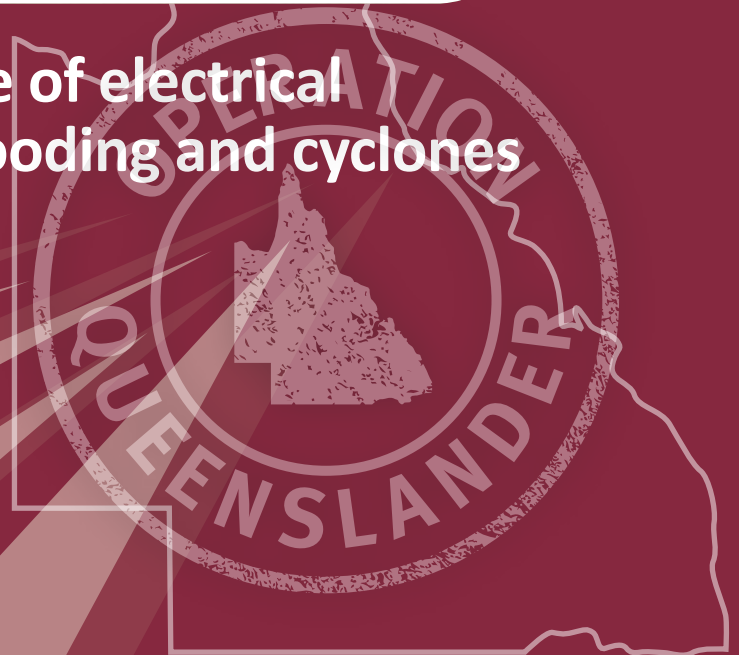




# Planning for stronger, more resilient electrical infrastructure



Improving the resilience of electrical infrastructure during flooding and cyclones



## Introduction

During the summer of 2010/2011 Queensland experienced unprecedented weather events that not only damaged about 165,000 homes, but also resulted in around 480,000 residences and businesses losing power across this period. While the power supply network was restored as quickly as possible, damage to some premises meant they could not re-connect to the power supply network for periods ranging from weeks to months. In light of this, all Queenslanders must ensure that they have an understanding of the electrical infrastructure network in our State and be prepared for the impact that natural disasters, specifically flooding and cyclones, can have on electricity supply.

One of the core functions of the Queensland Reconstruction Authority (the Authority) is to ensure that Queensland learns from the 2010/2011 natural disasters. Therefore the Authority has teamed up with ENERGEX Limited (ENERGEX), Ergon Energy and Powerlink with the aim of investigating and implementing improvements to the resilience of electrical infrastructure in the future.

An outcome of this partnership is the development of **Planning for stronger, more resilient electrical infrastructure – Improving the resilience of electrical infrastructure during flooding and cyclones**. This Guideline is intended to highlight key considerations in relation to electricity distribution, land use planning, emergency planning and management, building and design including the home.

It is also important to highlight that the considerations identified in this Guideline do not replace the need for Queenslanders living in areas prone to natural disasters, including flooding and cyclones, to be prepared to evacuate.

This Guideline is a companion document to the report **Rebuilding a stronger, more resilient Queensland** released on 12 September 2011. The report provides an overview of resilience in a disaster management context and details on the strategic resilience projects being delivered throughout Queensland in response to the disaster events of 2010-11. While it gives an overarching assessment of disaster resilience, this Guideline provides detailed advice on building and enhancing the State's resilience for electrical infrastructure.

**While you might not be directly affected by a flood or cyclone, your power supply may need to be disconnected because part of the network has been affected.**

## About this Guideline

This Guideline is intended to:

- Inform Queenslanders about the electricity supply network and the impacts that flooding and cyclones can have on electricity supply.
- Inform Queenslanders about the impact that the 2010/2011 events had on the electrical infrastructure network.
- Identify the lessons learnt from the recent natural disasters.
- Provide key considerations for electricity distribution, land use planning, emergency planning and management, building and design including the home.

