisbane CBD are shown in Table 15 below.

Table 15: 11kV cables for use in the Brisbane CBD

Preferred 11kV cables for use in the Brisbane CBD	
Size	**Type**
11kV 3 core 185mm²	Cu paper insulated, lead sheathed HDPE
11kV 3 core 300mm²	Cu paper insulated, lead sheathed HDPE
11kV 3 core or triplex 185mm²	Cu XLPE /CuScr/HDPE
11kV 3 core or triplex 240mm²	Cu XLPE /CuScr/HDPE
11kV 3 core or triplex 240mm²	Al XLPE /CuScr/HDPE
11kV triplex 400mm²	Al/WBT/CWS/WBT/MDPE[1 2]

Note 1: For use in C&I areas where higher load currents are required.
Note 2: Existing duct sizes may limit the use of this cable size.

9.1.3 LV cables used in Brisbane CBD

4C 240mm² Al XLPE/HDPE Low Voltage cable is the standard building block LV cable to be used in pit and duct systems. Note: 240mm² Al Low Voltage 4C XLPE PVC cable is not acceptable for use in frequently accessed cable pits.

However, other alternatives are available and the preferred LV cables to be used in the Brisbane CBD are shown in Table 16 below.

Table 16: LV cables for use in the Brisbane CBD

Preferred LV cables for use in the Brisbane CBD	
Size	**Type**
LV 185mm²	Cu 4 core XLPE/PVC/MDPE
LV 240mm²	Al 4 core XLPE/PVC/MDPE
LV 300mm²	Cu 4 core XLPE/PVC/MDPE

The LV cable is tee-jointed at branches in the cable route and at service take-offs; there are no pillars.

Refer to Figure 1 below for a typical LV circuit with servicing in a pit and duct reticulation.

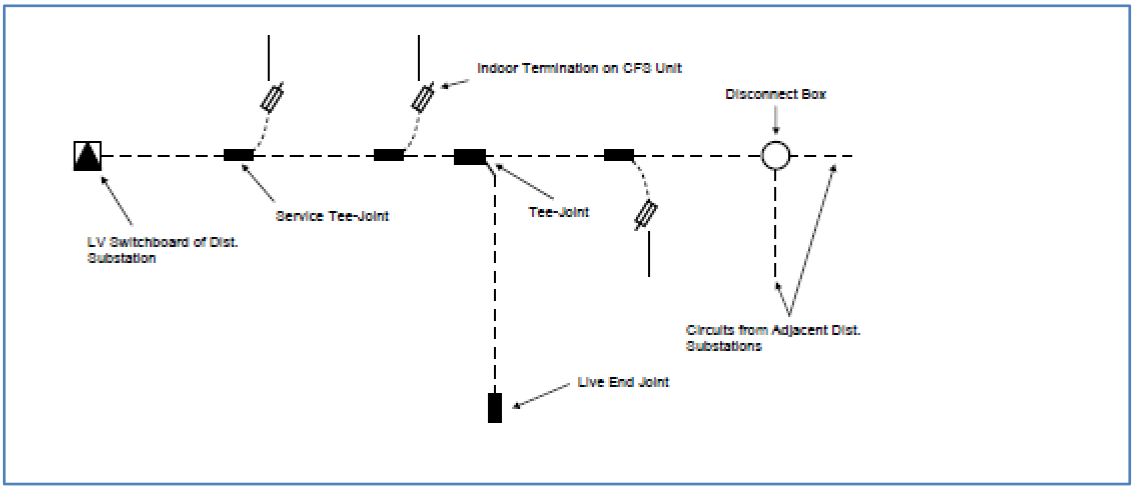


Figure 1: Typical LV service configuration for pit and duct reticulation

9.1.4 Three feeder mesh network configuration

Areas requiring higher security of electricity supply for multiple/many customers such as in the Brisbane CBD have a “three feeder mesh” HV network arrangement, or provision to be able to install this.

Three feeder mesh network configurations require additional ducts to be installed on the customer premises, compared to a loop-in/loop-out network configuration.

Three feeder mesh network configurations, once fully established, offer maximum reliability to Customers.

The layout of a three-feeder mesh network is shown in Figure 2 below.

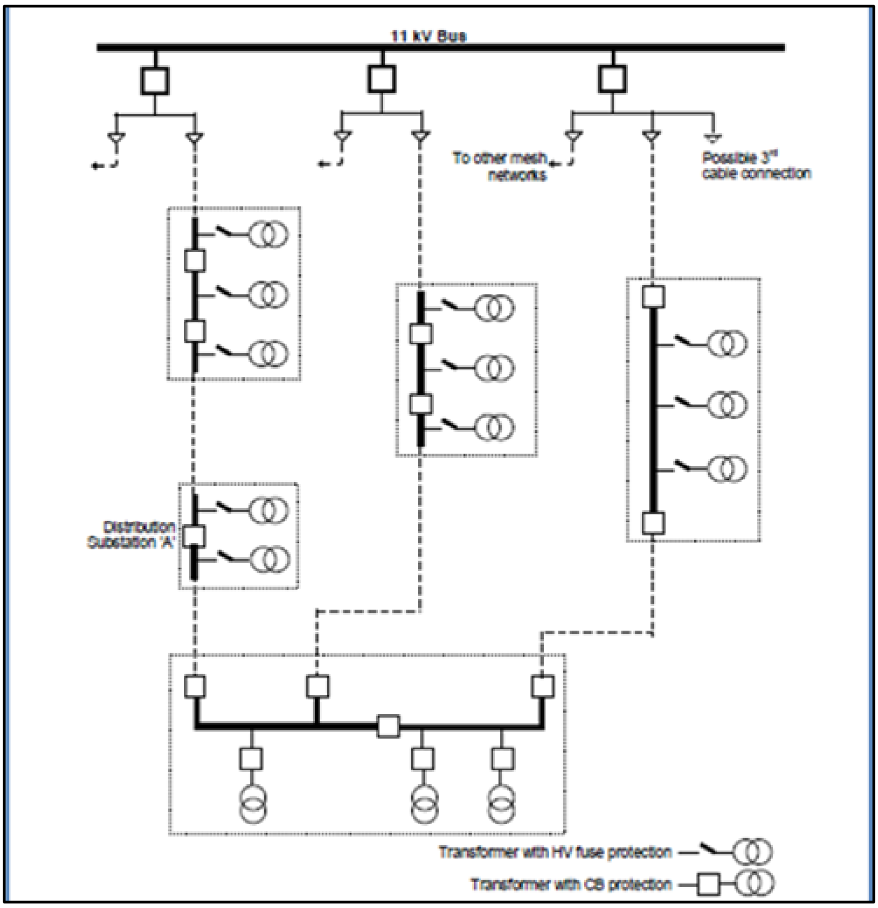


Figure 2: Typical three (3) feeder mesh network configuration

The substation capacity for a substation housing relay operated switchgear is:

- Up to and including six (6) circuit breakers
- Up to and including three (3) 1,500kVA transformers.

The establishment of indoor/chamber substations with the capacity to house relay operated switchgear is dependent on the Customer location, the surrounding environment, and the requirements of any planning authority including the DNSP.

Once an area is designated for three-feeder mesh development, planners and designers must carry out the following to enable the development of the mesh:

- A likely layout and route of the mesh, based on planning predictions
- A ductwork system must be planned so that ducts may be installed where roads are being redeveloped or constructed. Careful co-ordination of design and construction is required
- Adequate ventilation of transformer rooms
- Additional feeder/transformer capacity will most likely be required to supply existing and/or future local LV distribution and street lighting

Three-feeder mesh network have the following characteristics:

- Any two of the three feeders of the mesh ideally must be capable of supplying the total load of the mesh

- Distribution substations are installed generally in each major building or premise
- Local LV supply may be run onto the street from a distribution substation in a building in order to supply other customers on the street
- A fault in any of the 11kV cables within the mesh will result in the faulted cable being isolated by the CBs at each end of it. Supply is maintained to the majority of the load supplied by the mesh
- Where the 11kV bus in a distribution substation has a single CB for two transformers (e.g. Distribution Substation ‘A’) a fault in either 11kV cable connected to the substation will result in loss of supply to one transformer and partial loss of supply to the building. The building generally would have a transfer scheme on the LV side, a standby generator, or both
- If an 11kV cable fails which has a teed connection to a load, the teed load will lose 11kV supply until the cable is repaired
- Individual distribution transformers are protected generally by fused units, sometimes by CBs
- A large CBD or CBD like area may have many three-feeder mesh networks supplying it
- A three-feeder mesh may have a further backup connection to another three-feeder mesh, and other variations depending on the situation
- A HV circuit breaker may feed more than one mesh as shown, protection must be arranged to suit.

It should be noted that distribution substations designated for a 3-feeder mesh network may operate as a radial feeder for some time, until additional capacity requirements dictate an additional feeder connection.

9.2 Brisbane CBD Fringe areas and CBD Fringe Equivalent areas

Both Energex and Ergon Energy are looking to ensure the safety, reliability, and integrity of the electricity network in developing or growing areas over the life of the infrastructure.

The following arrangements are applicable to geographic areas designated as CBD Fringe or CBD Fringe Equivalent areas. It should be noted that such areas may be extended over time.

Refer Appendix B for a list of suburbs where the following requirements prevail.

The Queensland Government Department of State Development and Infrastructure defines development zones for land development. Zoning can be classified by purpose or location.

Zoning purpose includes (but is not limited to):

- Residential
- Centre
- Industrial
- recreational and
- special districts.

Zoning by locale includes (but is not limited to):

- Principle centre zone
- Major centre zone
- Centre zone
- Local centre zone
- Neighbourhood centre zone.

Refer to the Queensland Government website www.statedevelopment.qld.gov.au for additional information.

Specifically, for the purposes of CBD Fringe and CBD Fringe Equivalent areas, the following zoning information, along with the load/generation size, is used to determine the most appropriate electrical infrastructure for the development/s in question.

9.2.1 Planning zones and larger developments

The following transitional arrangements apply to:

a) Principal centre zones, major centre zones and district centre zones

b) Centre zones, local centre zone and neighbourhood centre zones

c) larger commercial / industrial developments

within the nominated CBD Fringe and CBD Fringe Equivalent areas.

Note 1: Where the zone may not be defined, but the development of the area in questions is consistent with such areas, then they are considered as fitting into that zone classification.

Note 2: Commercial developments include medium rise and high rise residential developments.

Should there be any doubt, then Distribution Planning are the sole determinant for electricity system development requirements.

For areas designated in sub-section 9.2.1 a) above:

1. Requiring two (2) or more transformers, or
2. Requiring a connection (load or generation) > 800kVA, a C & I substation housing relay operated switchgear is required.
3. Requiring a connection (load or generation) > 500kVA and ≤ 800kVA, (one transformer only), a padmount substation (with appropriate substation site sizing, communications conduits etc.) capable of housing remote operated switchgear is acceptable.
4. Requiring a connection (load or generation) ≤ 500kVA, (one transformer only) a padmount substation is acceptable.

For areas designated in sub-section 9.2.1 b) above:

5. Requiring two (2) or more transformers, or
6. Requiring a connection (load or generation) > 1,000kVA a C & I substation housing relay operated switchgear is required.

7. Requiring a connection (load or generation > 500kVA and ≤ 1,000 (one transformer only) a padmount substation (with appropriate substation site sizing, communications cables etc.) capable of housing remote operated switchgear is required
8. Requiring a connection (load or generation) ≤ 500kVA, a padmount substation is acceptable.

For areas outside those listed in sub-section 9.2.1, but within CBD Fringe and CBD Fringe equivalent areas:

9. >1,600 kVA, a C & I substation housing relay operated switchgear is required
10. Requiring a connection (load or generation) > 800kVA and ≤ 1,600kVA, a dual padmount arrangement is acceptable. Alternately, a C & I substation housing manually operated switchgear may be provided
11. Requiring a connection (load or generation) < 800kVA, a padmount substation is acceptable.

9.2.2 Temporary supplies

For temporary connections (e.g., TBS) non-relay operated switchgear, PMTs and substation rooms are acceptable, subject to network limitations and requirements specified in a Distribution Planning Report

9.2.3 Civil works and cable / conduit requirements

Where clause 9.2.1 applies and irrespective of load requirements of 9.2.1 a) or 9.2.1 b)

- all areas within in the mapping zone will be considered “pit and duct” with respect to civil works
- CBD & CBD Fringe areas - UDCM CBD cross-sections to be applied to all development frontages. The number of conduits will be determined by the DNSP.
- CBD Fringe Equivalent areas - UDCM Shopping Centre cross-sections to be applied to all development frontages. The number of conduits will be determined by the DNSP.

All CBD areas - total / spare conduit requirements above shall be applied to new HV cable routes regardless of existing conduits (existing ceramic ducts and Asbestos Cement pipes to be replaced with 125mm PVC conduits where practical and achievable)

9.2.3.1 Feeder cable requirements for CBD and CBD Fringe areas

As the CBD fringe is designed for future three feeder mesh and/or limited by 100mm conduits, these areas shall use 300mm^2 Cu PLY 11kV cables within road reserve and 400mm^2 Al Triplex 11kV cables within private property in/out of C&I Substations

CMEN LV ties shall be via 1x 300 Cu 4C LV cable minimum, 2x cables preferred.

9.2.3.2 Feeder cable requirements for CBD Fringe Equivalent areas

CBD Fringe Equivalent areas are designed for remote operated switchgear with reduced feeder requirements compared to CBD areas designed for future three feeder mesh and/or limited by 100mm conduits, these areas shall use standard building block feeder cables unless otherwise specified by a Distribution Planning Report

CMEN LV ties shall be via 1x 240 Al 4C LV cable minimum, 2x cables preferred.

9.2.4 Substation switchgear and spatial requirements

Where clauses 9.2.1 a) (1) (2) and 9.2.1 b) (5) (6) and item (9) apply:

1. CBD & CBD Fringe Areas:
    a. Substation Rooms shall be designed for relay operated switchgear requirements
    b. Switchgear installed in permanent substations to supply a Customer Connection shall be Relay Operated
2. CBD Fringe Equivalent Areas:
    a. Substation Rooms shall be designed for future relay operated switchgear requirements
        i. This may be achieved via installation of manually operated switchgear connection + additional spatial requirements for Relay Operated Switchgear to be installed in addition to the RMU + N-1 Transformers (for LV Connections); or
        ii. This installation of Relay Operated Switchgear as part of the initial connection
    b. Minimum switchgear requirements are manually operated switchgear only, subject to network and protection requirements detailed in the Distribution Planning Report

9.3 Legacy retail and commercial areas reticulated with PLY cables

Some parts of Greater Brisbane commercial and retail areas have PLY cables installed. These areas may need consideration similar to Brisbane CBD where PLY cables are installed. The relevant DNSP contact in Table 1 can provide additional information on the location and type of cables installed in these areas and the options available for new connections.

9.4 Urban areas

Urban areas will comprise overhead lines, underground cables, or a combination of the two.

The choice of substation type will be dictated by the current network topology and the type of load/generation to be connected. e.g., a shopping centre will typically require an indoor / chamber substation.

More and more urban environments are installing underground electricity networks.

Developers must comply with any planning authority requirements.

In addition, the DNSP reserves the right to make the final decision regarding an overhead or underground connection. The DNSP decision will be based on the local network topology, a technical assessment of the connection and any known future requirements.

HV cable installation on radial networks (spurs) in urban areas should only be considered where the factors below can be realized:

- The total nameplate rating of installed distribution transformers is ≤ 1,200kVA, or
- The total number of distribution transformers installed is ≤ four, (regardless of total nameplate rating), and
- The HV network is unlikely to be extended, and
- Mobile generation support is available within a two (2) hour drive of the installed cable site.

Note: HV spurs do not include supply to single industrial, commercial, or agricultural customers. Single customers may choose the level of security of supply they require from the distribution network. (i.e., N or N-1 etc). N – 1 arrangements are subject to the availability of such connections and are likely to require the Customer to pay for this, as a secondary supply.

Where a loop in/loop out network arrangement is required for DNSP purposes, the DNSP will advise the Customer of this.

9.5 Regional areas

For regional area planning and design, it is necessary to be specific in the geographic location and the feeder classification to determine which of an urban or rural environment is best suited to the connection in question.

9.6 Rural and remote areas

For rural areas, lines tend to be overhead, so for loads up to 500kVA, a pole type substation is appropriate. For loads greater than 500kVA, HV connections are preferred.

Where skilled resources are located within ninety minutes of the site in question, for loads greater than 500kVA, ground mounted substations are acceptable.

Otherwise, sections of HV underground cable in a radial HV network in rural and remote areas should be avoided due to the extended times required to find a fault, and then test and repair the cable. The availability of appropriately skilled staff in close proximity to rural and remote areas cannot be guaranteed outside of major centres. Extended travel times add to outage times, and this is to be avoided wherever possible.

10 Subdivisions – common requirements

10.1 Subdivisions general

The planning and design of any underground work must be integrated into an overall vision for development of the electrical network. Planning provisions cater for the orderly and cost-effective growth and development of the network and its safe and reliable operation for both load and generation through:

- Prudent investment in network assets
- The avoidance of costly augmentation and
- The avoidance of replacement of assets to meet demand growth
- Compliance with Safety Net reliability measures.
- There must be no reduction of existing HV feeder capacity
- All conductor/cable installation must be designed and constructed/installed to achieve the full conductor/cable rating

Real estate developments and subdivisions are also considered Major Customer Connections. Additional information may also be found in the Major Customer Connections Manual, the Standard for Major Customer Connections and on the applicable DNSP's website.

The information in this manual supersedes the documents referred to in this sub-section 10.1 on planning matters. However, documents referenced in sub-section 10.1 relating to construction matters prevail.

10.2 Subdivision categories

The planning, design and construction of underground electrical reticulation and any associated street lighting by a real estate developer for the following real estate development categories shall need to be carried out in accordance with the DNSP requirements:

a) urban residential subdivisions

b) rural residential subdivisions

c) commercial & industrial subdivisions

d) commercial developments within a residential subdivision; and

e) street lighting.

10.2.1 Eligible subdivisions

Energex

Eligible subdivisions connecting or coupling to the Energex network include:

- Residential freehold subdivisions, irrespective of the number of lots. (Includes commercial developments within the subdivision)
- Rural residential subdivisions
- Commercial and Industrial subdivisions
- Community Title Schemes with internal Energex reticulation (must supply five or more lots).

Ergon Energy

Eligible subdivisions connecting or coupling to the Ergon Energy network include:

- Residential freehold subdivisions, irrespective of the number of lots. (Includes commercial developments within the subdivision)
- Rural residential subdivisions
- Commercial and Industrial subdivisions.
- Community Title Schemes (eligibility conditions may apply).

10.2.2 Ineligible subdivisions

Energex

Ineligible subdivisions connecting or coupling to the Energex network include:

- Developments with inappropriate access, without clearly defined sealed roadways or insufficient area to install and maintain Energex assets.
- Amalgamation of lots
- Where twenty-four-hour access is not available to access the DNSP assets.
- Where Energex network standards cannot be achieved for the project.
- A subdivision by lease.
- Caravan parks.
- Caravan parks that contain a section of manufactured homes.
- Where it is proposed to have a combination of AS/NZS3000 reticulation and Energex reticulation
- Manufactured home parks.

Ergon Energy

Ineligible subdivisions connecting or coupling to the Energex network include:

- Retirement villages with permanent building structures
- Manufactured home parks
- Developments with inappropriate access, without clearly defined sealed roadways or insufficient area to install and maintain Ergon Energy assets.
- Amalgamation of lots
- Where twenty-four-hour access is not available to access the DNSP assets.
- Where Ergon Energy network standards cannot be achieved for the project.
- A subdivision by lease.
- Caravan parks.
- Caravan parks that contain a section of manufactured homes.

10.3 Interconnection with the existing network

The DNSP is the sole determinant of the type and location of any and all interconnections to the existing network[1], both HV and LV.

This is particularly relevant in multi-stage developments. A detailed staged development master plan must be provided and agreed with Energex or Ergon Energy for all multi-stage developments.

Details of interconnections with the existing network can be provided by Distribution Planning.

Concept plans shall be submitted for all proposed subdivisions at concept enquiry stage for each stage of the Development.