## Expectations

Given the unprecedented events of last summer, it is critical that everyone has a better understanding of the electricity network in Queensland. It is also important to understand that while you might not be directly affected by a flood or cyclone, your power supply may need to be disconnected because part of the network has been affected. Therefore Queenslanders need to be prepared in disaster situations to be without power for a period of time.

## The reality is that electricity and water do not mix and together can lead to serious life threatening and safety issues.

In flooding and cyclones it is inevitable that some loss of power will occur and as such the most effective safety measures will be put in place. Moreover, in some cases it is beneficial to pre-emptively disconnect power to ensure that less damage to electrical infrastructure occurs. This will mean that the power may be back on sooner.

This Guideline will assist in managing expectations for the reconnection of power to homes and businesses following a flood or cyclones by explaining the reasons for disconnection as well as how Queenslanders can best prepare for the loss of power.

## Queensland's regulatory framework

### Legislative Environment

In Queensland, electricity distributors are responsible for distributing electricity to customers across the State. The *Electricity Act 1994* (The Act) and the *Electricity Regulation 2006* are the primary pieces of legislation that govern Queensland's electricity industry. The Act gives electricity distributors the authority to operate in their areas of distribution.



Photo of Ergon Energy workers repairing the network courtesy of Ergon Energy

# 1 – Understanding electricity in Queensland

Queensland’s electricity network is complex and it is not expected that all Queenslanders will have a full understanding of the network. However, it is important to gain a basic understanding of the electricity network. Figure 2 below shows the typical electrical path from a power station to a dwelling or business.

**The electricity supply system in Queensland has four interconnected components:**

- Generation (Stage 1)
- Transmission (Stage 2)
- Distribution (Stage 3)
- Retail (Stage 4)