Considerations to include:

- Masterplan and multi-stage subdivisions that require HV works
- Large Commercial and Industrial subdivisions
- The subdivision site is within 1.5 kilometre radius of an existing or proposed zone substation
- The subdivision requires alterations to sub-transmission assets, (33kV and above), remote operated assets or pilot cables. e.g. pole mounted reclosers, voltage regulators
- There are HV planning issues or switching issues that require evaluation by the DNSP
- There are possible conflicts with adjacent subdivisions
- There are project specific issues that need to be resolved prior to the detailed design
- Non-standard proposals for the LV reticulation. e.g., Non-standard alignments
- Conflicts with bio-retention basins, narrow footpaths, protected vegetation, etc.
- Streetlighting projects detailing with major civil works, ie road widening where installation of additional HV conduits for future use may be required to be installed as part of the underground streetlighting works in the road corridor.
- Concrete cable pit and duct network
- CBD and CBD like / Prestige precincts which generally have a full concrete verge from kerb to property boundary
- Planned Community Title Schemes located within a residential development
- Planned Commercial and Industrial developments located within a residential development e.g. Shopping centres, schools, community centres, etc
- Developments containing narrow laneways or restricted width verge.
- All concept plans shall be updated/resubmitted every 12 months or submitted into Energex and Ergon Energy for validation if there are any deviations/changes to these concepts or master planned developments for Network Planning acceptance.

The subdivision shall, at a minimum, retain the existing distribution feeder capacity. i.e., Neither Energex nor Ergon Energy will accept a reduction in existing feeder capacity as a result of connecting

[1] This includes any proposed network where future plans exist for such networks. Developers will be advised of any such plans should they exist.

a subdivision. The DNSP will provide cable sizes required for each proposed development during the concept enquiry stage.

10.3.1 Inter-feeder ties and maximum spur size on existing networks

For existing networks in urban areas (interconnected networks) where augmentation or expansion is occurring, the maximum size of a spur is 1.2MVA. (Based on the summated nameplate rating of the distribution transformers of the entire spur).

For existing spurs commencing at an existing underground HV tee-joint, the maximum spur size is:

- Less than 1.2MVA of the summated transformer nameplate rating or
- Less than four (4) distribution substations,

whichever occurs first.

Where either situation is identified, the spur shall be converted to a loop in / loop out arrangement.

10.3.2 HV tee joints (parallel branch joints) on the existing HV network

The use of HV tee joints (parallel branch joints) is no longer permitted for augmentations or extensions to the HV network. Straight joints and the use of RMUs is the available option.

Note 1: Any existing tee joint shall be designed out for security of the HV network.

10.4 Development sites with existing DNSP substation/s

Land sites that are proposed for redevelopment where the DNSP already has a substation must retain provision for at least equivalent substation capacity within the redeveloped site. Any proposal to relinquish the substation site or reduce the substation capacity will require approval from the Manager, Network Management.

10.5 Purchase of existing DNSP assets

Where a Customer requests to purchase existing DNSP assets, the Network Management team must be involved in the associated discussions, negotiations, with the final decision on any asset sales residing with the Manager, Network Management.

10.6 Disturbing loads within subdivisions

The design consultant needs to be aware of any planned disturbing loads and/or motor start requirements for items such as sewer pump stations, water pump boosters, etc that are required to be installed by the developer as an integral part of the subdivision.

For all subdivision projects where the developer is planning to install pump stations, etc the design consultant shall submit a detailed concept proposal to the relevant DNSP contact shown in Table 1 for evaluation and feedback.

Refer to section 7.11 for additional requirements regarding power quality.

10.7 Easements and Consent to Work

In freehold standard lot subdivisions, all Energex, and Ergon Energy HV assets and LV assets shall be installed by the developer in an area of public road reserve. Road reserve cuts outs are and remain an acceptable practice for locating substations and HV switching stations.

There are also project specific instances when an easement may need to be provided by the developer for the security of the network assets. The items below relate to the provision of easements in subdivision projects:

- During the planning phase of the project, the design consultant shall request approval from the relevant DNSP contact shown in Table 1 for any proposed easements through parks, reserves, or commercial and industrial lots with the intent to protect land locked supply to the single C&I lot only and not to install HV backbone through a lot to supply external network.
- Easements for HV and LV underground cables should be a minimum width of three (3) metres wide and with sufficient access to allow future repairs and maintenance. Any proposed alternative sizes of easements shall be negotiated with the relevant DNSP contact shown in Table 1. The DNSP will determine when a wider easement is required during the concept enquiry stage.
- An Exclusion zone easement around all residential padmount sites is required to address noise, emf, fire and explosion risks ensuring premises are not constructed too close to our padmounts. This will ensure compliance with the AS/NZS standards and the EQL Underground Distribution Construction Manual.

Energex or Ergon Energy do not permit easements through residential lots for HV or LV cables.

10.7.1 Electrical assets crossing property boundaries

Existing consumer's lines and cables that cross property boundaries created as the result of a subdivision, shall be relocated at the developer's expense prior to the DNSP issuing the Certificate of Supply. Each new lot being created must be serviced directly from the road reserve as per the QECM requirements. Approval from the DNSP is required at concept stage for supply to be made available unless designated by the LGA under a reciprocal rights Service and Access Easement in favour of the relevant lots.

The requirements in the QECM a required to be met.

10.8 Approvals from planning authorities and other authorities

The design consultant is responsible for obtaining all approvals required for a subdivision or development project. These include items such as:

- • Local council / EDQ approval of the electrical reticulation design.
- • Local council / EDQ approval of the public lighting design.

Other approvals that may need to be obtained by the design consultant include:

- Department of Transport Main Roads (DTMR) for public lighting on a state-controlled road
- DTMR for electrical reticulation works on a state-controlled road
- Vegetation management reports and approval for vegetation works
- The approval of any proposed works in Powerlink transmission easements
- The approval of proposed works near oil / gas transmission pipelines
- The approval of proposed works near trunk water pipelines
- The approval of proposed works near rail authority assets

- Any Environmental permits, cultural heritage reports, water crossings.

It is the design consultant’s responsibility to provide any required EMF reports based on engineering data supplied by Energex or Ergon Energy.

11 Urban Residential Subdivisions

Residential developments can range from small, isolated developments through to extensive developments covering large tracts of land. To be considered as an urban residential subdivision the following criteria must be met:

- Generally, lot numbers ≥ five lots per hectare. (i.e., an average lot size of < 2,000m^2)
- Internal road/s from which all lots can be serviced using Energex or Ergon Energy
- Energex or Ergon Energy design and construction standards
- Reticulation required to supply the proposed new lots
- There must be an obvious close and clear alignment between the development geographically and the location and timing of any “associated” electrical works.
- Make three phase LV supply available to all lots.

While there is no minimum number of lots for an urban residential subdivision, we would typically expect there to be a minimum of 5 lots. For residential subdivisions ≤ 5 lots, refer to sub-section 11.6: Urban residential subdivisions in towns and rural areas

Where an urban residential subdivision is proposed within the existing, developed boundaries of a town or directly abutting the existing, developed boundaries of a town, then, for the purposes of voltage drop, an urban distribution feeder may be assumed.

For urban residential subdivisions beyond or not abutting the existing developed town boundaries, the planning requirements for rural residential subdivisions apply. Refer section 12 Small residential subdivisions.

Additional requirements apply for relocation of existing DNSP assets, or changes to the DNSP’s existing assets beyond the that are not within the immediate proximity or adjacent to, the proposed subdivision development.

Refer to the

- Energex contestable work on the Energex website
- Ergon Energy contestable work on the Ergon Energy Network website

for additional information.

Should there be any inconsistency between this manual and either of the above Handbooks, then the information in this manual prevails.

11.1 Padmount substations

The network should be planned and designed to achieve the optimal number of padmount substations necessary to meet the calculated design demand (load and generation) and voltage regulation requirements, while providing sufficient future capability to meet ultimate load and generation capacity.

For residential subdivisions, the designer shall propose a 315kVA padmount transformer as the primary used option. The DNSP will determine any request for a transformer larger than a 315kVA at concept enquiry stage.The largest padmount transformer in any subdivision is not to exceed 500kVA.

Determining the location and size of padmount substations should be done considering the ultimate subdivision state, being the total lots available and the projected load and generation demands.

Load and generation demands can be determined by multiplying the number of lots by the ADMD and ADME figures provided in section 18.

The number of padmount substations initially installed will be determined by the anticipated timing of lot sales, and the subsequent size and type of dwellings being built on them.

In developments likely to experience slower lot sales, Energex or Ergon Energy may agree to the provision of vacant padmount substation sites (rather than sites with the padmount substation constructed) where the HV cables loop in and out of each site, to provide for future connection to a padmount substation.

Connections personnel must consult with Distribution Planning to confirm growth projections on impacted feeders.

11.1.1 Padmount substations and RMU site location

Padmount substation sites and Ring Main Unit sites located in freehold subdivisions shall be recessed into the property alignment on an area of land dedicated as public road reserve.

Padmount substation sites and Ring Main Unit sites shall comply with the requirements listed in sub-section 6.5.2.1 with additional considerations listed below:

- The padmount substation shall be situated as close as practicable to the subdivision load centre to allow for the shortest possible LV circuits.
- Special attention shall be given to environmentally sensitive areas (schools, childcare centres, etc), swimming pool areas (minimum clearance 5m), hazardous area facilities, fire hydrants, fire booster pumps, telecommunication assets, etc when planning the location of Padmount Transformers and Ring Main Units
- Design consultants also need to be aware of the increased clearance distances for separately earthed high voltage assets
- 24-hour, 7-day unrestricted access shall be provided to Padmount substation sites and Ring Main Unit sites including minimum access for truck and generator.

To ensure Energex or Ergon Energy and future customers do not have clearance issues in the future, Padmount substations shall be located such that there are sufficient clearances from habitable areas and non-fire rated parts of any buildings. Subject to the physical location of the substation, Energex or Ergon Energy may require an easement within the adjacent lot/s to ensure future buildings do not compromise required clearances.

Clearance zones may extend beyond property boundaries and as such, the impact shall be shown for neighbouring properties.

In addition, Energex and Ergon Energy will not permit a new substation to be positioned in a location that is adjoining an allotment that is already owned by a 3rd party. This is only possible if the padmount substation site is already in dedicated road reserve (for a transformer) prior to the adjoining lot being sold to a third party.

Additional information can be found in the:

- Energex Underground Construction Manual
- Ergon Energy Underground Construction Manual

- Ergon Energy's Standard for Distribution Line Design Underground.

11.1.1.1 Padmount Substations - Generator Access

Padmount substations are to be located so that it is possible to manoeuvre and position a 500kVA trailer mounted generator in an area adjacent to the substation where the parking location of the generator does not require traffic control while the generator is on site.

11.1.1.2 Padmount substations and RMU sites – access and access tracks

Energex and Ergon Energy require 24/7 access to their assets. While it is always the first preference to construct a sealed roadway to provide access to DNSP assets, in some instances the DNSP may accept an alternative surface as a 'means of last resort.". The alternative surface is to be RPEQ certified and meets the DNSP standards.

Adopting the above location principle should avoid the need for access tracks.

11.2 Conduits

- In multistage developments, the developer shall fund the installation of all conduits required for the ultimate load of the development.
- In a residential subdivision, a minimum of four HV conduits on the "main backbone routes" through the subdivision shall be installed.
- When open cutting or boring an existing roadway to supply a development, a minimum of one additional spare LV conduit and 2 HV conduits are to be installed if HV network is within the vicinity of the development.

11.3 HV cables sizes used in residential subdivisions

New 11kV and 22kV underground feeders are designed in accordance with each DNSP's design and construction standards. These standards include the use of polymeric (XLPE) and paper (PLY) insulated cables. The use of each is location specific, and advice on what is appropriate will be provided during the application process. For example, paper lead cable has been used extensively for underground feeders in the CBD's of Brisbane, Ipswich, and the Gold Coast. XLPE insulated cables have been predominantly used outside these areas and exclusively for feeder exits from zone substations, as backbone for 11kV and 22kV feeders and in URD subdivisions.

The DNSP will provide cable sizes required for each proposed development during the concept enquiry stage.

11.3.1 Energex

Standard 11kV feeder cable shall consist of three (3) core and/or triplex XLPE insulated 11kV cable.

Table 17: Standard cables used in Energex subdivisions

Application	Cable
Feeder Backbone	Triplex 400mm^2 Al
URD	Triplex 240mm^2 Al

All 11kV underground cables within 1.5km radius of an existing or future zone substation shall be Triplex 400mm^2 Al. Underground 11kV feeder ties may be 240mm^2 Al XLPE if not within 1.5km radius of an existing or future zone substation unless directed by the DNSP.

11.3.2 Ergon Energy

Standard 11kV and 22kV feeder cable shall consist of single (1) core and/or triplex XLPE insulated cable as shown in Table 18 below.

Table 18: Standard cables used in Ergon Energy subdivisions

11kV	
Application	Cable
Feeder Backbone	Triplex 400mm^2 Al
Feeder cable	Triplex 185mm^2 Al
22kV	
Application	Cable
Feeder Backbone	630mm^2 Al 1C
Feeder cable	Triplex 185mm^2 Al

All 11kV underground cables within 1.5km radius of an existing or future zone substation shall be Triplex 400mm^2 Al. Underground 11kV feeder ties may be 185mm^2 Al XLPE if not within 1.5km radius of an existing or future zone substation unless directed by the DNSP.

11.4 HV network layout in Urban Residential Developments

In urban areas, the typical HV network configuration is to have switches on the feeder backbone every 650kVA of installed transformer capacity, and to have inter-feeder ties for every 1.2MVA of installed capacity on an 11kV network, and 3MVA on a 22kV network. This planning philosophy is often called “4 into 3,” where, when one feeder fails, the surrounding three feeders pick up the lost load.

Within subdivisions, the primary HV network layout is an interconnected ring, with incoming and outgoing cables connected to load break/fault make switches within padmount substations or RMU’s. Within the padmount, transformers are connected to the bus linking the feeder switches by a switch/fuse combination.

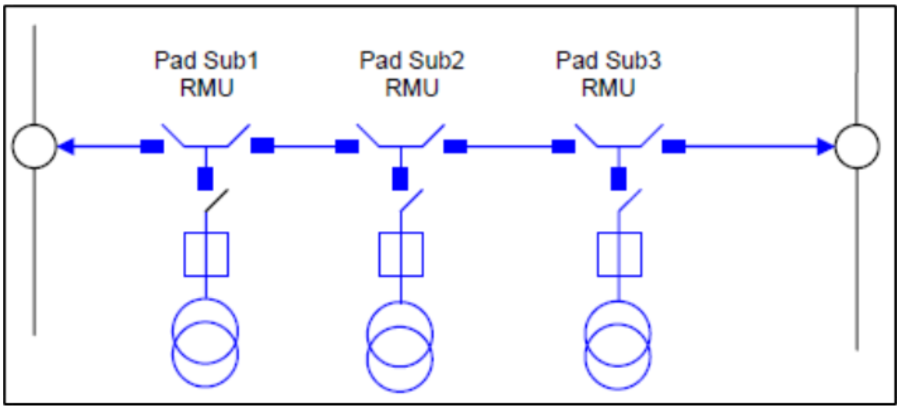


Figure 3: Interconnected HV backbone feeder

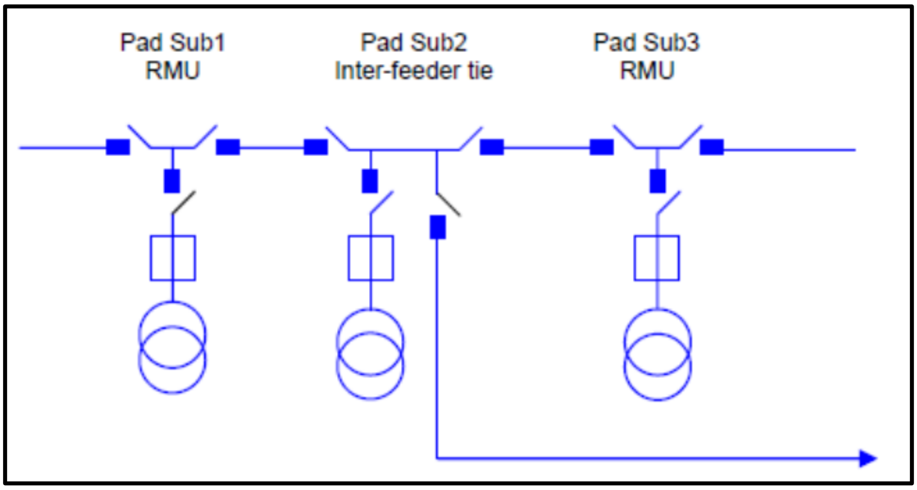


Figure 4: Interconnected HV backbone feeder with inter feeder tie

These arrangements provide for maintenance of current reliability performance, maximum operation flexibility, fault finding and maintaining supply to customers.

11.4.1 HV overhead networks

Suitably located load break gas switches are installed which permit supply to be switched from an alternative source when required. The location of HV switches shall be approved by the relevant DNSP. A HV switch is typically required for every 650kVA of installed transformer capacity. (Based on the transformer nameplate rating).

11.5 Staged developments and radial feeders

Each DNSP has a responsibility to ensure network configurations resulting from new developments are designed to facilitate the safe and timely restoration of supply, including repairs to the network following a fault.

11.5.1 Concept Enquiry Stage

The minimum information required at Concept Enquiry Stage (Energex and Ergon Energy areas) includes:

- A .dxf or .dwg & PDF's containing the lot layout.

- High Voltage (HV) concept plan (HV schematic), major electrical assets (cable size, conduit arrangement, transformers, switching assets, etc).
- Locations of HV and Low Voltage (LV) coupling points to the existing network.
- Access tracks.
- Civil & hydraulic design if conflicts are identified.
- Development Master Plan – staging plan, multiple developers / developments abutting and/or sharing the same HV & LV feeders.
- Community Title Development – Overall Master Concept – survey plan, architectural layout, including building design driveway locations, common property, landscaping plan, other utility assets, possible clashes with DNSP assets, civil design drawings, hydraulic design, solar if being proposed by the developer or builder if known.
- Anticipated completion dates of the electrical works to be gifted to the DNSP.
- A copy of the LGA's Decision Notice.

Note: every consecutive stage of the development will require the above information including an updated HV Master Plan for DNSP acceptance.

Where the DNSP identifies the need for a master plan, and it is not forthcoming, then the DNSP is likely to reject the subdivision proposal.

11.5.2 Inter-feeder ties for residential subdivisions

Developers are responsible for the design and construction of any HV feeder ties associated with and required by, or initiated by, a subdivision project. Master planned multistage or singular stage developments shall eliminate or reduce to a minimum the number of HV feeder spurs through effective HV network planning. A feeder spur shall only occur if there is no practical engineering means of creating a HV ring.

The DNSP may mandate loop in / loop out arrangements for the HV network based on projected future developments including the timing of these developments, future undergrounding of overhead lines, and/or reliability for planned and unplanned customer outages.

The following requirements for staged developments and the use of radial feeders (also referred to as 'spurs' or HV extensions) take these requirements into consideration.

A switched arrangement (RMU or Padmount substation) must be used for all loop-in / loop-out arrangements.

Switched arrangements apply for both overhead and underground HV feeders.

This capacity shall be determined from the total of the nameplate ratings of the connected transformers on the HV feeder spur. It shall not be determined using the number of customers or actual load.

Masterplan and multistage developments may construct HV feeder spurs before the ultimate HV feeder ring or the HV feeder tie is closed. These progressive HV feeder spurs shall be negotiated with the relevant DNSP and based on stage timing of the subdivision and the ultimate master plan.

Where the design capacity requirement of a development or the combined design capacity with adjoining developments exceeds 1.2 MVA and the developer is building successive stages, the connected capacity on a radial feeder may be permitted to temporarily exceed 1.2 MVA if all of the following conditions are met:

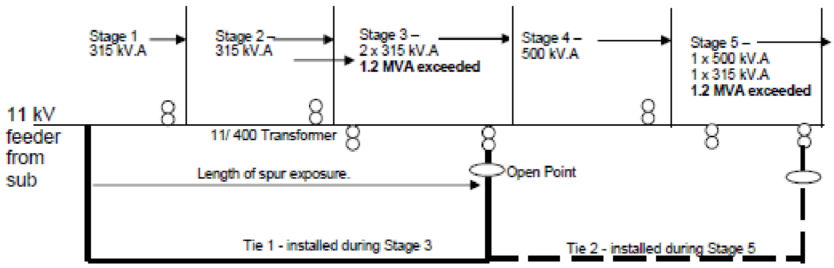
- A detailed staged development master plan must be provided and agreed with Energex or Ergon Energy
- The connected transformer capacity of the radial feeder must not exceed 2 MVA
- The developer may be required to provide a security bond to Energex or Ergon Energy for the agreed sum that it would cost Energex or Ergon Energy to construct a connection to remedy the radial arrangement
- The developer has 3 years to progress the development and complete the connection so that the radial connected capacity no longer exceeds 1.2 MVA.

In accordance with the distribution planning standard of both DNSP's, a HV feeder extension with ultimate load between 1.2 MVA and 3 MVA will require a HV tie. Where this need is created by the development of an urban subdivision, it is the Developers responsibility to provide (or provide for) the HV feeder tie.

Figure 5 provides a practical working example of application of an inter-feeder tie.

The following diagrams depict preferred supply arrangements for typical scenarios.

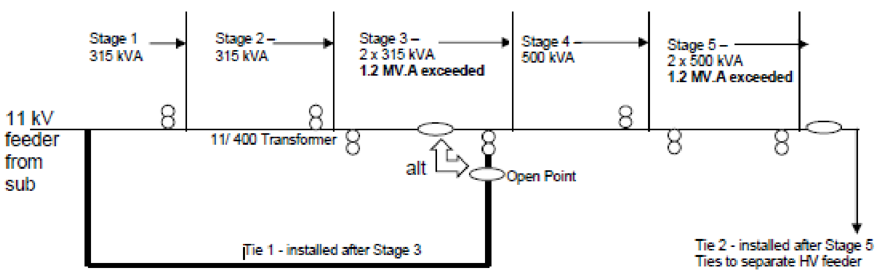
Scenario 1 – Tie Supplied by Same Feeder



Alternative options available under Scenario 1 include:

- Tie to alternate feeder after Stage 3 negating the need for Tie 1.
- Tie to alternate feeder after Stage 5 negating the need for Tie 2 and potentially facilitating recovery of Tie 1 if it is a temporary tie.

Scenario 2 – Tie Supplied by Alternate Feeder



Under this arrangement, recovery of Tie 1 is feasible subsequent to establishment of Tie 2.

Figure 5: Practical application of inter-feeder tie policy

11.5.3 HV tee joints (parallel branch joints)

For residential applications, HV tee joints are not allowed. The alternative is to install an RMU.

(Note: New HV tee joints are not acceptable on any part of the distribution network).

11.5.4 Distribution transformers – recommended maximum residential connections (new transformer)

The recommended maximum number of residential customers per transformer for any new urban residential subdivision (freehold), should be as per listed in Table 19: Recommended maximum number of residential customers in a freehold subdivision by substation size.

This recommended limitation is based on:

- For standard lots, maximum export capability (ADME) and not ADMD as it was previously. i.e., 5kVA per lot and
- Maximum allowable power flow (or current) through the distribution transformer is 110% of the nameplate rating of the transformer for ADME.

Table 19: Recommended maximum number of residential customers in a freehold subdivision by substation size

ADMD/ADME (kVA)	Distribution transformer size					
	63kVA	100kVA	200kVA	300kVA	315kVA	500kVA
5.0 Standard dwelling	13	22	44	66	69	110

11.6 Urban residential subdivisions in towns and rural areas

Where an urban residential subdivision is proposed

- within the existing, developed boundaries of a town, or
- directly abutting the existing, developed boundary of a town

then, for the purposes of voltage drop, an urban distribution feeder may be assumed.

For urban residential subdivisions beyond or not abutting the existing developed town boundaries, the planning requirements for rural residential subdivisions apply. Refer section 12

11.7 Small residential subdivisions

This scenario is applicable where the small subdivision is located where the existing network is not suitable to supply the subdivision and works are required to upgrade or extend the Energex or Ergon Energy network for the subdivision.

The developer is required to meet the following criteria:

- Residential developments creating an additional four new lots or less to be connected to the network i.e., a maximum total of five new lots on a new survey plan.
- The lots being created are for single residential dwellings only. (e.g., No units, no townhouses, no duplexes, etc)

- The proposed method of supply must comply with any policies specified in the local council's planning scheme and any specific conditions within the development approval for the subdivision.
- The proposed development shall not increase the VD% by more than 1% from existing figures (an existing and proposed LV drop model to be submitted on each concept at enquiry stage)
- Where the VD% exceeds the existing VD by 1% or more, the DNSP may require the developer to undertake works to ensure the VD is brought back to the DNSP standards.

Refer to the QECM for servicing details.

11.8 Preferred overhead conductor sizes

Where overhead conductor is required to connect a new development to the relevant DNSP's network, the preferred conductor sizes are listed below.

As mentioned previously, the choice of conductor must not reduce the capacity of the feeder backbone.

Where an alternate conductor is requested, liaison shall occur with Distribution Planning.

11.8.1 Energex network

The preferred overhead conductor sizes in the Energex network are shown in Table 20 below.

Table 20: Preferred overhead conductor sizes on the Energex network

Voltages	**11kV Urban**	
Conductor Code	**Conductor Type**	**Application**
Pluto	19/3.75 AAC	Validate for quantifiable benefits. Feeder backbone
Moon	7/4.75 AAC	Feeder backbone, radial feeders
Mars	7/3.75 AAC	Tee offs and spurs
Apple	6/1/3.0 ACSR	Rural lateral (not within 10km of coast)
Raisin	3/4/2.5	Rural special application
CCT	120mm^2 CCT AAAC 1120	Vegetation ingression
CCT	120mm^2 CCT AAAC 1350	Vegetation ingression
HV ABC	120mm^2	Feeder backbone
HV ABC	35mm^2	Radial spurs

The preferred conductors for use on the Energex LV network are the same as those on the Ergon Energy network. See Table 22 below.

11.8.2 Ergon Energy network

Ergon Energy has adopted a rationalised range of LV, 11kV, 22kV, 33kV and SWER conductors for regional areas. The following conductors are the preferred conductor sizes to be used.

Table 21: Preferred HV overhead conductor sizes on the Ergon Energy network

Voltages	11kV, 22kV, 33kV & SWER	
Conductor Code	**Conductor Type**	**Application**
Pluto	19/3.75 AAC	Urban and close rural heavy backbone
Moon	7/4.75 AAC	Urban backbone
Mars	7/3.75 AAC	Urban and close rural laterals
Iodine	7/4.75 AAAC	Rural backbone
Apple	6/1/3.0 ACSR	Rural lateral (not within 10km of coast)
Fluorine	7/3.00 AAAC	Rural lateral in coastal environment
Sultana	4/3/3.0 ACSR	SWER backbone
3/2.75	3/2.75 SC/AC	SWER lateral

Table 22: Preferred LV overhead conductor sizes on the Ergon Energy and Energex network

Voltages	LV	
Conductor Code	**Conductor Type**	**Application**
LV ABC	4 x 95mm^2	Standard LV reticulation cable
Moon	7/4.75 AAC	LV open wire applications
Pluto	19/3.75 AAC	Heavy LV open wire applications

Note: LV ABC remains the preferred overhead conductor. Open wire applications may be considered where there is existing open wire, or where load currents dictate higher amperages that dual LV ABC is able to provide.

11.9 Low Voltage (LV) networks in urban residential subdivisions

11.9.1 LV networks – general

Refer section 7.1.2: The Low Voltage (LV) network, for a full description of the LV network.

In URD subdivisions, customers are distributed along the LV circuit.

While the LV network consists of wholly overhead, wholly underground circuits, or a mix of both, LV circuits in new URD subdivisions are underground.

11.9.2 LV networks – physical configuration

The low voltage underground network consists of a three-phase network, which is divided into circuits. Each circuit is supplied from a distribution substation. Individual residential supply is taken from above ground service pillars, which are located within the road reserve fronting the vehicular access to the lot. Pillars are to be installed such that consumer mains are not installed in road reserve.

Note: There is no capacity to connect a customer service at the substation.

LV circuits emanate from the LV switchboard of the padmount transformer. LV underground cables loop from pillar to pillar to form a circuit as shown in Figure 6 below. The pillars are located at every other adjacent property boundary on both roadsides with 16mm^2 copper cable connecting the supply pillars on the mains cable roadside to the cross road pillars on the remote side.

Circuits of adjacent substations are connected via a linking pillar that incorporates a Combined Fuse Switch unit (CFS).

Note: Padmount substations must be situated to enable the distribution of the LV supply to customers by the standard cable sizes within statutory voltage limits. Refer section 10.1 above.

The electrical design of residential underground estates must integrate with existing network and future development of adjacent areas.

Typically, LV circuits are 200 – 400 m in length. Experience has shown that circuits in excess of 400m in length are likely to incur technical difficulties. Consideration to be given to installing an additional transformer where the LV circuits exceed 400m.

The final design shall make provision for contingency conditions, such as spare conduits for future additional circuits. The DNSP may determine additional spare conduits or future padmount sites are required in specific locations.

A typical LV circuit arrangement within an underground residential area is illustrated in Figure 6.

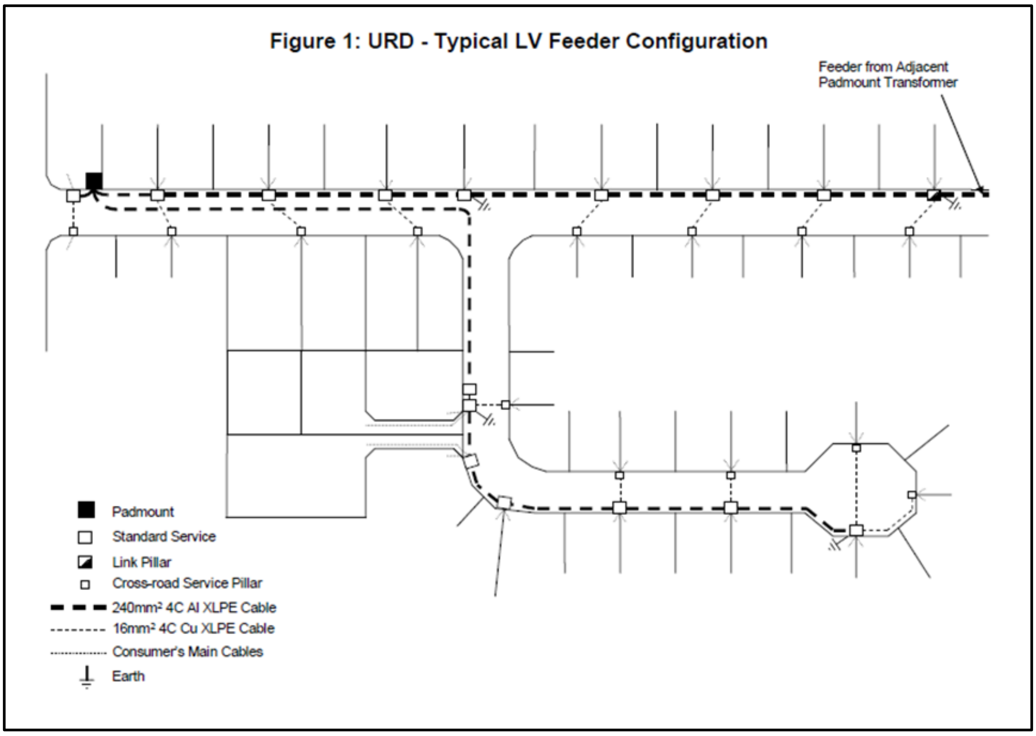


Figure 6: Typical URD LV circuit configuration

Figure 7 shows the use of a three-way pillar/distribution cabinet in an LV circuit.

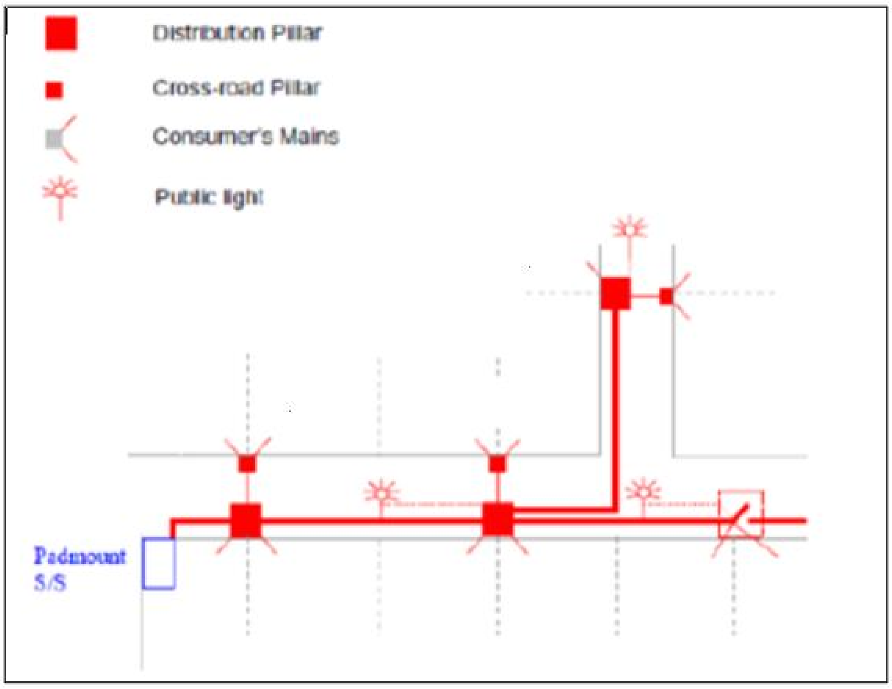


Figure 7: Typical LV circuit with one, two and three way pillars

11.9.2.1 LV connecting pillars and cabinets

Designs of underground residential electrical reticulation may make use of some or all the following types of above ground pillars:

- **One and two-way distribution pillars** - to distribute electricity to lots.
- **Two-way link pillars** - to create LV distribution mains normally open interconnect between adjacent padmount transformers.
- **Three-way pillars** - to create a LV distribution mains sectionalising point
- **Distribution cabinets** – shall not be installed in a residential subdivision
- **Cross road pillar** – for customer servicing

A two-way above ground link pillar is used to create “normally open” points between sections of the low voltage network supplied from neighbouring padmount substations.

A three-way above ground pillar is used to provide points of isolation within the low voltage distributor circuit, which incorporate long branch circuits.

Complete details of link pillars can be found in the Energex Underground Construction Manual and the Ergon Energy Underground Construction Manual.

11.9.3 LV assets in private driveways

The installation of the DNSP LV assets in private driveways is not desirable however will be considered by the DNSP at concept enquiry stage.

The private driveway shall have sufficient space to install DNSP LV assets in a 1.5m wide grassed area adjacent to the driveway.

A minimum of 3m wide underground electricity easement shall be granted in favour of the DNSP.

11.9.4 LV networks – paralleling of LV cables - (express LV circuit)

The paralleling of low voltage underground cables is only permitted on the first segment of the LV circuit from the padmount substation, this being between the LV CFS isolator at the substation and the first pillar on that circuit. Both cables must terminate on the same LV CFS in the substation and in the same LV pillar.

The following additional requirements also apply to LV paralleled cables:

- The maximum length of parallel cabling is 250 metres.
- Only one (1) express parallel LV circuit will be considered per padmount substation. Express parallel LV circuits require written approval from the relevant DNSP contact shown in Table 1 during the developer/consultant concept enquiry phase of the project
- Cable joints are not permitted on parallel LV express circuit cable runs
- Conduits for the parallel LV express feeder shall be installed together (side by side) along their full length and in accordance with standard design and construction requirements with provision of a minimum of one additional LV circuit
- Parallel circuits of overhead and underground LV shall not coexist on the same verge. The network shall be either overhead or underground, not both. This will involve undergrounding the overhead if the development is conditioned to e underground, or if the developer desires an underground network to supply their development.
- Leap frogging from pillar to pillar is not acceptable.

11.9.5 LV networks – tie policy

Low voltage ties between adjacent distribution transformers improve network reliability and operational flexibility, as well as facilitating the use of CMEN earthing at transformers.

Ties should be established on all circuits wherever practicable. If a tie is not available due to the road layout such as long cul-de-sac, a spare LV conduit is to be installed for the length of circuit.

Ties between LV circuits are 'normally open,' and should only be used as a back-up supply. i.e., they must not be run as rings to resolve voltage issues when planning and designing LV networks.

When designing an urban network, each LV circuit emanating from a transformer should tie to a similar circuit from an adjacent transformer. This will not always be practicable due to factors such as lot layout, road geometry and proximity of external circuits. However, reasonable efforts should be made to ensure that each urban transformer has at least one tie to an adjacent LV area. The DNSP may request additional LV ties when assessing concept designs at enquiry stage.

There should only be one interconnecting LV tie to any LV circuit.

As show in Figure 8, ties are facilitated by link pillars, and 3 way pillars

Figure 8 is an example of an ideal urban LV schematic with all LV circuits tied to adjacent areas with alternate HV feeds.

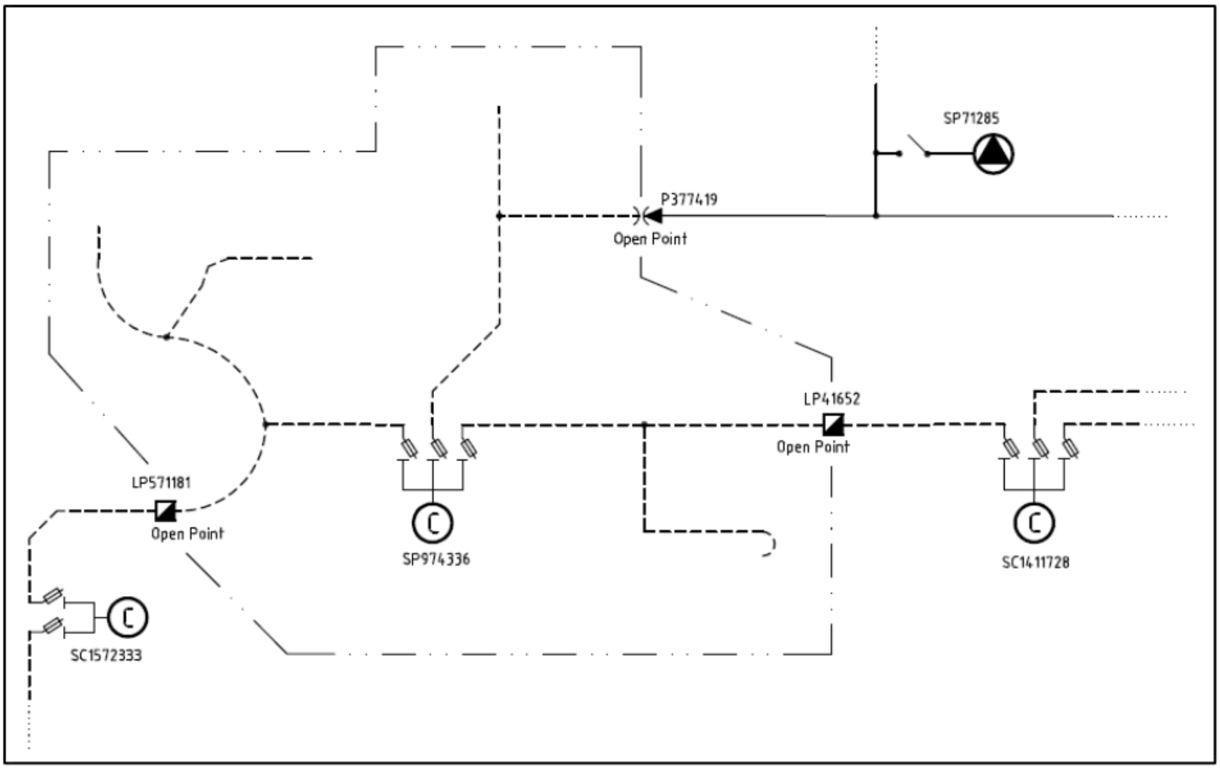


Figure 8: Ideal urban LV circuit schematic with LV ties to adjacent areas

Ties to padmount transformers that have the capacity to be fed from an alternate HV feeder are preferable to ties from padmount transformers fed from the same segment of HV mains between isolation points, since local HV problems or transformer problems will likely affect the LV primary circuit and tie circuit.

11.9.6 LV Networks phase balancing

The following principles shall be adopted when determining service phasing:

- the total number of services on each phase shall as far as possible be equal
- the sum of the moments of each phase shall as far as possible be equal
- designs shall as far as possible, eliminate possible future out-of-balances.

11.9.7 LV networks – The don'ts

In addition to voltage and cable size considerations, the items that are not acceptable in LV networks are:

- The use of rings (paralleling of LV circuits) to resolve voltage issues at the design stage is not acceptable

  (Note: The use or rings for the short-term relief of voltage issues on existing networks is acceptable)
- Both Energex and Ergon Energy do not permit the use of service pits in underground estates.
- Supplying underground to a new subdivision from existing OH (pole to pillar) shall be from the nearest LV pole to the development boundary frontage.