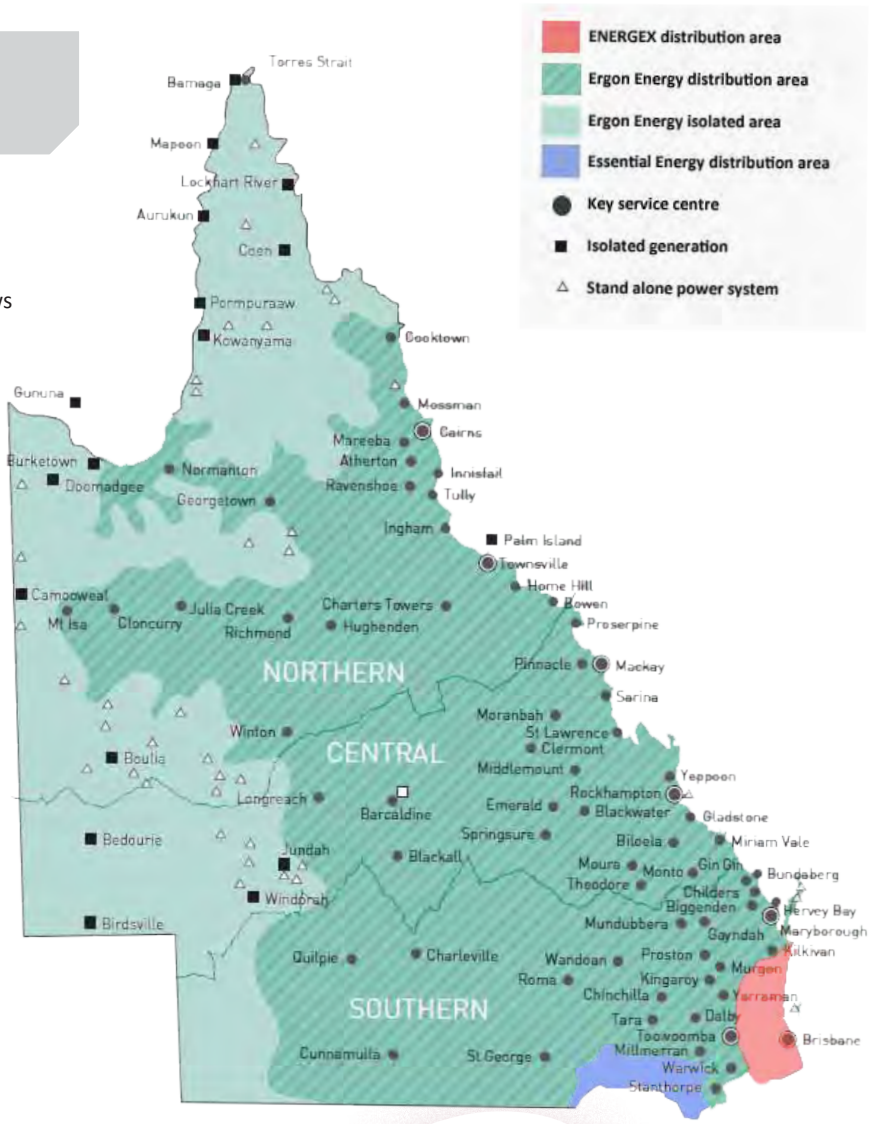
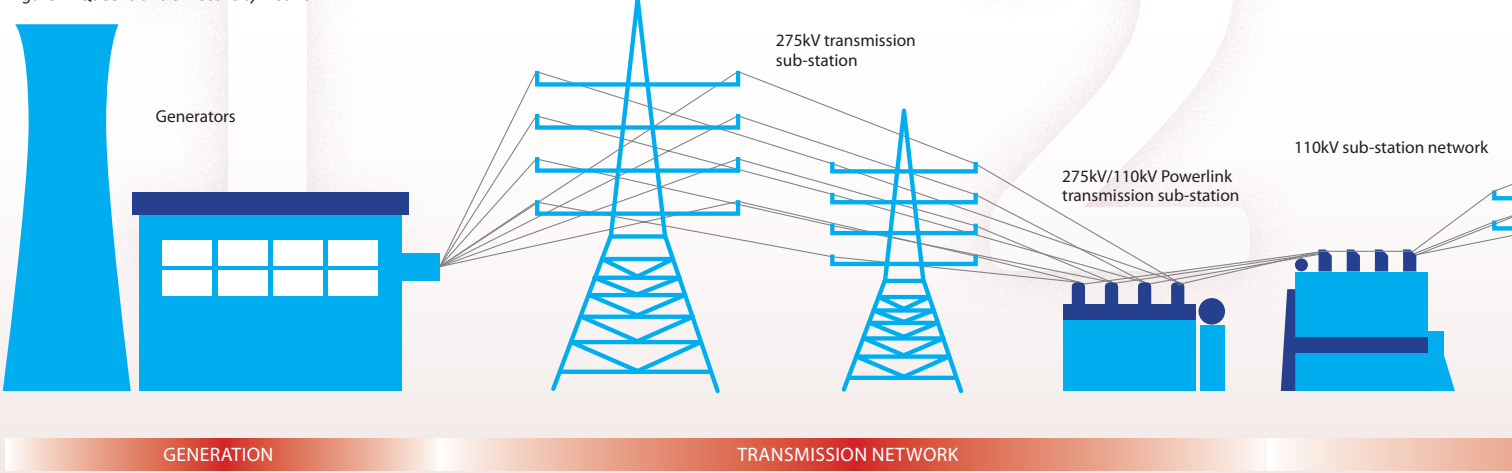


Figure 1: Map of electricity distributor jurisdictions in Queensland

Figure 2: Queensland’s Electricity Network



## Stage 1 – Generation

Electricity is generated at power stations, which use various resources – fuels (coal, gas, oil, biomass), water (hydro), wind or solar to generate power. Since the national electricity market was established in 1998, \$8 billion has been invested in electricity generation in Queensland. Queensland’s electricity generation is provided by Government Owned Corporations and a number of private companies.

## Stage 2 – Transmission

The electricity is increased in voltage at the power stations and fed into the high-voltage transmission network, which transports the electricity to many distribution networks. The Government Owned Corporation Powerlink owns and operates the State’s more than 13,000 circuit kilometre high voltage transmission network.

## Queensland's electricity network – jurisdictions

### Powerlink



Powerlink is responsible for planning and developing the electricity transmission network for the entire State of Queensland (**Stage 2 – Transmission**). This means that Powerlink carries out the State's network development to ensure that Queensland has a secure and reliable electricity supply and to address anticipated network limitations.

Powerlink's high voltage transmission network extends from north of Cairns to the New South Wales border and primarily transports high voltage electricity from generators to electricity distribution networks owned by ENERGEX, Ergon Energy and Essential Energy. Powerlink also transports electricity directly to large Queensland customers, such as aluminium smelters and New South Wales via the New South Wales/ Queensland Interconnector transmission line.

### ENERGEX



ENERGEX as a distributor (**Stage 3 - Distribution**) supplies electricity to a population of more than 2.8 million people and employs approximately 3800 employees. This includes the regions of Brisbane, Ipswich, Gold Coast and Sunshine Coast, as shown in Figure 1.

ENERGEX has 54,000 kilometres of powerlines and more than 600,000 power poles. ENERGEX's electricity distribution network spans more than 25,000 square kilometres throughout South East Queensland (SEQ), as shown on Figure 2.

In the past 10 years the population has dramatically increased in these areas, leading to a 30 per cent growth in customer numbers and a consequent rise in overall energy demand.

### Ergon Energy



Ergon Energy, as an generator, distributor and retailer (**Stages 1, 3 and 4**) has around 4600 employees and services around 690,000 customers across one million square kilometres – 97 per cent of Queensland.

Ergon Energy's network consists of about 150,000 kilometres of powerlines and a million power poles (**Stage 3 – Distribution**). Around 70 per cent of Ergon Energy's powerlines run through rural Queensland covering vast distances in largely unpopulated area, as seen in Figure 1.

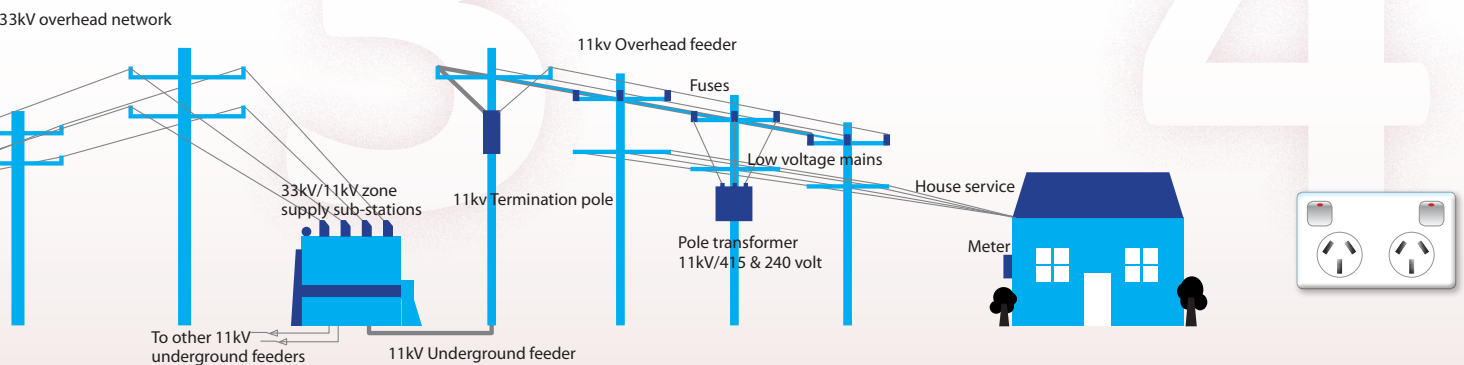
As a government-owned 'non-competing' electricity retailer Ergon Energy continues to play an important role engaging with the community around their electricity use (**Stage 4 – Retailers**).

### Essential Energy



Essential Energy is a NSW Government-owned corporation, with responsibility for building, operating and maintaining an electricity network which delivers essential services to more than 800,000 homes and businesses across 95 per cent of NSW, parts of southern Queensland, including the town of Goondiwindi (as shown in Figure 1) and northern Victoria (**Stage 3 – Distribution**). It includes more than 200,000 kilometres of powerlines and 1.4 million poles.