- Parallel circuits of overhead and underground LV shall not coexist on the same verge. The network shall be either underground or overhead, not both. This will involve undergrounding the overhead if the development is conditioned to be underground, or if the developer desires an underground network to supply their development.
- A limit of one LV underground cable can be installed directly from a pole transformer to supply residential lots.

11.9.8 Standard cable sizes

All new underground Low Voltage cables shall be 240mm^2 Al 4 Core XLPE cable for the backbone cable. 16mm^2 Cu 4 Core XLPE cable may be used for cross road pillars and the last section of the Low Voltage circuit. e.g., from the second last pillar to the last pillar on the end of LV circuit.

If the street is to continue at some future time into land that can be developed, then the 240mm^2 Al 4 Core XLPE cable shall be installed to the last pillar on the circuit.

12 Rural residential subdivisions

Rural residential subdivisions are subdivisions with less than five (5) lots per hectare for developments within both the Energex and Ergon Energy network. (Excludes isolated network areas but does include the North West Minerals Province area of Mt Isa.)

The developer shall:

- Provide internal road/s from which all lots can be serviced using Energex or Ergon Energy Standards
- Show the nominated building envelope for each lot on the design drawings
- Make three phase LV supply available to all lots.
- (Three phase LV supply is to be established on the road reserve as close as practical to the proposed building envelope. The developer/consultant shall give due consideration as to the local topography and the route of any future consumer's mains between the Point of Supply and the nominated building envelope).
- Time the development so there is an obvious close and clear alignment between the
- development and the timing of any "associated" electrical works.

12.1 Planning considerations

For rural developments the likely demand will not generally warrant an interconnected HV network unless this is required for other reasons.

The selection of the substation transformer size must be a practical balance between the cost of the distribution substations, the length of LV circuits and quality of supply and reliability considerations.

As the number of connected customers falls there is less diversity of demand and a greater impact from unbalanced supply factors making the extensive use of LV networks unattractive. The best solution will depend on allotment size, and it should be expected that transformer size and the extent of LV networks will decrease with an increase in allotment size.

In freehold subdivisions, DNSP assets (HV and LV) shall be located in an area of public road reserve. However, the design of supply to rural subdivisions also differs from other subdivisions. It is very difficult to position transformers to suit future residential sites; and in some cases, it may even be necessary to provide a HV extension into private property to suit a future customer connection.

In this situation, an easement is to be granted in favour of the affected properties where any DNSP assets are designed to be constructed/installed. Refer to section 16: Easements and Consent to Work (Wayleaves) for additional information on easements.

The option of overhead or underground electricity supply is dependent on a number of conditions. Refer subsections 12.2 and 12.3 below.

12.2 Options for underground electricity supply in rural residential subdivisions (including underground LV circuits)

The undergrounding of power lines in rural residential subdivisions is restricted to

- Where the local planning authority dictates this, or
- the HV assets are underground.

i.e., the option of LV underground circuits in rural residential subdivisions only exists where the HV infrastructure is also underground

It is preferred that there are sealed roads and formed curb and channel along the road reserve.

In some instances, the DNSP may require additional physical protection for LV pillars. This involves the pillar having a concrete apron and bollard protection.

Refer to Ergon Energy's Standard for Distribution Line Design Underground for additional information

The DNSP is the sole determinant of the need for extra LV pillar protection.

12.3 Options for overhead electricity supply in rural residential subdivisions

Given the variance in allotment sizes, a supply arrangement via an overhead HV backbone with lots having a dedicated substation is likely, provided that this option is consistent with planning authority requirements.

Pillars shall not be located in non-urban or rural areas where the HV infrastructure is overhead, due to the increased risk to the security of the electrical assets proposed to be installed. (e.g., where pillars may be subject to the risk of vehicle [slashers etc.] impacts and fire damage).

Alternate arrangements include the Customer to provide a property pole for the DNSP to connect an overhead LV service to.

All service connections must comply with the QECM.

Note: As previously mentioned, both Energex and Ergon Energy are required to plan, design, and operate their respective networks to achieve minimum reliability measures.

13 Commercial / industrial subdivisions

In general, the same principles apply to commercial and industrial subdivisions as Underground Residential Developments because the substation supplies distributed customers. However, for this customer class the electrical requirements of allotments are generally unknown and less predictable.

To be considered as a commercial / industrial subdivision the following criteria must be met:

- There must be internal road/s from which all lots can be serviced using Energex or Ergon Energy design and construction standards
- Each individual land parcel must directly abut a public road reserve
- Three phase reticulation is required to supply the proposed new lots
- There must be an obvious close and clear alignment between the development
- geographically and the location and timing of any “associated” electrical works.

Additional requirements apply for relocation of existing DNSP assets, or changes to the DNSP’s existing assets that are not within the immediate proximity or adjacent to, the proposed subdivision development.

Supply to commercial / industrial subdivisions may be either overhead, underground or a combination of both. The choice between overhead and underground supply is dependent on:

- Any planning authority requirements
- The type of existing electricity network supplying the area surrounding the proposed subdivision.
- A direction from the relevant DNSP. The DNSP is the sole determinant of the method of supply, and any decisions made are based on the existing network configuration, and future network needs.

Where supply to the commercial and industrial subdivision is underground, developments shall only have a loop in / loop out configuration for the HV network.

Where supply to the commercial and industrial subdivision is overhead, HV switching parameters apply. i.e., a HV switch is required for each 650kVA of installed transformer capacity. Remote operated switches are preferred for feeder backbone sectionalising and inter-feeder connections.

13.1 Distribution substations

The network should be planned and designed to achieve the optimal number of distribution substations necessary to meet the calculated design demand (load and generation) and voltage regulation requirements, while providing sufficient future capability to meet strategic or ultimate load and generation capacity.

The placement of distribution substations shall be installed on the larger of the new lot sizes giving consideration for potential higher load requirements for these lots.

For commercial / industrial subdivisions on the Energex network, a 500kVA transformer is the preferred minimum size.

The largest distribution transformer used in this type of subdivisions is 1,500kVA for 11kV networks and 1,000kVA for 22kV networks.

Determining the location and size of padmount substations should be done considering the ultimate subdivision state, being the total lots available and the projected load and generation demands.

The preferred arrangement is to balance the number of distribution substations with LV circuits for supply to distributed customers. There is a risk of over investment in LV circuits to cater for the unpredictable demands associated with this customer class. Consequently, it is Energex and Ergon Energy practice to minimise the number of LV circuits by establishing alternate distribution substation sites, including future sites, as this will provide greater flexibility for meeting demand variables. Without formal approval, no more than two LV circuits are to be installed from a new Padmount to allow future spare CFS units in the PMT to cater for future direct connections and load growth.

No overload is permitted on transformers supplying commercial and industrial installations. Table 14: Distribution transformers - assigned loading limit factor for well-ventilated situations, lists the maximum rating for differing transformer types, sizes, and configurations to be applied for planning and design purposes.

A minimum 45kVA per lot is generally used for transformer sizing, for both ADMD and ADME calculations.

The minimum ADMD and/or ADME value for new lots connecting in commercial and industrial subdivisions is 45kVA.

Load and generation demands can be determined by multiplying the number of vacant lots by this figure. Where the future load of a lot is known, is greater than 45kVA, and supply will be from the street, use the determined load/generation in lieu of the 45kVA per lot.

See section 8.4 Determining load and generator requirements for alternate ways to assess load and generation.

LV Drop settings for commercial/industrial subdivisions can be found in Appendix G.

The number of padmount substations initially installed will be determined by the anticipated timing of lot sales. (Resulting in vacant padmount substation sites where the HV cables will loop in and loop out). In developments likely to experience slower lot sales, Energex or Ergon Energy may agree to the provision of vacant padmount substation sites (rather than sites with the padmount substation constructed) where the HV cables loop in and out of each site, to provide for future connection to a padmount substation.

Connections personnel must consult with Distribution Planning to confirm growth projections on impacted feeders.

Padmount transformer sites and ring main unit sites shall comply with a 1 in 100-year event or the prescribed Defined Flood Level (DFL).

Land sites that are proposed for redevelopment where the DNSP already has a substation must retain provision for at least equivalent substation capacity within the redeveloped site. Any proposal to relinquish the padmount site or reduce the substation capacity will require approval from the Distribution Planning Manager.

13.1.1 Distribution substation sizing and provision for LV ties

Urban areas

When planning for and designing distribution substations in urban areas, allowance should be made:

- For customer loads up to and including 750VA, a single LV tie with a minimum of 200kVA load capacity; (i.e., add 200kVA to the customers load when considering the transformer size
- For customer loads in excess of 750kVA plus the 200kVA allowance for an LV tie, a two (2) or more transformer installation should be provided
- A substation enclosure that allows for an upgrade to at least the next transformer size
- The Customers installation to design for fault levels that consider the maximum transformer/substation size for the life of the installation.
- LV ties are to be installed on all LV circuits to prevent outages of commercial customers during maintenance of the network.

Rural areas

For commercial / industrial customers connecting to rural networks, any LV tie requirements shall be assessed on a site-specific basis by Distribution Planning.

13.1.2 Distribution substations & RMU sites selection

Refer to sub-section 6.5.1 in its entirety for site selection.

13.2 HV cables used in commercial / industrial subdivisions

The same HV cables are used in commercial / industrial subdivisions as in URD subdivisions.

Refer sub-section 11.2 for a list of cable sizes.

Paper lead cable has been used extensively for underground HV feeders in the CBD's of Brisbane, Ipswich and the Gold Coast. XLPE insulated cables have been predominantly used outside these areas and exclusively for feeder exits from zone substations, as backbone for 11kV and 22kV feeders and in commercial / industrial subdivisions.

Where new work is being undertaken, then it is Energex preference to establish the capability to utilise XLPE cables rather than paper lead cables. This involves the installation or availability of larger diameter HV cable conduits.

13.3 Industrial subdivisions with overhead electricity supply

The preferred supply arrangement is for the subdivision to connect to alternate HV feeders, one at the subdivision entry, and an alternate one at the subdivision exit.

HV ties within the subdivision will typically be overhead, however Energex or Ergon Energy may stipulate an underground tie is required for reliability or environmental reasons. The assessment of load is to include all load on affected spurs, not just the load that is being added by a single subdivision.

It is also preferable for HV ties to connect to an alternate HV feeder. Where this is impractical or uneconomic, the tie can spur from the same 11 kV feeder. In this instance, it is required that the tie spur traverses an independent route to the original feeder.

Note: HV ties do not include supply to single customers. Single customers may choose the level of security of supply they require from the distribution network. (i.e. N or N-1 etc).

13.4 HV Network layout in commercial / industrial subdivisions

Commercial & industrial subdivision developments shall only have a loop in / loop out configuration for the 11kV or 22kV HV network.

The subdivision shall cause no reduction of existing HV feeder capacity.

Loads are less predictable in commercial / industrial estates than for URD. The general magnitude of loads for a new commercial / industrial subdivisions may be estimated by:

- Considering allotment sizes and land zoning
- Examining nearby developments or earlier stages of the estate
- Confirming whether any lots have specific clients with known load/generation
- requirements.

Consumers with loads in excess of 100kVA (maximum demand calculated according to the latest revision of AS/NZS 3000) may require a distribution substation on their premises. Consumers with loads in excess 200A/phase are highly likely to require a substation on their premises.

Where there is a low likelihood of demand growth, consumers with loads ≤ 160A/phase may be supplied from a street circuit. However, as previously mentioned, with the electrification of the transport industry, low growth scenarios are considered unlikely.

Refer section 6.5: Requirements for substation on Customer Premises, and section 8: Commercial / industrial Customers, for details of distribution substations on customer premises.

13.4.1 HV tee joints (parallel branch joints)

For commercial / industrial applications, HV tee joints in underground developments are not allowed. The alternative is to install an RMU or a padmount substation with suitable switchgear.

(Note: New HV tee joints are not acceptable on any part of the distribution network).

13.4.2 Underground Industrial Developments (UID)

As with URD estates, reticulation in underground Commercial/Industrial (C&I) estates typically comprises padmount substations supplying LV circuits, looping between service pillars on alternate lot boundaries. All cables are run in conduits with the installation of spare conduits to provide for future load growth. The respective DNSP will advise the number of conduits for future requirements.

Loads are, however, generally much larger, and less predictable, and for this reason, UID networks differ from those used for URD as follows:

- All LV cables are 240 mm^2 4C Aluminium XLPE types
- Large-turret C&I service pillars are used. These have provision for up to 3 services.
- All C&I lots shall have a minimum of 6x125mm + 1x100mm comms conduits installed along all lot boundaries abutting road reserve. Road crossings to be a minimum of 6x125mm + 1x100mm comms conduits.

When a subdivision is known as having significantly large loads, the DNSP may require additional conduits to be installed as part of the project. The DNSP may request these additional conduits during the concept enquiry stage of the subdivision.

Figure 9 shows a typical arrangement for an Underground Industrial Development.

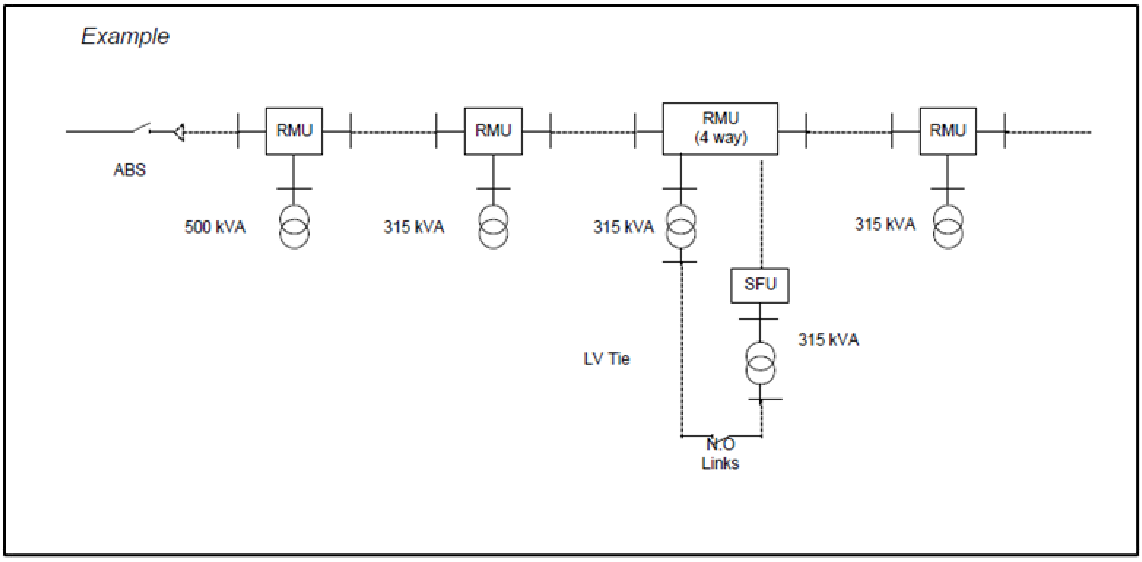


Figure 9: Typical arrangement for a UID estate

13.5 Supply to individual customers in industrial / commercial subdivisions

Where there is a confirmed future load greater than the base allowance of 45kVA, the developer/design consultant shall provide written evidence of the confirmed load/generation.

Refer to section 8 Commercial / industrial Customers and sub-section 6.5: Requirements for substation on Customer Premises, for details of larger customers within commercial / industrial subdivisions requiring a distribution substation on their premises.

The type of substation will typically be a pole or ground mounted substation for overhead supply, a padmount substation for underground supply, or, if the load is larger, a chamber/indoor substation will be required.

13.6 Staged developments and radial feeders – commercial / industrial subdivisions

Each DNSP has a responsibility to ensure network configurations resulting from new customer installations are designed to facilitate the safe and timely restoration of supply, including repairs to the network following a fault.

The following requirements for staged developments within commercial / industrial subdivisions take these requirements into consideration:

- The subdivision shall cause no reduction of existing HV feeder capacity
- Developers are responsible for the design and construction of any HV feeder ties associated with and required by, or initiated by, a subdivision project. Master planned and multistage developments shall eliminate the number of HV feeder spurs through effective HV network planning
- Masterplan and multistage developments may construct large HV feeder spurs before the ultimate HV feeder ring or the HV feeder tie is closed. These progressive HV feeder spurs

shall be negotiated with the relevant DNSP and acceptance by the DNSP will be based on stage timing of the subdivision, the ultimate master plan and the associated reliability of supply risk to connected customers

- The DNSP mandates loop in / loop out arrangements for the HV network within industrial / commercial subdivisions based on projected future developments including the timing of these developments, future undergrounding of overhead lines, and / or reliability for planned and unplanned customer outages
- In overhead estates, the DNSP may request the installation of conduits by the developer to allow for the future undergrounding of the HV network.

Where the DNSP identifies the need for a master plan, and it is not forthcoming, then the DNSP is likely to reject the subdivision proposal.

13.7 Low Voltage (LV) networks in Underground Industrial Developments (UID)

13.7.1 LV networks general

The low voltage underground network consists of a three-phase network, which is divided into circuits. Each circuit is supplied from a distribution substation. Initial supply to Individual lots is taken from above ground service pillars, which are located within the road reserve at lot boundaries.

LV circuits emanate from the LV switchboard of the padmount transformer. Note: There is no capacity to connect a customer service at the substation unless the substation abuts the Customers premise, and the load justifies such a connection.

No more than two LV circuits are to be installed form a Padmount to allow future spare CFS units in the PMT to cater for future direct connections and load growth.

Padmount substations must be situated to enable the distribution of the LV supply to customers by the standard cable sizes within statutory voltage limits.

All new underground LV cables in the LV network are 240mm^2 Al XLPE.

Connection to each lot is a three (3) phase connection, so phase balancing for LV service purposes is not required.

The electrical design must integrate with the existing network and future development of adjacent areas.

A two-way above ground link pillar is used to create “normally open” points between sections of the low voltage network supplied from neighbouring padmount substations. LV ties are to be installed on all LV circuits to prevent outages of commercial customers during maintenance of the network.

A three-way above ground pillar or a distribution cabinet, is used to provide points of isolation within the low voltage distributor circuit, which incorporate long branch circuits.

The designer shall make provision for contingency conditions, such as spare conduits for future additional circuits. The DNSP may request these additional conduits during the concept enquiry stage of the subdivision.

Typically, LV circuits are to be designed to 200 –400 m in length. Experience has shown that circuits in excess of 400m in length are likely to incur technical difficulties.

A typical LV circuit arrangement within an industrial estate is illustrated in Figure 10 below.

13.7.2 LV physical configuration

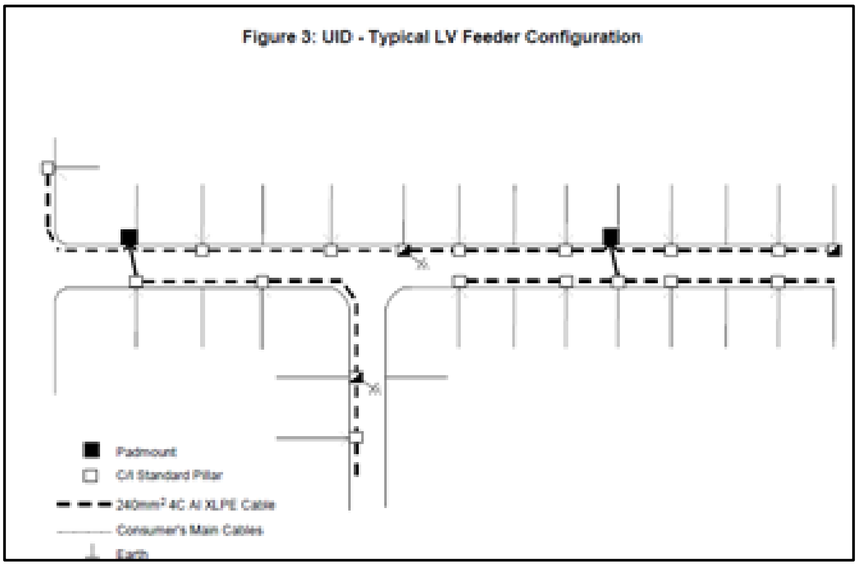


Figure 10: UID - typical LV circuit configuration

13.7.3 LV network pillars and cabinets in industrial subdivisions

Pillars are located on the boundary between lots, so that the standard practice of servicing each lot can be serviced from the one pillar.

When there is a confirmed future load, greater than the base allowance of 45kVA supply for each subdivision lot being created, the DNSP will permit this to be incorporated as a part of the subdivision project, provided that no additional transformers are required.