# Queensland's electricity distribution networks are extensive, with a total line length of about 200,000 kilometres.



DISTRIBUTION

RETAILERS

### Stage 3 – Distribution

The voltage of the electricity is progressively reduced at a series of sub-stations spread throughout the networks until it is at its final voltage of 240 V/415 V for supply to homes and businesses. For the majority of Queensland, ENERGEX and Ergon Energy are responsible for the distribution of electricity, with a very small area by the NSW distributor, Essential Energy.

### Stage 4 – Retailers

When customers arrange to have electricity connected, they contact an electricity retailer who makes the appropriate arrangements and bills the customer for the electricity used. There are a number of retailers operating in Queensland. They buy electricity from the generators and on sell to their customers.

Source: This information has been sourced and modified from the Department of Employment, Economic Development and Innovation

## 2 – What happened in summer 2010/2011

From July to December 2010, extremely heavy rainfall was experienced across large parts of eastern Australia, with Queensland experiencing its wettest spring on record. This rain pattern was influenced by the strongest La Niña effect in the Pacific Ocean since the mid-1970s and as a result, Queensland's catchment areas were significantly saturated before major rain events occurred during November 2010 to April 2011.

There were a number of significant events throughout this period which had major impacts upon electrical infrastructure. This included major flooding throughout Central and Southern Queensland, flash flooding in Toowoomba and Lockyer Valley, major flooding in Ipswich and Brisbane and Severe Tropical Cyclone Yasi (Cyclone Yasi) which made landfall as a Category 5 Tropical Cyclone.

During the flooding and cyclone events of summer 2010/2011 Queensland's electricity distributors were required to initiate rapid response and recovery processes to ensure the electricity network sustained the least damage and that power was able to be restored as soon as possible. The following outlines the task that was faced by Ergon Energy, ENERGEX and Powerlink during the damage and response phases.



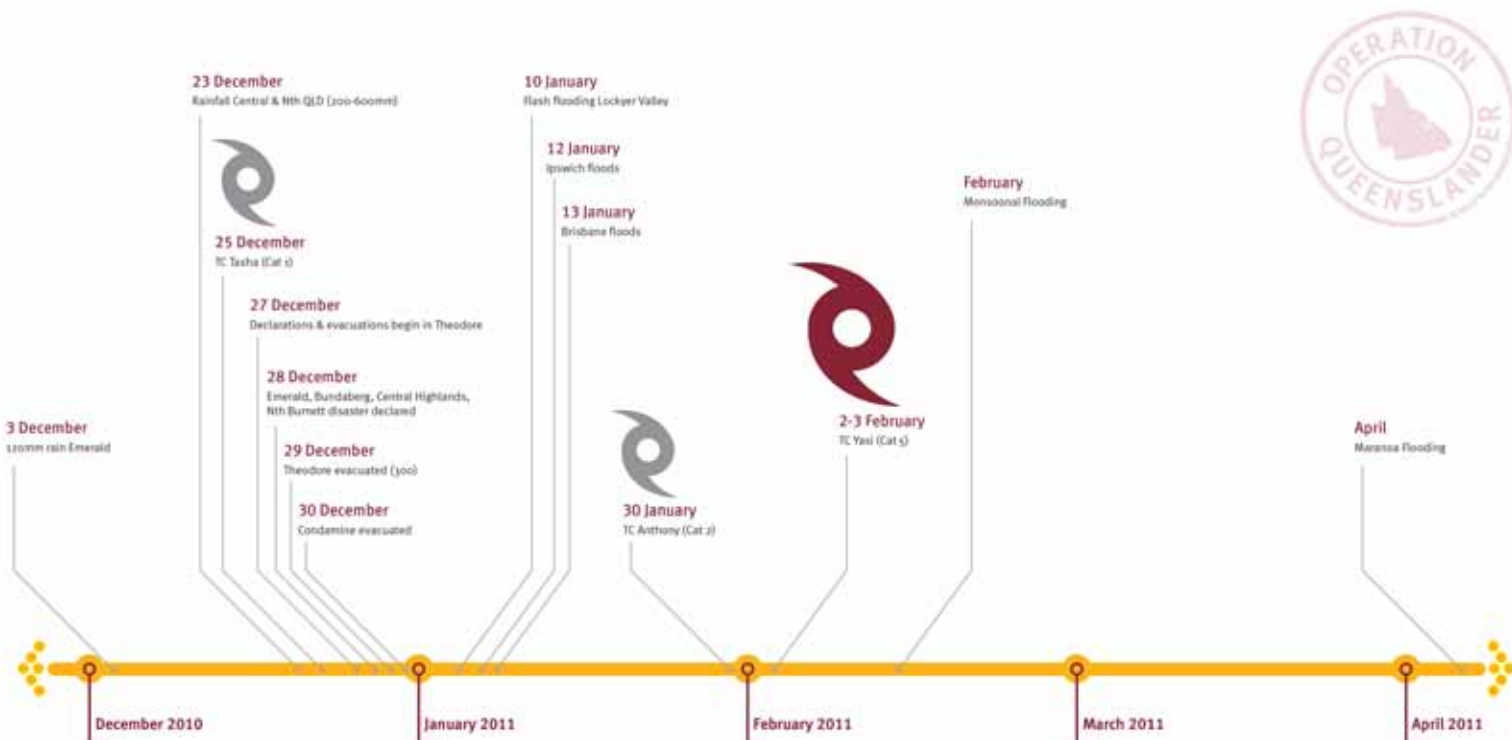
Photo of fallen powerlines at Tully Heads provided courtesy of Queensland Government



Photo taken in Oxley on the Ipswich Motorway provided courtesy of ENERGEX

Never before had electricity distributors had to face such a task.

## 2010/2011 Timeline of events



## Damage and response

### Ergon Energy

The flooding and cyclones of summer 2010/2011 resulted in the entire State being disaster activated. Entire towns were submerged, some repeatedly. In the first stage of any response, the priority is on returning the supply to the transmission network, the bulk supply points and then the high voltage backbone of the network to enable restoration to the largest number of customers as quickly as possible. At the same time, there is a focus on restoring critical infrastructure, including hospitals and medical centres, schools, water treatment facilities and sewerage pumping stations, evacuation centres, key telecommunication sites and significant shopping centres, as well as the essential sites for Ergon Energy's restoration effort.



Photo of repair works underway after Cyclone Yasi provided courtesy of Ergon Energy.

Fortunately during the flood events of December 2010 and January 2011, in townships including Rockhampton, Bundaberg, Toowoomba, Maryborough, Emerald, Dalby and Theodore, Ergon Energy's network did not sustain major damage. However for flood-related safety reasons, at least 10,500 homes and businesses had their power interrupted as a result of regional flooding.

Unfortunately this was not the case for the cyclones that hit the Queensland coast – damage to Ergon Energy's network and impact on residents was much greater. Table 1 provides data about the extent of impact to Ergon Energy's customers, and the speed with which Ergon Energy worked to restore power.

Cyclone Yasi damaged power supplies to nearly a third of Ergon Energy's customer base with extensive damage to the network from Cooktown to Sarina and west to Mt Isa. All up, the system interrupted the power to more than 220,000 homes and businesses and at least 50 major substations (**Stage 3 – Distribution**) were off supply after the initial impact. In the worst affected areas the network had to be rebuilt from the ground up.

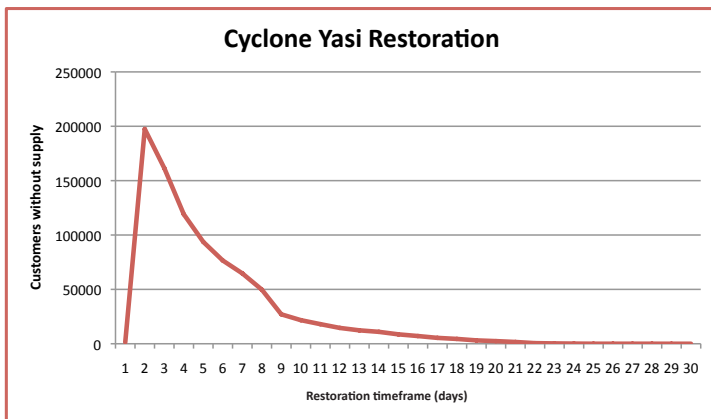


Figure 3: Ergon Energy's restoration by customer and date  
Note: While approx. 220,000 customers lost power in Cyclone Yasi, this did not occur at the same time