Developers/consultants shall provide written evidence of the confirmed load. The confirmed future load shall not be calculated by using a VA per square metre basis for the overall size of the lot being created in the subdivision.

Where high load requirements have been confirmed at > 200A per lot, an industrial service pillar, a “supa pillar,” or an LV distribution cabinet shall be installed as part of the subdivision project. This may require dedicated LV circuits from the distribution substation.

Three-way pillars must be installed for cross road 240mm^2 LV mains in addition to the commercial and industrial pillars supplying the lots in the subdivision.

It may not be possible to fully meet all these criteria and the local government authority may have preferences for these sites, which need to be considered.

Refer to the relevant DNSP’s design and construction manuals for additional information.

13.7.4 Pit and duct installation

The relevant DNSP may require concrete cable pit and duct reticulation in lieu of, or in addition to conduits, should the electrical corridor not be turf, or there is a reasonable likelihood that the location will require to be accessed in the future.

13.7.5 LV network tie policy

Low voltage ties between adjacent distribution transformers improve network reliability and operational flexibility, as well as facilitating the use of CMEN earthing at transformers. LV ties are to be installed on all LV circuits in a C&I subdivision to prevent outages of commercial customers during maintenance of the network.

Refer sub-section 13.1.1 for LV tie policy in Urban areas.

In Rural areas, LV ties should be installed wherever practicable.

Ties between LV circuits are ‘normally open,’ and should only be used as a back-up supply. i.e., they must not be run as rings to resolve voltage issues when planning or designing the LV network.

As stated in sub-section 11.9.2 above, ties are facilitated by link pillars, 3-way pillars and distribution cabinets.

Figure 8 is an example of an ideal urban LV schematic with all LV circuits tied to adjacent areas with alternate HV feeds.

13.8 Industrial and commercial subdivisions in rural environments

For rural developments the likely demand will not generally warrant an interconnected HV network unless this is required for other reasons. The selection of the substation transformer size must be a practical balance between the cost of substations, HV and LV line costs, and reliability considerations.

As the number of connected customers falls there will be less diversity of demand and a greater impact from unbalanced supply factors making the extensive use of LV networks unattractive. The best solution will depend on allotment size, and it should be expected that transformer size and the extent of LV networks will decrease with an increase in allotment size.

An arrangement using overhead high voltage (HV) pole substations and overhead services is the preferred construction for large allotments.

Initial design will allow for the provision of a basic HV "backbone" supply to the subdivision. The design should attempt, as much as possible, to cater for the efficient location of future substations HV extensions and LV mains.

Just as for rural residential subdivisions, pillars shall not be located in non-urban or rural areas, due to the risk of vehicle [slashers etc.] impacts and fire damage. Proposals to locate pillars in non-urban locations need the approval of Distribution Planning and Network Management.

In some situations where the supplied load is > 315A/phase, the DNSP may accept the consumers mains on the DNSP pole. Such arrangements must be confirmed in writing by the DNSP.

All servicing arrangements must comply with the QECM.

Additional requirements include (but are not limited to):

- Where an existing overhead site is being altered, the entire site shall be upgraded to the current planning and design standards
- Where long runs and spans of bare low voltage conductors have previously been used, HV reticulation in combination with a greater numbers of smaller capacity distribution transformers may be required for the project
- Three phase LV supply is to be established on the road reserve as close as practical to the proposed building envelope. The developer/consultant shall give due consideration as to the local topography and the route of any future consumer’s mains between the DNSP Point of Supply and the nominated building envelope

- The provision for future HV overhead mains shall be considered during the planning phase for any overhead reticulation i.e., full height poles being installed making allowance for future HV mains to be erected above the proposed LV mains required for the subdivision
- In some cases, it may even be necessary to provide a HV extension into private property to suit a future site. This will require an easement. Refer section 16.1 for additional information
- Existing consumer's lines that cross property boundaries as the result of a subdivision are required to be relocated at the developer's expense.

The developer shall:

- Provide internal road/s from which all lots can be serviced using Energex or Ergon Energy
- Standards
- Show the nominated building envelope for each lot shall be shown on the design drawings
- Make three phase LV supply available to all lots
- (Three phase LV supply is to be established on the road reserve as close as practical to the proposed building envelope. The developer/consultant shall give due consideration as to the local topography and the route of any future consumer's mains between the Point of Supply and the nominated building envelope)
- Time the development so there is an obvious close and clear alignment between the
- development and the timing of any "associated" electrical works
- Existing consumer's lines that trespass and cross the property boundaries created as the result of a subdivision shall be relocated at the developer's expense.

On completion of the electrical works for the subdivision, future DNSP Customers will be required to arrange for their own individual electricity supply from the constructed backbone system. This will normally involve the provision of a substation and/or low voltage mains.

14 Community Title Schemes (CTS)

In addition to the requirements below, electrical work in Community Title Schemes must comply with the requirements of the QECM.

14.1 Energex network

These section 14.1 general design parameters apply to both Standard Lot Format Plan and Building Format Plan Residential Community Title Schemes.

Energex permits the internal reticulation of a Community Title Scheme as contestable work provided that the internal road is located within common property and the internal road provides vehicular access to all dwellings. The Energex internal reticulation must supply five (5) or more lots and requires multiple LV service pillars. Consideration shall be given to a staged Community Title Scheme development. Spare HV/LV conduits will be required throughout the Community Title scheme, Energex & Ergon Network will not accept Pillars to be located in concrete pathways, they will require a grass cut out to allow access for maintenance and replacement in the future. The DNSP may request these additional conduits during the concept enquiry stage of the subdivision.

If the Community Title Scheme does not meet these above requirements, and the design parameters as listed below, then Energex considers the project non-contestable works which will be designed and constructed by Energex with a single Service Point.

The following general design parameters apply for Community Title Schemes with Energex internal reticulation:

- ADMD/ADME and LV drop requirements are the same as standard residential subdivisions. See section 18
- Community title lots located within a freehold residential subdivision will require a minimum ADMD allowance of 45kVA as per the standard for commercial and industrial lots, or the associated residential ADMD/ADME per proposed residential premise
- Two HV conduits will be required to the location of the community facility lot from the existing 11kV network, and a detailed concept plan shall be submitted to Energex. If the planned AS/NZS3000 ultimate load is known for the community facility lot, and this load exceeds 45kVA, then the design consultant shall use this AS/NZS3000 known load in all LV Drop calculations and may need to install the relevant padmount transformer. A community facility lot is for uses such as a clubhouse, entertainment venue, etc.
- Energex conduits, cables and assets shall be installed on a consistent alignment in common property consistent with the details contained in the Energex Underground Distribution Construction Manual
- The allocated corridor for Energex assets shall be an area that is turfed with only cross overs for driveways and parking bays, and a minimum width of 1.5 metre common property verge. The allocated corridor shall be free of all landscaping (such as gardens including mulched beds, shrubs, and trees) and permanent structures (such as Bio-retention basins, rubbish bin enclosures, group mailboxes, carports, and retaining walls
- The maximum permissible size of Padmount Transformer for a CTS residential subdivision is 500kVA for C&I loads and 315kVA for residential..

In Community Title Schemes, Energex will not approve:

- A reduction in the width of the allocated corridor

- Any proposed “pillar cut-outs” into the lots.
- Electrical assets that are not within common property.

The supply method for a Standard Format Plan CTS development is each lot must have three phase supply available to the lots.

The supply method for a Building Format Plan CTS development is a maximum of four individual single-phase units supplied from a single six fuse LV pillar. The location of the main switchboard for each unit needs to be shown on the works plans.

A Community Title Scheme must not have mixed points of supply from Energex network both inside and outside of the development.

Community Title Schemes require the installation of an 11kV loop in / loop out arrangement within the development. To maintain flexibility in the 11kV network, a 4-way RMU may be required where the 11kV network enters the development. This is to avoid having the 11kV feeder backbone looping in and out of the development and impacting reliability to customers outside the development should there be a network fault inside the CTS development.

24 Hour unrestricted access is required to all Energex assets located within the Community Title Scheme.

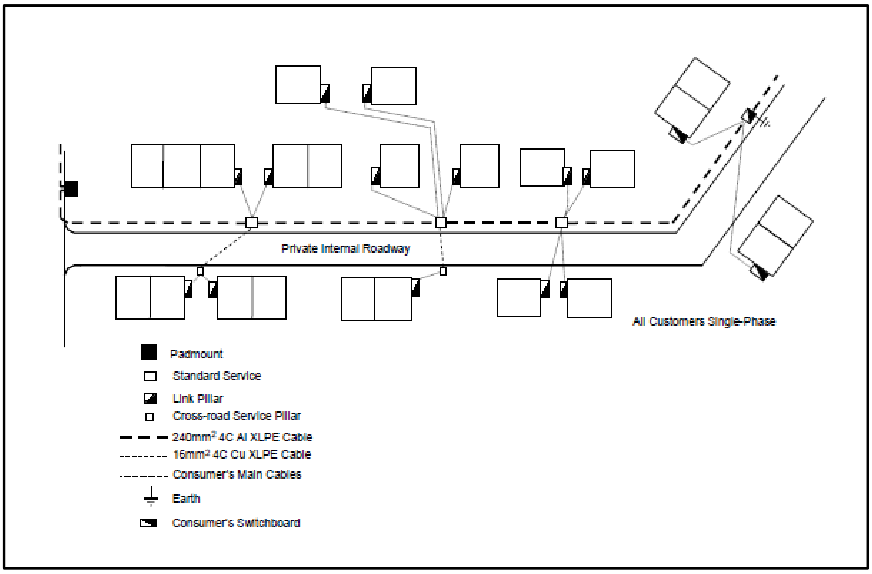


Figure 11: Community title - typical LV network configuration

Servicing of lots within the CTS must be in accordance with the QECM.

14.2 Ergon Energy network

Ergon Energy does not permit developers to design and install/construct electrical reticulation within Community Title Schemes:

- As community title developments are all on private land and there are no public road reserves, easements will be required for all Ergon Energy assets. The following easements are required:
- Padmount Substations, site size shall be as per the Ergon Energy Underground Construction Manual, drawings 5000 and 5114. The easement will be exclusive to Ergon Energy. i.e., no other services can cross the easement

- Cable trenches, easement width shall be equal to the required trench size. The easement for cable trenches will not restrict other services from crossing the easement provided the minimum separations are maintained.

In all cases Ergon Energy assets are to be located on common land within the community title and not within individual lots.

Easements for padmount substations and cable trenches are to be granted at no cost to Ergon Energy and are required to be registered prior to energisation of the connection assets.

Servicing of lots within the CTS must be in accordance with the QECM.

15 Other development types

15.1 Manufactured home (residential) parks

The DNSP will typically provide one DNSP Service Point from the road reserve/property boundary to common property. An additional DNSP Service Point may be provided where the requirements of the QECM are met.

Any connections within the manufactured home park must be in accordance with the QECM for both the Energex and Ergon Energy networks.

15.2 Laneway developments

Any connection/s to and within laneway developments must be in accordance with the QECM for both the Energex and Ergon Energy networks

15.3 Hatchet lot subdivisions

Any connection/s to and within hatchet lot subdivisions must be in accordance with the QECM for both the Energex and Ergon Energy networks.

Where there are two or more “hatchet lots” located behind another lot with access down the side of the front lot, the developer shall make underground supply available in the road reserve.

It may be necessary for the developer to provide two or more service pillars adjacent to each other on the footpath in the road reserve. No more than two customers shall be supplied from any six-fuse pillar.

If the direct means of pedestrian and vehicular access to the rear lot or rear lots is via an access and services easement, then the AS/NZS3000 consumer’s mains to the rear lot/s shall be located within the access and services easement.

The DNSP will not permit a Services Easement (this being solely for services) for the AS/NZS3000 consumer’s mains to the rear lot/s when the direct means of vehicular / pedestrian access to the rear lot/s is via a different route.

The Point of Supply shall be located in the immediate vicinity of the vehicular entry to the rear lot/s.

15.4 LV assets in private driveways

The installation of the DNSP LV assets in private driveways is not desirable, however will be considered by the DNSP at concept enquiry stage.

The private driveway shall have sufficient space to install DNSP LV assets in a 1.5-meter-wide grassed area adjacent to the driveway.

A minimum of three-meter-wide underground electricity easement shall be granted in favour of the DNSP.

The DNSP will provide a connection from the road reserve/property boundary via a pillar.

All connections must comply with the QECM.

16 Easements and Consent to Work (Wayleaves)

16.1 Easements

Easements or Consent to Works are required for all Energex or Ergon Energy HV assets and underground cables assets installed on freehold or leased property/lots and plans.

For tenure requirements for Energex or Ergon assets installed or constructed on crown, state, or council owned land, refer to the relevant Fact Sheet available from the contacts listed in Table 1.

Easements provide the DNSP with the right of clear access on a permanent basis to ensure electrical infrastructure can be regularly or immediately inspected, operated, maintained, and repaired to ensure a safe and reliable supply of electricity.

These DNSP assets include, (but are not limited to) HV overhead lines, HV and LV underground cables, distribution substations [padmount, indoor/chamber, ground etc], RMU's, distribution cabinets and any associated civil infrastructure.

All easements must include and provide for unimpeded 24/7 access for plant, equipment, and personnel. Equipment includes (but is not limited to) trucks, cranes, Elevated Work Platforms (EWPs), back hoes etc. i.e., equipment necessary to maintain, repair or replace the electrical assets and associated civil infrastructure.

Access to line assets contained within an existing easement corridor should be made along the easement corridor. If this is not possible due to topography or boundary fencing, alternative access arrangements are required. Where alternate access arrangements are negotiated, they should also be included in an easement.

As easements are registered on the land title, a separate easement is required for each parcel of land on which the electrical infrastructure is to be located.

Each DNSP has standard easement terms and conditions for use for Electricity Easements, which must be incorporated into an easement submission. These terms and conditions are not negotiable. Additional information is available on each DNSP's website and can also be provided by the relevant DNSP contact listed in Table 1, in conjunction with the EQL Property Department.

The easement encumbers the property regardless of the transfer of ownership and will remain operative in perpetuity (i.e., forever) as long as the DNSP requires. An easement does not, by nature, affect the ability to later subdivide the land. In subdivisions, newly created lots will be encumbered by any pre-existing easement.

Easements may be acquired either by negotiation or resumption and are taken as a matter of policy over all new HV assets, and all underground electric lines on private property regardless of capacity.

Note: Care should be taken by developers, planners, and project managers to ensure easement requirements are identified early in a project to allow adequate lead time for acquisition and registration of easements on title.

Where an easement or wayleave cannot be obtained in the time available (excluding customer-initiated delays, then the alternate process listed in sub-section 16.1.8 must be entered into and progressed.

Every application for participation in the alternate process must be approved by the Manager, Network Management.

16.1.1 Easement details

Where the DNSP has determined that an easement is the relevant tenure for all or part of the Customers connection requirements, the DNSP will provide the required size (width, length and volume if required) of the easement.

Easement sizes will vary depending on factors such as the receiving environment, line or cable voltage, number of circuits, circuit layout, assets required, clearance requirements, electric and magnetic field considerations, common vs separate earthing requirements etc.

Common easement sizes (non-volumetric) are shown in Table 23 below.

Table 23: Typical easement widths and sizes

Asset type	DNSP	Site Sizes are indicative only
LV and HV overhead lines	Energex Ergon Energy	10m to 30m
Cable trench[1]	Energex Ergon Energy	3m to 10m
HV switches/protective devices	Energex Ergon Energy	2.8m x 3.0m to 6.8m x 11.0m
Padmount substation	Energex Ergon Energy	2.8m x 3.0m to 13.0m x 15.0m
C&I substation – outdoor	Energex Ergon Energy	Site specific – will be advised during the application phase
C&I substation – indoor	Energex Ergon Energy	Site specific – will be advised during the application phase

Notes 1: Site specific 'apron' style easements will be negotiated for situations where substations are recessed into a property. This width of such easements will be site specific.

The DNSP is the sole determinant of the required easement size/s.

16.1.2 Minimum cable easement width

The minimum cable easement width is three (3) metres. All easements shall be of sufficient width to provide for installation and maintenance of electrical assets, including the use of appropriate plant and equipment to undertake the necessary works. This is for both HV and LV underground cables.

16.1.3 Easements in freehold subdivisions

Refer Section 10.7 for additional easement details in freehold subdivisions.

16.1.4 Easements in Community Title Schemes

Energex and Ergon Energy have differing requirements for Community Title Schemes.

Refer Section 14 for specific information regarding each DNSP's requirements.

16.1.5 Development work within DNSP existing easements

All proposed works in an existing Energex or Ergon Energy easement shall be approved by the relevant DNSP Property Department, prior to any works commencing within the easement.

This includes any civil works; electrical reticulation works, and public lighting works associated with a subdivision or development project.

All requests for approval of proposed works within a DNSP easement must be in writing and in the first instance be submitted to the relevant DNSP contact listed in Table 1.

The easement conditions on existing easements should be investigated by the design consultant prior to planning and designing any alterations or upgrades to the existing network.

16.1.6 Alterations to existing DNSP assets due to change of land use (Including road closures)

Alterations to existing works are sometimes necessitated by changes in land use. Where DNSP existing assets are requested to be removed, relocated or both, Energex and Ergon Energy recover the cost of such work. (Such work is classified as an ACS).

Easements are required for all DNSP assets where they are outside existing or proposed public road reserves. This includes DNSP assets remaining in their current location, and assets being relocated.

16.1.7 Electricity supply relocation or abolishment involving substations on customer premises

Where a substation exists on a property undergoing development, and the developer requests relocation of the substation, then the required action and associated costs are dependent on whether the substation has any requirement to continue supplying customer/s.

This includes supplies on the property (such as a builders' temporary supply) and/or supplies beyond the property boundary. i.e., the substation has circuits connecting back into the street/s supplying other customers.

In this situation the applicant is responsible for all costs associated with the DNSP providing an alternate supply to the network (regardless of whether the DNSP assets are within or without an easement).

Where abolishment of a substation (within an easement) supplying customers beyond the property boundary is requested, the applicant is responsible for all costs associated with the DNSP finding and providing an alternate supply.

Where abolishment of a substation (without an easement – after 1994) supplying customers beyond the property boundary is requested, the DNSP is responsible for recovering the electrical assets on the property and finding and supply customers external to the property with an alternate supply. However, the applicant is required to provide the DNSP with a reasonable time frame to arrange an alternate supply.

All substation relocation and abolition requests impacting customers beyond the property boundary must be done in conjunction with Network Management. The Manager, Network Manager is the final decision maker in approving the alternate supply arrangements.

16.1.8 Easement requirements prior to issuing a "Certificate of Supply"

Where an easement is required on a subdivision project and before a Certificate of Supply is issued to the developer or approval is granted to switch and commission the new assets, Energex or Ergon Energy requires the developer to provide the following items:

- A copy of the surveyor signed survey plan showing the proposed easement, and
- The relevant easement documentation.

The design consultant is responsible for ensuring that the easement documentation is forwarded to the relevant DNSP contact listed in Table 1.

The relevant DNSP contact will ensure that the easement satisfies the relevant DNSP's requirements and if so, will then arrange for the easement documentation to be executed by Energex's Property Department and returned to the developer or their solicitors.

All costs and outlays associated with the preparation and lodgement of easement documentation in a subdivision project are the responsibility of the customer/developer.

16.2 Consent To Works (formerly wayleaves)

16.2.1 Protection of wayleave consent

Energex and Ergon Energy infrastructure on private property is generally protected by easements or Consent to Works. Each DNSP has statutory rights under the *Electricity Act 1994 (Electricity Act)* and the Electricity Regulation 2006 (Electricity Regulation).

Consent to Works are covered by the *Electricity Act* sections listed below:

- Section 98 – Electricity entity entitled to access its works
- Section 112 – Future owner or occupier of place taken to have consented to building of works
- Section 136 – Entry to repair etc works or electrical installations

and the following relevant sections of the Queensland Electricity Regulation:

- Section 59 – Owner to provide space for substation
- Section 60 – Supply to other customers from substation.

Where there is no registered easement or a wayleave/consent to work cannot be found, the above sections of the legislation give each DNSP the right to retain and maintain existing electrical infrastructure on private property. This applies to all assets installed prior to 1994 and all substations and associated assets supplying load to a customer > 100kVA.

Wayleave consent given by a property owner (or existing in accordance with the above legislation) is deemed to be consent of any and all subsequent property owners and occupiers.