One of Ergon Energy's key strategies in the overall restoration response was the deployment of a fleet of mobile generators throughout the communities hardest hit by Cyclone Yasi. Ergon Energy had 70,000kVA in generating capacity available for deployment, through both their own inventory and external providers. At the peak, and to meet customers' requirements, 155 generators were deployed in the field, with 109 generators running concurrently at one point while others were in transit or on standby. This meant that many communities were able to maintain basic services while repairs to the power network continued.

Table 1: Ergon Energy's extent of cyclone impact and response time

EVENT	EXTENT OF IMPACT	RESPONSE TIME
Cyclone Tasha – 25 December 2010	About 8,500 customers off supply	48 hours restore power, where safe to do so
Cyclone Anthony – 30 January 2011	About 15,300 customers off supply	48 hours restore power, where safe to do so
Cyclone Yasi – 3 February 2011	About 220,000 customers off supply & 50 major sub-stations off supply	Restored power to 200,000 customers within 1 week, the balance within 3 weeks
Regional Flooding (December - January)	About 10,500 customers off supply	Usually 48 hours where safe, depending on peak

This overall strategy saw supply restored to all but around 20,000 homes and business within the first week. By comparison, in Cyclone Larry there were about 90,000 customers with interrupted supply initially and Ergon Energy had brought this down to around 15,000 customers off supply by the end of the first week.

In the case of Cyclone Yasi, the restoration of supply was completed for all properties able to be connected, after 23 days of Ergon Energy and others crews working long hours in extremely difficult conditions.

*“Despite dreadful conditions, the hard work and expertise of the Ergon crews backed up by their ENERGEX and interstate colleagues saw all but 20,000 of the 200,000 properties blacked out restored within a week – a remarkable effort.”*

**Hon Stephen Robertson, Minister for Energy and Water Utilities**  
Ministerial Statement in relation to Cyclone Yasi

**Total Ergon Energy customers affected (including flooding and cyclone impact): approx. 255,000**

**During the three week operation for the Cyclone Yasi response, Ergon Energy acquired and/or used for repairs or rebuilds:**

- around 600km of cable and conductor line
- almost 2300 poles and cross arms
- 25,000 fuses and lightning arrestors
- 6700 insulators
- 350,000 hardware items like bolts, screws, brackets and clamps
- 1,340 personnel and support staff on the ground.

## ENERGEX

In January 2011 ENERGEX's assets were exposed to severe flooding across SEQ. The flash flood events in Toowoomba and the Lockyer Valley were followed by significant flooding in the Upper Brisbane Valley that resulted in flooding throughout SEQ not seen since the 1974 floods.



Damage to ENERGEX's infrastructure caused three significant effects for the ENERGEX electricity network:

1. Devastation of property including ENERGEX assets in the Lockyer Valley area.
2. Major pre-emptive interruption of electricity supply to approximately 150,000 customers at the time of the peak in SEQ (mostly in Brisbane and Ipswich).
3. The clean up and restoration of power to around 60,000 (of the total 150,000) homes and businesses affected by flood waters.

During the 2011 flood events, ENERGEX undertook the following proactive responses:

- Adopted actions to minimise the risk of damage to vulnerable assets and infrastructure, including disconnecting vulnerable substations and powerlines, and removing equipment from those substations at risk from floodwater.
- Liaised with other stakeholders including local governments and local disaster management groups (LDMGs).
- Determined what information needed to be provided to customers related to flood risks and public safety in a timely, efficient manner.
- Adopted a proactive, multi-faceted communications strategy to communicate with customers, industry stakeholders, government and employees to protect the safety of the community, minimise damage to assets and ensure the timely reconnection of electricity supply.