16.3 Purchase of Land by Energex or Ergon Energy

There are occasions whereby Energex or Ergon Energy purchases the whole of a property to accommodate electrical works. This usually occurs when a major sub-transmission line is constructed through highly developed areas of small allotments.

If the route of a proposed overhead or underground electric line requires an easement which would either totally or seriously encumber an allotment and this would deprive it of the only building site, the DNSP would be required to purchase such a site at a value typically determined by the Valuer General.

17 Additional considerations

In addition to easement requirements, the Customer is responsible for acquiring all tenure rights required for the installation of electrical assets on the premises, including the cost of doing so.

Tenure rights may include consideration of matters such as

- cultural heritage requirements under the *Aboriginal Cultural Heritage Act 2003* (Qld), the *Torres Strait Islander Cultural Heritage Act 2003* (Qld) and the *Queensland Heritage Act 1992* (Qld) and cultural heritage management plans
- native title requirements under the *Native Title Act 1993* (Cth) and Indigenous land use agreements
- the *Sustainable Planning Act 2009* (Qld), State and regional planning policies, local government planning schemes, any required development applications, and approvals
- vegetation clearing requirements including under the *Vegetation Management Act 1999* (Qld);
- the requirements of the *Nature Conservation Act 2002* (Qld);
- environmental requirements and offsets, including under the *Environmental Protection Act 1994* (Qld) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), and environmental management plans;
- the application of the *Mineral Resources Act 1989* (Qld) or the *Petroleum and Gas (Protection and Safety) Act* 2004 (Qld)

Other legislation and government departments may be relevant depending upon the geographic location and nature of the works, for example, legislation dealing with marine environments, workplace health and safety, air quality etc.

18 After Diversity Maximum Demand (ADMD) and After Diversity Maximum Export (ADME)

18.1 Introduction

Both Energex and Ergon Energy have used ADMD as a foundational building block for the planning and design of LV networks, and the sizing of distribution transformers.

With the proliferation and continuing growth of roof top solar, we now have to consider both demand and generation. i.e., maximum demand, minimum demand, and reverse power flows.

The electrification of the transport industry, and particularly the increase in the use of electric vehicles, adds another dimension to the considerations to be made when planning and designing both HV and LV networks.

Other technologies such as small residential battery systems, and the increase in use of power electronic interfaced appliances and lighting all impact how electricity networks are used, including the impact on ADMD.

As a result of the changes in the way the network is used by residential customers, and particularly in regard to the impact on LV networks, during the last quarter of 2022, and the first half of 2023 Energy Queensland have completed a review of how this change affects the way we plan and design LV networks.

In addition to ADMD, there is also current and future loading problems due to PV export power. This PV export also has a degree of diversity and will be referred to as After Diversity Maximum Export (ADME).

18.2 A Revised (new) methodology (2023)

ADMD has historically been derived on the basis of peak domestic customer loads assumed to follow a statistical normal distribution.

The ADMD study conducted found that this assumption is no longer the most accurate to follow, and a more accurate representation of domestic customer loads is achieved by using a skewed distribution called the Generalised Extreme Value (GEV) distribution.

In addition, the continued strong take up of roof top solar on domestic detached premises has resulted in the ADME measure having the most influence on network current flows. (i.e., Load and generation), with generation, or reverse power flows projected to have the greater influence in the planning and design of LV networks into the future.

Conclusions

In this study new values of the ADMD have been determined. These values were generated using tens of thousands of sampled customer metering data points, along with EV charging data and distribution transformer monitoring data.

The major findings may be summarised as:

- The legacy derivation of ADMD(N) assuming normally distributed demands does not result in the best fit to the sampled data. Alternatively, a power law formula fit to the data via curve fitting optimisation resulted in a better representation of the sampled ADMD values
- The standard customer scenario (no EV, batteries etc.) findings discovered that the ADMD was approximately 1.5 - 2kVA less than the legacy ADMD values (however

bearing in mind that legacy values allowed headroom for “betterment” of loads into the future)

- The impact of 1 EV on ADMD was approximately +0.4kVA and the impact of 2 EVs was approximately +0.8kVA
- There is some diversity in export, resulting in an $ADME_{(100)}$ of approximately 4.5kVA, however in the future that an export of 5kVA per PV residential customer should be assumed
- While the power law formula was the better fit to data, the legacy formula, and associated parameters ($ADMD_{inf}$, SD, k), were able to be optimised in order to approximate the power law formula. This enables the use of the new findings in legacy programs such as LV Drop software
- If 2 EVs are assumed, and PV export can be controlled, we can expect $ADMD_{(100)}$ values between 3.9 - 4.2kVA
- Alternatively, if PV export cannot be controlled, the limiting design value for LV networks would by 5kVA
- Customers with Battery Energy Storage Systems (BESS) did not have a consistently lower ADMD than the standard Customer ADMD. Because of this marginal impact, no further consideration has been given to BESS on design ADMDs

It is intended that these results, particularly the EV charging impacts and the increased use of BESS, are reviewed every three to five years to ensure that the impact of emerging technologies are adequately represented in the ADMD design values.

Outcomes

Specifically:

- New values will apply to ADMD calculations
    - Includes EV consideration
- ADME values have been determined so voltage rise calculations can now be included in LV network voltage management
    - Recognising the impact of roof top solar penetration on LV circuits
- The new methodology has been “fitted” to allow the use of existing LV network planning tools, namely the continued use of LV Drop software
- The new design values can be implemented immediately.

18.3 Comparison of ADMD (and ADME) legacy settings and new settings

To asset network planners, network designers, connections staff and external consultants, the following tables are provided for use in LV Drop software.

These tables are split between greenfield sites and brownfields sites.

18.3.1 ADMD / ADME settings – greenfield and brownfield sites

18.3.1.1 Energex network

Table 24: Energex greenfield ADMD / ADME values

Title	Description	kVA	Std dev	k	pf
Small dwellings					
Legacy	Retirement village units, cluster housing, duplex units, relocatable homes, units/townhouses, low-cost housing	3.0	1.5	2	0.97
Replaced with					
ADMD[1] **No EV**	Small housing/townhouse/unit/apartment **without car accommodation**	**3.2**	**3.2**	**2**	**1.0**
ADMD[1] **+ 1 EV**	Small housing/townhouse/unit/apartment **with car accommodation**	**3.6**	**3.6**	**2**	**1.0**
Standard dwellings					
Legacy	Middle houses (3-4 bedrooms) (majority of new houses)	4.0	2.0	2	0.97
Replaced with					
ADMD[2] **+ 2 EV's** **+ full PV**	Standard housing (3-4 bedrooms) (majority of new houses)	**4.5**	**4.7**	**2**	**1.0**
Prestige dwellings					
Legacy	Prestige housing	7.0	3.5	2	0.97
Replaced with					
ADMD[3] **+ 2 EV**	Prestige housing	**5.0**	**6.2**	**2**	**1.0**

Note 1: "Retirement village, units, cluster housing, duplex units, relocatable homes, units/townhouses, low-cost housing" renamed to "small house/townhouse/unit/apartment." Planners, designers, and connection staff may choose a combination of both 'with' and 'without' car accommodation for modelling purposes.

Note 2:Given the projected future export limit of 5kVA for customers with PV systems, and the likely instances of residential developments with 100% PV penetration, the limiting value for ADMD/ADME will be due to the 5kVA export limit. The worst-case demand in the future will be customers with 1 or 2 EVs.

Note 3:The affluent areas have a significantly higher ADMD value, and therefore should have separate ADMD design parameters. Given the ADMD value is larger than the export limit of 5kVA, the load component is the limiting factor.

Table 25: Energex brownfield ADMD / ADME values

Title	Description	kVA	Std dev	k	pf
Small dwellings					
Legacy	Retirement village units, cluster housing, duplex units, relocatable homes, units/townhouses, low-cost housing	3.0	1.5	2	0.97
Replaced with					
ADMD[4] No EV	Small housing/townhouse/unit/apartment **without car accommodation**	**1.6**	**1.2**	**2**	**1.0**
ADMD[4] + 1 EV	Small housing/townhouse/unit/apartment **with car accommodation**	**2.0**	**1.4**	**2**	**1.0**
Standard dwellings					
Legacy < 2004	Middle houses (3-4 bedrooms) (majority of new houses)	3.25	1.6	2	0.97
Legacy ≥ 2004	Middle houses (3-4 bedrooms) (majority of new houses)	4.0	2.0	2	0.97
Replaced with					
ADMD[5] + 1 EV	Standard housing (3-4 bedrooms) (majority of new houses)	**2.9**	**2.3**	**2**	**1.0**
Prestige dwellings					
Legacy	Prestige housing	7.0	3.5	2	0.97
Replaced with					
ADMD[6] + 1 EV	Prestige housing	**5.0**	**6.2**	**2**	**1.0**

Note 4: Brownfield and greenfield values for small dwellings are the same.

Note 5: With the steadily increasing uptake of rooftop solar systems, and the exponential growth in EV sales, the ADMD +1 EV scenario has been selected as the most appropriate selection in modelling middle housing on the existing network, with ADMD value being the predominate consideration. For brownfield applications, should planners, designers and connections staff be aware of a more specific requirement as a result of local knowledge, then they may choose alternate connection/s.

Note 6: The affluent areas have a significantly higher ADMD value, and therefore should have separate ADMD design parameters. Given the ADMD value is larger than the export limit of 5kVA, the load component is the limiting factor even when considering only one EV connection. One EV is chosen reflecting the progressive uptake of EV's.

18.3.1.2 Ergon Energy network

Table 26: Ergon Energy greenfield ADMD / ADME values

Title	Description	kVA	Std dev	k	pf
Small dwellings					
Legacy	Not listed				
Added					
Southern ADMD[1] No EV	Small housing/townhouse/unit/apartment **without car accommodation**	**3.2**	**3.2**	**2**	**1.0**
Southern ADMD[1] + 1 EV	Small housing/townhouse/unit/apartment **with car accommodation**	**3.6**	**3.6**	**2**	**1.0**
Northern ADMD[1] No EV	Small housing/townhouse/unit/apartment **without car accommodation**	**3.2**	**3.2**	**2**	**1.0**
Northern ADMD[1] + 1 EV	Small housing/townhouse/unit/apartment **with car accommodation**	**3.6**	**3.6**	**2**	**1.0**
Standard dwellings					
Legacy	Southern – per lot	4.0	4.0	1	0.97
Legacy	Northern – per lot	5.0	5.0	1	0.97
Replaced with					
Southern ADMD[2] + 2 EV's + full PV	Standard housing (3-4 bedrooms) (majority of new houses)	**4.5**	**4.7**	**2**	**1.0**
Northern ADMD[2] + 2 EV's + full PV	Standard housing (3-4 bedrooms) (majority of new houses)	**4.5**	**4.7**	**2**	**1.0**
Prestige dwellings					
Legacy	Not listed				
Added					
Southern ADMD[3] + 2 EV	Prestige housing	**5.0**	**6.2**	**2**	**1.0**
Northern ADMD[3] + 2 EV	Prestige housing	**5.0**	**6.2**	**2**	**1.0**

See notes at Table 24.

Table 27: Ergon Energy brownfields ADMD / ADME values

Title	Description	kVA	Std dev	k	pf
Small dwellings					
Legacy	Not listed				
Added					
Southern ADMD[4] No EV	Small housing/townhouse/unit/apartment **without car accommodation**	**1.6**	**1.2**	**2**	**1.0**
Southern ADMD[4] + 1 EV	Small housing/townhouse/unit/apartment **with car accommodation**	**2.0**	**1.4**	**2**	**1.0**
Northern ADMD[4] No EV	Small housing/townhouse/unit/apartment **without car accommodation**	**1.6**	**1.2**	**2**	**1.0**
Northern ADMD[4] + 1 EV	Small housing/townhouse/unit/apartment **with car accommodation**	**2.0**	**1.4**	**2**	**1.0**
Standard dwellings					
Legacy < 2004	Middle houses (3-4 bedrooms) (majority of new houses)	4.0	4.0	1	0.97
Legacy ≥ 2004	Middle houses (3-4 bedrooms) (majority of new houses)	5.0	5.0	1	0.97
Replaced with					
Southern ADMD[5] + 1 EV	Standard housing (3-4 bedrooms) (majority of new houses)	**2.9**	**2.3**	**2**	**1.0**
Northern ADMD[5] + 1 EV	Standard housing (3-4 bedrooms) (majority of new houses)	**2.9**	**2.3**	**2**	**1.0**
Prestige dwellings					
Legacy	Not listed	7.0	3.5	2	0.97
Added					
Southern ADMD[6] + 1 EV	Prestige housing	**5.0**	**6.2**	**2**	**1.0**
Northern ADMD[6] + 1 EV	Prestige housing	**5.0**	**6.2**	**2**	**1.0**

See notes at Table 25.

18.4 LV Drop software settings

Recommendations for LV Drop software settings replicating the Power Law formula are included in Appendix E

Appendix A Considerations for determining load requirements

(Informative)

Determination of the electrical requirements are the responsibility of the developer/consultant and should be established from the best available information.

Some traditional methods of calculating load requirements include (but are not limited to):

1. Existing operations, or in the case of a new plant from knowledge of the equipment to be installed with a working diversity applied
2. VA per square metre
3. The total of the connected load of all equipment in the premises
4. AS/NZS 3000.

Each of the above methods has its advantages and disadvantages. Methods 3 and 4 provide an estimate of the undiversified demand which if adopted typically results in over design or an over-capitalisation of facilities. These would typically only be used when there is no diversity or when considering worst possible situations within an installation. e.g., when taking into account appropriate cable sizes, voltage drop, voltage rise and thermal ratings.

Experience has shown that methods 3 & 4 tend to give a value of maximum demand that is of the order of 60% higher than the actual measured value. Whilst it is not a recommended method of estimating maximum demand, it is useful in that it can be used as a check on the plausibility of the value obtained using the preferred methods.

Disturbing loads and consideration for parallel generation require special consideration and are mentioned elsewhere throughout this document.

In assessing load and generation requirements, customers are expected to have a good idea of the site load and generation requirements at the time of submitting a connection request. This may include the likely loading pattern. Understanding the loading pattern may provide the opportunity optimise the electrical infrastructure at the site.

Determining load requirements options.

Typical values for large installations normally fall within the range 80 to 150 VA/m^2. The estimate of maximum demand for the installation being planned/designed is then obtained very simply by multiplying the estimated VA/m^2 by its "gross floor area".

Table 28: Maximum demand based on gross floor area

Offices - Not air-conditioned	50
Offices - air-con - cooling only	85
Offices - air-con - reverse cycle	75
Offices - air-con - electrical reheat - Open Areas	100
Offices - air-con - electrical reheat Zonal	110
Offices - air-con - variable volume	70
Car parking[1] - open air	See note 1

Car parking[1] - ventilated	See note 1
Warehousing - unventilated	10
Warehousing - ventilated	15
Shops - Not air-conditioned	70
Shops - air-conditioned	100
Shops - with Large Refrigeration	150
Shopping centres - Not air-conditioned public areas	100
Shopping centres - air-conditioned public areas	120
Light industrial - lighting	15
Light industrial - ventilation and lighting	30
Light industrial - air-condition and lighting	55
Theatres, halls, etc - ventilated	60
Theatres, halls, etc - air-conditioned	100
Hotels, Taverns, Restaurants	80
Lifts - Low Rise (Gross building area)	5
Lifts - High Rise (Gross building area)	10
Refrigerated cooling plant - small	125
Refrigerated cooling plant - large	100

Notes: 1: Consultants should reference the National Construction Code for information on carparking requirements.

In choosing an appropriate value of VA/m^2 from within the above range of values, consideration should be given to the factors listed in Table 29.

Table 29: Factors to be considered when calculating maximum demand

CRITERIA	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	RURAL
Size & Type of Building	Yes	Yes	Yes	Not normally
Car Parking	Yes	Yes	Yes	Not normally
Number & Size of Lifts	Yes	Yes	Possibly Eqpt	No
Lighting	Yes	Yes	Yes	Yes
Type of Tenancy				
- single	No	Yes	Yes	Yes
- multiple	Yes	Yes	Yes	Not normally
Unusual loads	No	Yes	Yes	Yes
Future Expansion Change of Use in Long Term	Yes	Yes	Yes	Not normally
Retail/Food/Shops	Possibly	Yes	Not normally	Not normally
Tariffs	Yes	Yes	Yes	Yes
Large No. of visual display units	No	Yes	Not normally	No
Photocopies	Not normally	Yes	Not significant	No
Amenities	No	Yes	Yes	No
No. of Points of Supply	Possibly	Yes	Yes	Possibly

Usage Pattern (Cyclic V Cont.)	No	Not normally	Yes	Not normally
Past Experience (not Interstate)	Yes	Yes	Yes	Yes
Energy Management Systems	No	Yes	Not normally	No
Type of A/C System	Yes	Yes	Yes	Yes
Space Heating (Electric)[1]	Yes	Yes	Yes	Yes
Type of Hot Water Distribution[1]	Yes	Yes	Yes	Yes
Penetration of Gas etc. (electrification)[1]	Yes	Yes	Yes	No
Computer Loads	Yes	Yes	Yes	Yes
Refrigeration	Yes	Yes	Yes	Yes
Cooking	Yes	Yes	No	No
Power Factor Correction	No	Yes	Yes	No
Time of Load Peak - Winter	Yes	No	No	Yes
- Summer	No	Yes	Yes	No
Percentage of Installation Used	No	Yes	Maybe	No
Energy Efficiency of Building	No	Yes	No	No

Note: Changes to heating and hot water consideration reflect the move to electrification of these services.

Appendix B CBD, CBD Fringe and CBD Fringe Equivalent areas

(Normative)

The following postcodes require indoor / chamber substation on Customer premises to be capable of housing relay operated (remotely operated) switchgear.

CBD

The current CBD designated area is the Brisbane CBD area designated with postcode 4000.

CBD Fringe areas

CBD Fringe Areas include the suburbs of:

- Milton (postcode 4064)
- Spring Hill (postcode 4000)
- Petrie Terrace (postcode 4000)
- Fortitude Valley (postcode 4006)
- Bowen Hills (postcode 4006)
- Herston (postcode 4006)
- Newstead (postcode 4005)
- Teneriffe (postcode 4005)
- New Farm (postcode 4005)
- South Brisbane (postcode 4101)
- West End (postcode 4101)
- Woolloongabba (postcode 4102)
- East Brisbane* (postcode 4169)
- Kangaroo Point (postcode 4169)

Note*: For the suburb of East Brisbane, it is the area specifically included in the expanded Woolloongabba Priority Development Area.

CBD Fringe Equivalent areas

CBD Fringe Equivalent areas include the suburbs of:

- Southport (postcode 4215)
- Surfers Paradise (postcode 4217)
- Broadbeach (postcode 4218)
- Maroochydore (postcode 4558)

Appendix C Voltage drop - comparison of changes

(Informative)

This Appendix lists the legacy and current maximum LV drop on LV networks.

Distribution feeder type	Legacy design LV drop	Current maximum LV drop	Description
Urban	6.0%	6.0%	5% LV mains 1% service
Rural/Short Rural	6.0%	3.0%	2% mains 1% service
Long Rural	Not specified	1.6%	Mains and service. Minimum mains
SWER	Site specific study	1.6%	Mains and service Minimum mains

Appendix D Ferroresonance explained

(Normative)

In power systems, the most common place to find ferroresonance is with a three-phase distribution transformer energised through an underground cable of moderate length. Under no load, or very light load conditions, the capacitance of the cable is sufficient to precipitate ferroresonant behaviour under single phase switching conditions (e.g., the operation of an HV fuse or asynchronous operation of single phase 11kV switches such as a drop-out fuse unit).

The simplest form of occurrence of a ferroresonance circuit in a URD distribution system is when the single-phase operating switchgear or switch fuses are located some distance away from the transformer itself, with a length of cable joining the switchgear and transformer. A circuit of this sort could occur, for example, where a substation is "satellited" from a switching station, with the switchgear at the switching station being single-phase operated. Refer Figure 12.

In the case where single-phase switching is performed directly at the transformer terminals, there is no capacitance in circuit and as a result no abnormal circuit. The equivalent circuit of a cable under no load conditions is essentially a capacitive circuit. The presence of the cable introduces a capacitance into the circuit and forms a series LC (inductive and capacitive) circuit with the transformer winding. Under no load can be represented by an iron cored inductance, in series with the core-sheath capacitance of the cable.

[Note that this circuit applies to 3-core screened and single core cables. i.e., there is no core-to-core capacitance]. The three-phase equivalent circuit is shown in Figure 12 below.

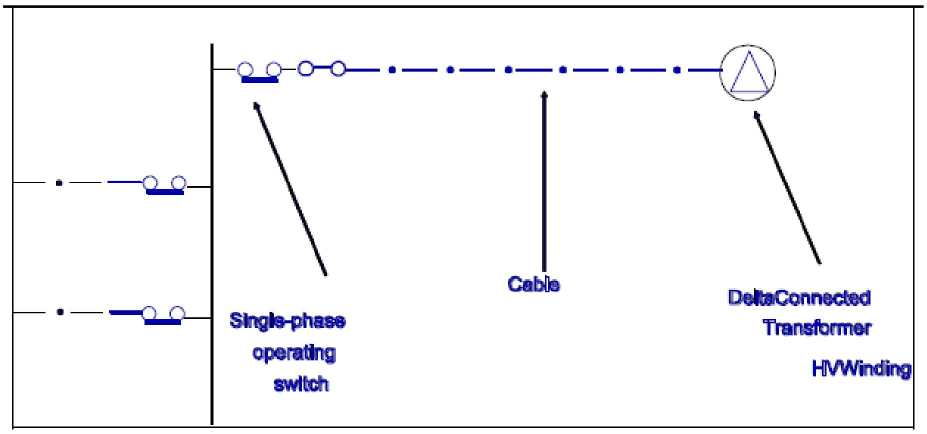


Figure 12: Single line diagram - ferroresonant circuit arrangement

With one phase energised (R phase for example as shown in Figure 13 a series circuit is formed consisting of the magnetised inductance Lm between R and Y phases and the Y phase core-to-sheath cable capacitance. In parallel with this circuit is a second identical series circuit consisting of the magnetised inductance Lm between R and B phases and the B phase core-to-sheath capacitance. Since each branch of this parallel circuit is identical, the potential between the points Y and B is zero and therefore the magnetising inductance Lm between Y and B phases does not enter into the circuit. Combining the circuit components results in an equivalent series circuit consisting of a capacitance in series with a nonlinear inductance which is therefore the ferroresonant circuit as shown in Figure 14 below.

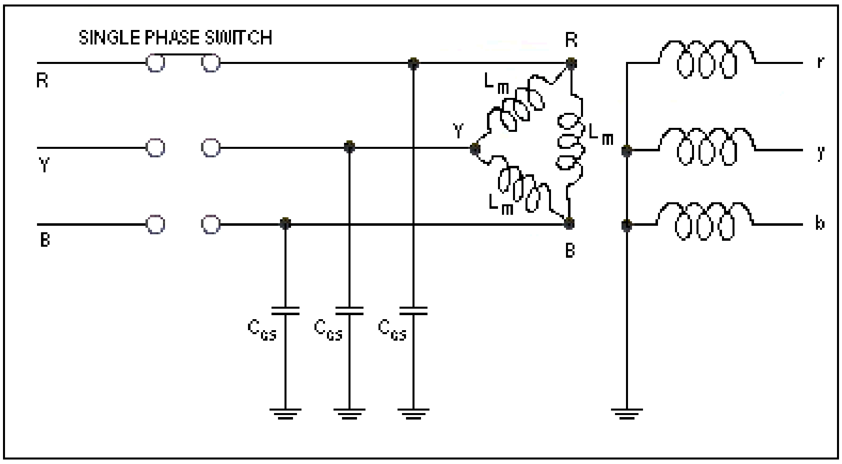


Figure 13: Three phase equivalent ferroresonance circuit

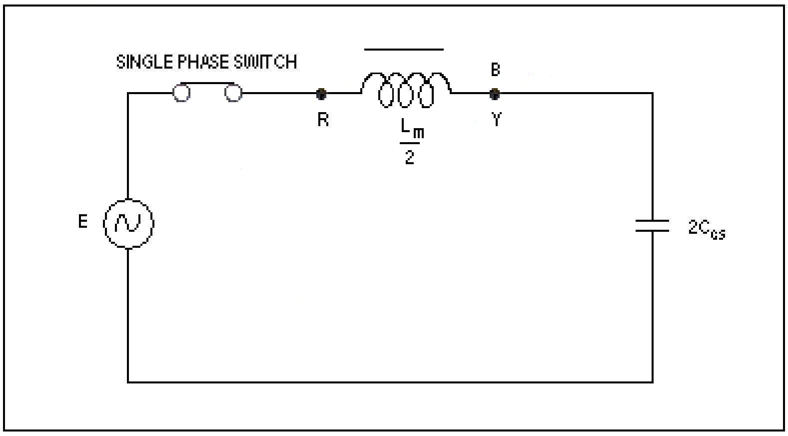


Figure 14: Equivalent ferroresonance circuit

D.1 Methods of ferroresonance control

The four most effective methods of controlling ferroresonance are;

1. three-phase switching;
2. single-phase switching at transformers;
3. resistive load on the transformers; and
4. limiting cable length.

From a network planning and design perspective, methods (i) and (iv) are available to the network designer to limit the impact of ferroresonance.

Where transformers without switchgear are identified on the existing network and have cables connected, the following options should be considered:

- installation of ganged OH drop-out fuses (maximum transformer size 300 kVA); or
- installation of an air-break switch
- installation HV underground switchgear or a padmount substation replacement.

Methods 2. and 3. require special operating procedures to ensure that there is effectively no length of cable being energised or de-energised at the same time as the transformer, or the presence of some load.

Appendix E LV Drop software settings

(Informative)

E.1 LV Drop software settings - residential

E1.1 Energex greenfield LV Drop software settings - residential

Table 30: Energex greenfield LV Drop software settings - residential

Variable/descriptor	Legacy Energex	Revised setting
LV Drop edition	To be advised	**Multi-Stat**
Transformer source voltage	243V	**243V**
Transformer nominal voltage	238V	**238V**
Confidence factors		
(Set A – Residential)		
Transformer loading	1.65	**1.65**
Cable loading	2	**2**
Voltage drop	2	**2**
Transformer type	Actual Impedance	**Actual Impedance**
Unbalance factor	1.0 - (1 phase study)	**1.8 (3 phase study)**
Standard deviation	50% ADMD	**as per revised ADMD criteria**
Standard deviation ratio	2	**2**
Default load type	as per ADMD criteria	**as per revised ADMD criteria**
Default generation type	not stated	**as per revised ADME criteria**
Load data	phase total	**3 phase total**

E1.2 Energex brownfield LV Drop software settings - residential

Table 31: Energex brownfield LV Drop software settings - residential

Variable/descriptor	Legacy Energex Energy	Revised setting
LV Drop edition	Multi-Stat	**Multi-Stat**
Transformer source voltage	243V	**243V**
Transformer nominal voltage	238V	**238V**
Confidence factors		
(Set A – Residential)		
Transformer loading	1.65	**1.65**
Cable loading	2	**2**
Voltage drop	2	**2**
Transformer type	Actual impedance	**Actual impedance**
Unbalance factor	1.0 (single phase study)	**1.8 (3 phase study)**
Standard deviation	50% ADMD	**as per revised ADMD criteria**
Standard deviation ratio	2	**2**
Default load type	as per legacy ADMD criteria	**as per revised ADMD criteria**
Default generation type	not stated	**as per revised ADME criteria**
Load data	phase total	**3 phase total**

E1.3 Ergon Energy greenfield LV Drop software settings - residential

Table 32: Ergon Energy greenfield LV Drop software settings - residential

Variable/descriptor	Legacy Ergon Energy	Revised setting
LV Drop edition	To be advised	**Multi-Stat**
Transformer source voltage	230V	**230V**
Transformer nominal voltage	230V	**230V**
Confidence factors		
(Set A – Residential)		
Transformer loading	**1.65**	**1.65**
Cable loading	**2**	**2**
Voltage drop	**2**	**2**
Transformer type	LOIMP	**LOIMP**
Unbalance factor	To be advised	**1.8 (3 phase study)**
Standard deviation	1 ADMD	**as per revised ADMD criteria**
Standard deviation ratio	1	**2**
Default load type	as per ADMD criteria	**as per revised ADMD criteria**
Default generation type	not stated	**as per revised ADME criteria**
Load data	phase total	**3 phase total**

E1.4 Ergon Energy brownfield LV Drop software settings - residential

Table 33: Ergon Energy brownfield LV Drop software settings - residential

Variable/descriptor	Legacy Ergon Energy	Revised setting
LV Drop edition	Multi-Stat	**Multi-Stat**
Transformer source voltage	230V	**230V**
Transformer nominal voltage	230V	**230V**
Confidence factors		
(Set A – Residential)		
Transformer loading	1.65	**1.65**
Cable loading	2	**2**
Voltage drop	2	**2**
Transformer type	LOIMP	**LOIMP**
Unbalance factor	**1.8** (3 phase study)	**1.8** (3 phase study)
Standard deviation	1 ADMD	**as per revised ADMD criteria**
Standard deviation ratio	1	**2**
Default load type	as per ADMD criteria	**as per revised ADMD criteria**
Default generation type	not stated	**as per revised ADME criteria**
Load data	phase total	**3 phase total**

E1.5 LV Drop Software settings – industrial/commercial – (Energex and Ergon Energy)

Table 34: Energex and Ergon Energy LV Drop software settings – industrial/commercial

Variable/descriptor	Legacy Energex	Legacy Ergon Energy	Revised joint setting
(Set B – Commercial)			
Transformer loading	2	2	**2**
Cable loading	2	2	**2**
Voltage drop	2	2	**2**
Transformer type	actual transformer size	actual transformer size	**actual transformer size**
Unbalance factor	1.8 – (3 phase study) 1.0 - (1 phase study)	1.8 not applicable	**1.8 (3 phase study)**
Standard deviation	not specified	0	**0**
Standard deviation ratio	not specified	-	**-**
Default load type	0kVA or lot specific (≥ 30kVA)	30kVA or lot specific (≥ 30kVA)	**45kVA or lot specific**
Load data	phase total	phase total	**3 phase total**
Segment data	Set to conductor/cable type and length that will be most used in the study	User defined based on study	**Set to conductor/cable type and length that will be most used in the study**
Other fields	Set as per operator preference	Not used	**Set as per operator preference**

Appendix F Energex Zone Substation location and classification

(Normative)

Brisbane City

Geographic				Substation details			Feeder category numbers	
Place name	**Place category**	**LGA name**		**ZSS_ID**	**ZSS name**	**Feeder voltage (kV)**	**UR**	**SR**
Acacia Ridge	Suburb	Brisbane City		ARG	Acacia Ridge	11	7	1
Annerley	Suburb	Brisbane City		ALY	Annerley	11	4	2
Ashgrove	Suburb	Brisbane City		AGE	Ashgrove	11	7	3
Locale	Suburb	Brisbane City		ATC	Astor Terrace	11	6	0
Bald Hills	Suburb	Brisbane City		BHL	Bald Hills	11	4	3
Brighton	Suburb	Brisbane City		BRT	Brighton	11	4	0
Bullimba	Suburb	Brisbane City		BLB	Bulimba	11	8	0
Buranda	Locale	Brisbane City		BDA	Buranda	11	5	1
Calamvale	Suburb	Brisbane City		CMV	Calamvale	11	9	1
Camp Hill	Suburb	Brisbane City		CHL	Camp Hill	11	9	1
Brisbane CBD	Locale	Brisbane City		CST	Charlotte St	11	0	0
Chermside	Suburb	Brisbane City		CSE	Chermside	11	10	1
Clayfield	Suburb	Brisbane City		CFD	Clayfield	11	5	1
Coopers Plains	Suburb	Brisbane City		CPL	Coopers Plains	11	7	1
Coorparoo	Suburb	Brisbane City		CPR	Coorparoo	11	7	0
Eight Mile Plains	Suburb	Brisbane City		EMP	Eight Mile Plains	11	4	4
Enoggera	Suburb	Brisbane City		ENG	Enoggera	11	7	1
Keperra	Suburb	Brisbane City		GLY	Grovely	11	8	0
Hamilton	Suburb	Brisbane City		HTN	Hamilton	11	9	1
Holland Park	Suburb	Brisbane City		HPK	Holland Park	11	6	3
Holland Park	Suburb	Brisbane City		HPE	Holland Park East	11	5	0
Inala	Suburb	Brisbane City		INA	Inala	11	7	2

Indooroopilly	Suburb	Brisbane City		IDY	Indooroopilly	11	7	0
Jindalee	Suburb	Brisbane City		JDL	Jindalee	11	6	0
Kedron	Suburb	Brisbane City		KRN	Kedron	11	13	0
Kelvin Grove	Suburb	Brisbane City		KVG	Kelvin Grove	11	13	0
Kenmore	Suburb	Brisbane City		KMR	Kenmore	11	9	3
Lota	Suburb	Brisbane City		LTA	Lota	11	6	1
Fortitude Valley	Suburb	Brisbane City		MLS	McLachlan St	11	16	1
Milton	Suburb	Brisbane City		MLT	Milton	11	10	1
Moorooka	Suburb	Brisbane City		MRK	Moorooka	11	7	1
Mt Gravatt	Suburb	Brisbane City		MTG	Mt Gravatt	11	8	2
Newstead	Suburb	Brisbane City		NSD	Newstead	11	9	0
Nudgee	Suburb	Brisbane City		NGE	Nudgee	11	7	1
Nundah	Suburb	Brisbane City		NDH	Nundah	11	8	1
Oxley	Suburb	Brisbane City		OXL	Oxley	11	8	0
Rocklea	Suburb	Brisbane City		RLA	Rocklea	11	7	1
Runcorn	Suburb	Brisbane City		RCN	Runcorn	11	6	3
Salisbury	Suburb	Brisbane City		SBY	Salisbury	11	7	2
Sandgate	Suburb	Brisbane City		SGT	Sandgate	11	9	1
Carindale	Suburb	Brisbane City		SRD	Scrub Road	11	6	0
St Lucia	Suburb	Brisbane City		STL	St Lucia	11	4	1
Stafford	Suburb	Brisbane City		SFD	Stafford	11	8	0
Sunnybank	Suburb	Brisbane City		SBK	Sunnybank	11	6	0
Taringa	Suburb	Brisbane City		TRG	Taringa	11	5	1
The Gap	Suburb	Brisbane City		GAP	The Gap	11	5	1
Tingalpa	Suburb	Brisbane City		TGP	Tingalpa	11	6	0
Toowong	Suburb	Brisbane City		TWG	Toowong	11	10	1
Upper Mt Gravatt	Suburb	Brisbane City		UMG	Upper Mt Gravatt	11	6	2
Spring Hill	Suburb	Brisbane City		VPK	Victoria Park	11	9	1
Woolloongabba	Suburb	Brisbane City		WRD	Wellington Rd	11	16	2
West End	Suburb	Brisbane City		WED	West End	11	21	1
Wynnum	Suburb	Brisbane City		WNM	Wynnum	11	7	0
Zillmere	Suburb	Brisbane City		ZMR	Zillmere	11	9	1

Ipswich City

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Amberley	Suburb	Ipswich City		ABY	Amberley	11	0	2
Booval	Suburb	Ipswich City		BVL	Booval	11	8	0
Carole Park	Suburb	Ipswich City		CPK	Carole Park	11	6	2
Carole Park	Suburb	Ipswich City		CPC	Carole Park Central	11	9	1
Ipswich south	Locale	Ipswich City		CNA	Cooneana	11	2	3
Goodna	Suburb	Ipswich City		GNA	Goodna	11	3	3
Ipswich Central & East	Suburb	Ipswich City		IPS	Ipswich South	11	3	3
Karrabin	Rural area	Ipswich City		KBN	Karrabin	11	1	4
Marburg	Town	Ipswich City		MBG	Marburg	11	0	3
Ipswich North	Suburb	Ipswich City		NIP	Nth Ipswich	11	8	2
Redbank Plains	Suburb	Ipswich City		RBK	Redbank	11	5	1
Ipswich Central	Suburb	Ipswich City		RST	Roderick St	11	10	0
Rosewood	Town	Ipswich City		RWD	Rosewood	11	0	3
Springfield	Suburb	Ipswich City		SPF	Springfield	11	3	0
Springfield Lakes	Suburb	Ipswich City		SFC	Springfield Central	11	5	1
Yamanto	Suburb	Ipswich City		YMT	Yamanto	11	1	2

Logan City

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Beenleigh	Suburb	Logan City		BLN	Beenleigh North	11	4	1
Bethania	Suburb	Logan City		BTA	Bethania	11	2	3
Browns Plains	Suburb	Logan City		BPN	Browns Plains	11	11	3
Cornubia	Suburb	Logan City		CNB	Cornubia	11	2	2
Crestmead	Suburb	Logan City		CRM	Crestmead	11	10	1
Jimboomba	Suburb	Logan City		JBB	Jimboomba	11	0	7
Kingston	Suburb	Logan City		KSN	Kingston	11	8	2
Logan Village	Suburb	Logan City		LGV	Logan Village	11	0	4
Loganholme	Suburb	Logan City		LHM	Loganholme	11	10	0
North Maclean	Rural area	Logan City		NMC	North Maclean	11	0	8
Springwood	Suburb	Logan City		NSW	North Springwood	11	13	2
Tanah Merah	Suburb	Logan City		TMH	Tanah Merah	11	7	1
Woodridge	Suburb	Logan City		WRG	Woodridge	11	12	1

Redland City

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Birkdale	Suburb	Redland City		BKD	Birkdale	11	7	0
Capalaba	Suburb	Redland City		CPB	Capalaba	11	6	2
Capalaba	Suburb	Redland City		CPS	Capalaba South	11	5	1
Cleveland	Suburb	Redland City		CVL	Cleveland	11	6	3
Stradbroke Island	Locale	Redland City		IBS	Ibis	11	0	1
Mt Cotton	Rural area	Redland City		MCN	Mt Cotton	11	1	3
Raby Bay	Suburb	Redland City		RBY	Raby Bay	11	11	0
Redland Bay	Suburb	Redland City		RLB	Redland Bay	11	3	3
Russell Island	Town	Redland City		RIS	Russell Island	11	0	3
Stradbroke Island	Rural area	Redland City		SIS	Stradbroke Is	11	2	0
Victoria Point	Suburb	Redland City		VPT	Victoria Point	11	5	2

Moreton Bay Region

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Deception Bay	Suburb	Moreton Bay Region		DBY	Deception Bay	11	7	1
Kallangur	Suburb	Moreton Bay Region		DRD	Duffield Road	11	6	0
Kallangur	Suburb	Moreton Bay Region		KLG	Kallangur	11	8	2
Lawnton	Suburb	Moreton Bay Region		LTN	Lawnton	11	7	1
Mango Hill	Suburb	Moreton Bay Region		MHL	Mango Hill Bus 1	11	10	1
Morayfield	Suburb	Moreton Bay Region		MFD	Morayfield	11	2	6
Morayfield	Suburb	Moreton Bay Region		MFN	Morayfield North	11	3	5
Murrumba	Rural area	Moreton Bay Region		MRB	Murrumba	11	1	1
Narangba	Suburb	Moreton Bay Region		NRA	Narangba	11	3	5
Ningi	Town	Moreton Bay Region		NGI	Ningi	11	0	3
Nth Pine Dam	Rural area	Moreton Bay Region		NPD	Nth Pine Dam	11	0	2
Redcliffe	Suburb	Moreton Bay Region		RCF	Redcliffe	11	9	0
Samford	Rural area	Moreton Bay Region		SMF	Samford	11	2	5
Scarborough	Suburb	Moreton Bay Region		SBH	Scarborough	11	5	1
Strathpine	Suburb	Moreton Bay Region		SPE	Strathpine	11	7	0
Toorbul Point	Town	Moreton Bay Region		TPT	Toorbul Point	11	1	2
Wamuran	Rural area	Moreton Bay Region		WMR	Wamuran	11	0	4
Whiteside	Suburb	Moreton Bay Region		WSE	Whiteside	11	1	3
Woodford	Town	Moreton Bay Region		WFD	Woodford	11	0	5

Gold Coast City

Geographic			Substation details			Feeder category numbers	
Place name	Place category	LGA name	ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Coomera	Suburb	Gold Coast City	CMA	Coomera	11	9	2
Currumbin	Suburb	Gold Coast City	CRB	Currumbin	11	5	1
Pacific Pines - Gaven	Suburb	Gold Coast City	GVN	Gaven	11	5	2
Paradise Point- Hollywell	Suburb	Gold Coast City	HWL	Hollywell	11	10	0
Hope Island	Suburb	Gold Coast City	HIS	Hope Island	11	9	1
Coolangatta	Suburb	Gold Coast City	KRA	Kirra	11	7	0
Labrador	Suburb	Gold Coast City	LDR	Labrador	11	10	0
Merrimac	Suburb	Gold Coast City	MMC	Merrimac	11	7	3
Miami	Suburb	Gold Coast City	MAI	Miami	11	7	0
Mudgeeraba	Suburb	Gold Coast City	MGP	Mudgeeraba West Pkg	11	3	5
Palm Beach	Suburb	Gold Coast City	PBH	Palm Beach	11	6	1
Parkwood	Suburb	Gold Coast City	PKW	Parkwood	11	5	1
Pimpama	Suburb	Gold Coast City	PPE	Pimpama East	11	5	5
Robina	Suburb	Gold Coast City	RBA	Robina	11	14	3
Southport	Suburb	Gold Coast City	SPO	Southport	11	25	0
Staplyton	Rural area	Gold Coast City	STT	Stapylton	11	2	2
Surfers Paradise	Suburb	Gold Coast City	SPD	Surfers Paradise	11	23	0
Varsity Lakes	Suburb	Gold Coast City	VSL	Varsity Lakes	11	11	1
Yatala	Suburb	Gold Coast City	YTA	Yatala	11	9	3

Sunshine Coast Region

Geographic			Substation details			Feeder category numbers	
Place name	Place category	LGA name	ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Beerwah	Town	Sunshine Coast Region	BWH	Beerwah	11	5	11
Birtinya	Suburb	Sunshine Coast Region	BTY	Birtinya	11	4	0
Caloundra	Town	Sunshine Coast Region	CLD	Caloundra	11	9	9
Coolum Beach	Suburb	Sunshine Coast Region	CLM	Coolum	11	3	5
Currimundi	Suburb	Sunshine Coast Region	CMD	Currimundi	11	4	3
Eumundi	Town	Sunshine Coast Region	EMD	Eumundi	11	3	0
Kawana Waters	Rural area	Sunshine Coast Region	KWA	Kawana	11	8	1
Kenilworth	Town	Sunshine Coast Region	KWH	Kenilworth	11	0	3
Landsborough	Town	Sunshine Coast Region	LBH	Landsborough	11	0	4
Maleny	Town	Sunshine Coast Region	MLY	Maleny	11	0	4
Mooloolaba	Suburb	Sunshine Coast Region	MLB	Mooloolaba	11	3	6
Nambour	Large centre	Sunshine Coast Region	NBR	Nambour	11	6	6
Palmwoods	Town	Sunshine Coast Region	PWC	Palmwoods Central	11	0	5
Maroochydore	Suburb	Sunshine Coast Region	WMD	West Maroochydore	11	3	7
Yandina	Town	Sunshine Coast Region	YDA	Yandina	11	1	4

Noosa Shire

Geographic			Substation details			Feeder category numbers	
Place name	Place category	LGA name	ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Black Mountain	Town	Noosa Shire	BMT	Black Mountain	11	0	4
Cooran	Town	Noosa Shire	COR	Cooran	11	0	4
Noosaville	Suburb	Noosa Shire	NVL	Noosaville	11	9	6
Peregian Beach	Suburb	Noosa Shire	PGN	Peregian	11	2	2
Tewantin	Suburb	Noosa Shire	TWT	Tewantin	11	2	6

Lockyer Valley Region

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Carpendale	Rural area	Lockyer Valley Region		CPD	Carpendale	11	0	3
Gatton	Town	Lockyer Valley Region		GTN	Gatton A	11	2	5
Glenore Grove	Town	Lockyer Valley Region		GGR	Glenore Grove	11	0	5
Helidon	Town	Lockyer Valley Region		HDN	Helidon	11	0	4
Laidley	Town	Lockyer Valley Region		LLY	Laidley	11	0	5
Lockrose	Rural area	Lockyer Valley Region		LRE	Lockrose	11	0	4
Mt Sylvia	Rural area	Lockyer Valley Region		MSV	Mt Sylvia	11	0	2
Postmans Ridge	Rural area	Lockyer Valley Region		PRG	Postmans Ridge	11	0	3
Spring Creek	Rural area	Lockyer Valley Region		SPC	Spring Creek	11	1	2
Tenthill	Rural area	Lockyer Valley Region		THL	Tenthill	11	0	4

Gympie Region

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Goomboorian	Rural area	Gympie Region		GBN	Goomboorian	11	0	3
Gympie North	Suburb	Gympie Region		GYN	Gympie North	11	3	3
Gympie South	Rural area	Gympie Region		GYS	Gympie South	11	1	3
Imbil	Town	Gympie Region		IBL	Imbil	11	1	1
Tin Can Bay	Town	Gympie Region		TCB	Tin Can Bay	11	0	3

Somerset Region

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Coominya	Town	Somerset Region		CMY	Coominya	11	2	2
Esk	Town	Somerset Region		ESK	Esk	11	0	3
Kilcoy	Town	Somerset Region		KCY	Kilcoy	11	1	4
Lowood	Town	Somerset Region		LWD	Lowood	11	2	1
Somerset Dam	Rural area	Somerset Region		SDM	Somerset Dam	11	0	1
Tarampa	Rural area	Somerset Region		TRP	Tarampa	11	0	5
Toogoolawah	Town	Somerset Region		TGW	Toogoolawah	11	0	5
Wivenhoe	Rural area	Somerset Region		WHO	Wivenhoe	11	0	3

Scenic Rim Region

Geographic				Substation details			Feeder category numbers	
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR
Beaudesert	Town	Scenic Rim Region		BDT	Beaudesert	11	1	5
Boonah	Town	Scenic Rim Region		BNH	Boonah	11	5	0
Bromelton	Rural area	Scenic Rim Region		BTN	Bromelton	11	3	3
Peaks Crossing	Town	Scenic Rim Region		FDS	Flinders	11	0	3
Innisplain	Locality	Scenic Rim Region		IPL	Innisplain	11	0	4
Kalbar	Town	Scenic Rim Region		KBR	Kalbar	11	0	5
Mt Tamborine	Town	Scenic Rim Region		MTB	Mt Tamborine	11	0	7
Tamborine Village	Town	Scenic Rim Region		TBV	Tamborine Village	11	0	4

Appendix G Ergon Energy Zone Substation location and classification

(Normative)

Townsville City

Geographic				Substation details			Feeder Category Numbers		
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR	LR
Aitkenvale	Suburb	Townsville		AITK	Aitkenvale	11	10	0	0
Mount Louisa	Suburb	Townsville		ALSH	Alan Sherriff	11	8	4	0
Belgian Gardens	Suburb	Townsville		BEGA	Belgian Gardens	11	3	7	0
Black River	Suburb	Townsville		BLRI	Black River	11	1	7	0
Bluewater	Town	Townsville		BLUE	Bluewater	11	0	2	0
Bohle	Suburb	Townsville		BOHL	Bohle	11	4	6	0
Cranbrook	Suburb	Townsville		CRAN	Cranbrook	11	7	1	0
Thuringowa Central	Suburb	Townsville		DAGL	Dan Gleeson	11	6	0	0
Garbutt	Suburb	Townsville		GARB	Garbutt	11	9	0	0
Hermit Park	Suburb	Townsville		HEPA	Hermit Park	11	9	0	0
Hermit Park	Suburb	Townsville		MAFU	Max Fulton	11	9	0	0
Mutarnee	Town	Townsville		MUTA	Mutarnee	11	0	1	0
Townsville City	Suburb	Townsville		NESM	Neil Smith	11	9	0	0
Oonoonba	Suburb	Townsville		OONN	Oonoonba	11	4	1	0
Douglas	Suburb	Townsville		PEAR	Peter Arlett	11	7	3	0
Rasmussen	Suburb	Townsville		RASM	Rasmussen	11	2	6	0
Rollingstone	Town	Townsville		ROLL	Rollingstone	11	0	1	0
Annandale	Suburb	Townsville		ROPL	Ross Plains	11	4	3	1
Saunders	Town	Townsville		SAUN	Saunders	11	0	1	0

Townsville South	Suburb	Townsville		STUA	Stuart	11	3	6	0
Townsville Port	Locale	Townsville		TOPO	Townsville Port	11	4	1	0
Woodstock	Town	Townsville		WOSO	Woodstock South	11	0	3	1

Toowoomba Region

Geographic				Substation details			Feeder Category Numbers		
Place name	**Place category**	**LGA name**		**ZSS_ID**	**ZSS name**	**Feeder voltage (kV)**	**UR**	**SR**	**LR**
Broxburn	Rural area	Toowoomba		BROX	Broxburn	11	0	5	0
Cawdor	Rural area	Toowoomba		CAWO	Cawdor Skid B	11	0	2	0
Cecil Plains	Town	Toowoomba		CEPL	Cecil Plains	11	0	5	0
Charlton	Rural area	Toowoomba		SKIK	Charlton Skid K	11	0	2	0
Clifton	Town	Toowoomba		CLIF	Clifton	11	0	3	0
Crows Nest	Town	Toowoomba		CRNE	Crows Nest	11	0	1	2
East Toowoomba	Suburb	Toowoomba		EATO	East Toowoomba	11	9	1	0
Highfields	Large Centre	Toowoomba		HIGH	Highfields	11	0	2	0
Kearney Springs	Suburb	Toowoomba		KESP	Kearneys Spring	11	2	5	0
Meringandan	Town	Toowoomba		MERN	Meringandan	11	1	3	0
Millmerran	Town	Toowoomba		MILM	Millmerran	11	0	2	1
Mt Sibley	Rural area	Toowoomba		MOSI	Mt Sibley	11	0	2	1
Toowoomba - Central	locale	Toowoomba		NOST	North Street	11	4	5	0
Norwin	Rural area	Toowoomba		NORW	Norwin	11	0	4	0
Oakey	Town	Toowoomba		OAKE	Oakey	11	2	6	2
Pampas	Rural area	Toowoomba		PAMP	Pampas	11	0	3	1
Peranga	Town	Toowoomba		PERA	Peranga	11	0	3	1
Purrawunda	Rural area	Toowoomba		PURR	Purrawunda	11	2	1	1
Cawdor	Rural area	Toowoomba		CAWD	Skid B (Cawdor)	11	0	2	0

Charlton	Rural area	Toowoomba		SKIK	Skid K (Charlton)	11	0	2	0
Toowoomba	Suburb	Toowoomba		SOTO	South Toowoomba	11	6	1	0
Toowoomba	Suburb	Toowoomba		TWCE	Toowoomba Central	11	11	0	0
Torrington	Suburb	Toowoomba		TORR	Torrington	11	3	8	0
Toowoomba - West	Suburb	Toowoomba		WETO	West Toowoomba	11	7	0	0
Yarraman	Town	Toowoomba		YARR	Yarraman	11	0	2	2
Yarranlea	Town	Toowoomba		YARA	Yarranlea BSP	33	0	2	0
Yarranlea	Town	Toowoomba		YASO	Yarranlea South	11	0	2	0

Cairns Region

Geographic				Substation details			Feeder Category Numbers		
Place name	**Place category**	**LGA name**		**ZSS_ID**	**ZSS name**	**Feeder voltage (kV)**	**UR**	**SR**	**LR**
Cairns City	Large Centre	Cairns		CACI	Cairns City	22	14	0	0
Cairns North	Suburb	Cairns		CANO	Cairns North	22	8	3	0
Cairns Terminal	Locale	Cairns		CATE	Cairns Terminal	22	14	1	0
Edmonton	Large centre	Cairns		EDMO	Edmonton	22	2	6	0
Gordonvale	Large centre	Cairns		GORD	Gordonvale	22	0	2	0
Kamerunga	Suburb	Cairns		KAME	Kamerunga	22	4	6	0
Kewarra Beach	Suburb	Cairns		KEBE	Kewarra Beach	22	3	2	0

Fraser Coast Region

Geographic				Substation details				Feeder Category Numbers		
Place name	Place category	LGA name		ZSS_ID	ZSS name	Substation classification	Feeder voltage (kV)	UR	SR	LR
Gootchie	Rural area	Fraser Coast		GOOT	Gootchie	Rural	11	0	2	1
Howard	Town	Fraser Coast		HOWA	Howard	Rural	11	0	3	0
Maryborough	Suburb	Fraser Coast		MACI	Maryborough City	Urban	11	3	3	0
Owanyilla	Town	Fraser Coast		OWAN	Owanyilla	Rural	11	0	4	0
Pialba	Suburb	Fraser Coast		PIAL	Pialba	Urban	11	2	4	0
Point Vernon	Suburb	Fraser Coast		POVE	Point Vernon	Urban	11	3	5	0
Maryborough (old)	Suburb	Fraser Coast		ROST	Rocky Street	Urban	11	1	7	0
Torquay	Suburb	Fraser Coast		TORQ	Torquay	Urban	11	5	4	0
Maryborough	Town	Fraser Coast		TUAN	Tuan	Rural	11	1	1	0

Bundaberg Coast Region

Geographic				Substation details			Feeder Category Numbers		
Place name	**Place category**	**LGA name**		**ZSS_ID**	**ZSS name**	**Feeder voltage (kV)**	**UR**	**SR**	**LR**
Bargara	Large centre	Bundaberg		BARG	Bargara	11	0	5	0
Bullyard	Town	Bundaberg		BULL	Bullyard	11	1	2	0
Bundaberg	Large Centre	Bundaberg		BUCE	Bundaberg Central	11	7	0	0
Childers	Town	Bundaberg		CHIL	Childers	11	0	4	0
East Bundaberg	Suburb	Bundaberg		EABU	East Bundaberg	11	0	8	0
Gayndah	Town	Bundaberg		FARN	Farnsfield	11	1	4	1
Givelda	Rural area	Bundaberg		GIVE	Givelda	11	1	2	0
Gooburrum	Rural area	Bundaberg		GOOB	Gooburrum	11	0	2	2
Meadowvale	Rural area	Bundaberg		MEAD	Meadowvale	11	0	4	0
South Bundaberg	Suburb	Bundaberg		SOBU	South Bundaberg	11	1	6	0
South Kolan	Town	Bundaberg		SOKO	South Kolan	11	0	4	0
Wallaville	Town	Bundaberg		WALL	Wallaville	11	0	4	1
Bundaberg	Suburb	Bundaberg		WEBU	West Bundaberg	11	9	2	0
Woodgate	Town	Bundaberg		WOOG	Woodgate	11	0	1	0

Rockhampton Region

Geographic				Substation details			Feeder Category Numbers		
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR	LR
Berserker	Suburb	Rockhampton		BERS	Berserker	11	8	0	0
Rockhampton	Locale	Rockhampton		CAST	Canning Street	11	7	0	0
Rockhampton	Suburb	Rockhampton		FREN	Frenchville	11	4	3	0
Gracemere	Suburb	Rockhampton		GRAC	Gracemere	-	-	-	-
Lakes Creek	Town	Rockhampton		LACR	Lakes Creek	11	3	2	0
Gracemere	Suburb	Rockhampton		MALC	Malchi	11	1	3	1
Mount Morgan	Town	Rockhampton		MOMR	Mt Morgan	11	0	3	0
Parkhurst	Suburb	Rockhampton		PARK	Parkhurst	11	2	5	0
Kawana	Suburb	Rockhampton		ROGL	Rockhampton Glenmore	11	1	7	0
Rockhampton	Suburb	Rockhampton		ROSO	Rockhampton South	11	6	1	0

Mackay Region

Geographic				Substation details				Feeder Category Numbers		
Place name	Place category	LGA name		ZSS_ID	ZSS name	Substation classification	Feeder voltage (kV)	UR	SR	LR
Mackay	Locale	Mackay		ALST	Alfred Street	Urban	11	6	4	0
Balberra	Town	Mackay		BALB	Balberra	Rural	11	0	2	0
Calen	Town	Mackay		CALE	Calen	Rural	11	0	2	1
Carmila	Town	Mackay		CARM	Carmila	Rural	11	0	1	0
Crediton	Town	Mackay		CRED	Crediton	Rural	11	0	1	0
Eton	Town	Mackay		ETON	Eton	Rural	11	0	4	0
Eungella	Town	Mackay		EUDA	Eungella Dam	Rural	11	1	1	0
Farleigh	Town	Mackay		FARL	Farleigh	Rural	11	0	3	0
Glenella	Town	Mackay		GLEL	Glenella 11kV	Urban	11	3	3	0
Koumala	Town	Mackay		KOUM	Koumala	Rural	11	0	2	0
Laguna Quays	Town	Mackay		LAQU	Laguna Quays	Rural	11	0	1	1
Louisa Creek	Town	Mackay		LOCR	Louisa Creek	Rural	33	0	5	0
Mackay	Suburb	Mackay		MACT	Mackay City	Urban	11	4	0	0
Marion	Town	Mackay		MASO	Marian South	Rural	11	1	2	0
McKinley Creek	Town	Mackay		MCCR	McKinley Creek	Rural	11	0	3	0
Mirani	Town	Mackay		MIRA	Mirani	Rural	11	0	2	0
Mount Basset	Locale	Mackay		MOBA	Mt Bassett	Rural	11	1	3	0
Mackay	Suburb	Mackay		NOMA	North Mackay	Urban	11	4	4	0
Pinnacle	Town	Mackay		PINN	Pinnacle	Rural	11	0	3	0
North Mackay	suburb	Mackay		PLAN	Planella	Rural	11	1	4	0
Pleystone	Town	Mackay		PLEY	Pleystowe	Rural	11	0	5	0
Rosella	Town	Mackay		ROSE	Rosella	Rural	11	0	4	0
Sarina	Town	Mackay		SARI	Sarina	Rural	11	1	5	1

Mackay	Suburb	Mackay		SOMA	South Mackay	Urban	11	6	1	0
Mackay	Suburb	Mackay		WEMA	West Mackay	Urban	11	6	1	0

Gladstone Region

Geographic				Substation details			Feeder Category Numbers		
Place name	**Place category**	**LGA name**		**ZSS_ID**	**ZSS name**	**Feeder voltage (kV)**	**UR**	**SR**	**LR**
Agnes Water	Town	Gladstone		AGWA	Agnes Water	22	0	3	1
Lake Awoonga	Rural area	Gladstone		AWOO	Awoonga	11	1	1	0
Tannum Sands	Large Centre	Gladstone		BORE	Boyne Residential	11	1	3	0
Calliope	Town	Gladstone		CALL	Calliope	11	0	3	1
Clinton	Suburb	Gladstone		CLIN	Clinton	11	2	3	0
Gladstone	Locale	Gladstone		GLFS	Friend Street	11	4	3	0
Gladstone south	Suburb	Gladstone		GLSO	Gladstone South	11	3	4	0
Littlemore	Town	Gladstone		LITT	Littlemore	11	0	2	0
Raglan	Town	Gladstone		RAGL	Raglan	11	0	1	2
Yarwun	Rural area	Gladstone		LARO	Skid D (Landing Road)	11	1	2	0

Whitsunday Region

Geographic				Substation details			Feeder Category Numbers		
Place name	Place category	LGA name		ZSS_ID	ZSS name	Feeder voltage (kV)	UR	SR	LR
Bowen	Large Centre	Whitsunday		BOWE	Bowen	11	0	6	0
Cannonvale	Suburb	Whitsunday		CANN	Cannonvale	11	2	4	0
Gumlu	Rural area	Whitsunday		GUML	Gumlu	11	0	2	0
Guthalungra	Rural area	Whitsunday		GUTH	Guthalungra	11	0	1	0
Airlie Beach	Suburb	Whitsunday		JUPO	Jubilee Pocket	11	1	2	0
Kelsey Creek	Rural area	Whitsunday		KECE	Kelsey Creek East	11	0	6	0
Bowen	Large Centre	Whitsunday		MERI	Merinda	11	0	5	0
Mount Rooper	Rural area	Whitsunday		MORO	Mount Rooper	11	1	1	0
Proserpine	Town	Whitsunday		PRMI	Proserpine Mill	11	1	0	0
Shute Harbour	Town	Whitsunday		SHUT	Shutehaven	11	1	1	0
Wirralie	Rural area	Whitsunday		WIRR	Wirralie	33	0	3	0

Remainder of Ergon Energy network

The Ergon Energy network in all remaining LGAs, including Mt Isa, (i.e., those not listed) shall be considered rural.

Appendix H Changes and updates

(Informative)

Major revisions/changes

- Revised and standardised settings for use in LV Drop software, including aligned residential ADMD values for Ergon and Energex in greenfield and brownfield developments.
- Revised default Commercial lot ADMD from 60kVA to 45kVA per lot.
- Increased maximum size of indoor/chamber substations from 3 x 1500kVA to 4 x 1500kVA transformers
- A strengthening of the requirement for the protection of DNSP assets through easements.