**ENERGEX was well prepared for the January 2011 flood events as a result of the implementation of the Summer Preparedness Plan, the Business Continuity Plan (BCP) and the Corporate Emergency Management Plan which incorporated the Flood Risk Management Plan 2010/2011 that was developed when the La Niña weather system was identified and a high likelihood of an increased rainfall was forecast.**

ENERGEX's priority at all times is to ensure the safety of the community and ENERGEX employees. ENERGEX's next objective was to restore power to the community as quickly as possible when it was safe to do so. This was to ensure that there were no electricity-related fatalities or injuries. There were no incidents that occurred during the flood that can be attributed to electrical faults or short circuits.

In the Lockyer Valley, the automatic switches that were tripped on the 33kV and 11kV powerlines worked as they should in an emergency situation and, as a result, there were no electricity related injuries or deaths.

On 21 January 2011, almost all customers that could be re-connected, were re-connected. At that time, there still remained many thousands of homes that were not capable of being re-connected or ENERGEX had not yet received advice that they could be re-connected. A small number of premises are still without power.

### Total customers affected at the time of flood peak 150,000. Specific damage to ENERGEX's assets included:

- 25 zone substations (33kV to 11kV) were switched off due to flood inundation of the substation or loss of incoming supply lines due to the flood
- 6 zone substations were directly affected by flood waters
- 95 poles had to be replaced, most in western region of SEQ
- 120 pad mount and ground distribution transformers were removed and replaced
- 98 kilometres of overhead conductors were replaced
- 10 major substations in Brisbane's CBD were impacted resulting in a loss of supply to 21 CBD buildings, with 4 CBD substations out of services for 7 days.

### Powerlink

Up to 20 per cent of Powerlink's assets (13,000 circuit kilometres of transmission network and 114 substations) were exposed to flood and cyclonic conditions during the statewide flooding and Cyclone Yasi. However, only 0.03 per cent of transmission assets sustained material damage during this period. During the natural disaster events and immediate recovery period, 99.9 per cent of bulk electricity supplies were maintained via the transmission network. The network proved extremely resilient, despite being exposed to extreme rain, flooding and cyclonic winds.

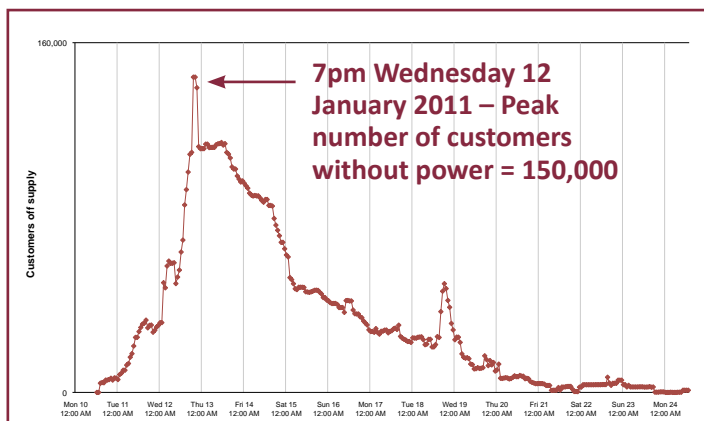


Figure 4: Graphical representation of ENERGEX response to the major flooding in SEQ January 2011

### 3 – What have we learnt?

Summer 2010/2011 showed that no matter how prepared Queensland is for floods and cyclones, there are still lessons to be learnt and improvements to be made.

According to the Council of Australian Governments, disaster resilience can be defined as **‘the capacity to prevent, mitigate, prepare for, respond to and recover from the impacts of disasters’**<sup>1</sup>. Building resilience will enhance Queensland’s ability to minimise the effects of future disaster events and to efficiently and effectively cope with their impacts. Resilience is a dynamic quality and is usually developed and strengthened over time. This can be achieved by guiding and supporting a range of resilience strategies in the key areas of built infrastructure, land use planning, emergency management and planning and community education capacity building.

Resilience, in the context of critical infrastructure, can be defined as the ability of an asset or system assets, to continue to provide essential services when threatened by an unusual event (e.g. a flood or cyclone) as well as its speed of recovery and ability to return to normal operation after the threat has receded<sup>2</sup>. Resilience also involves designing an infrastructure asset, or adapting an asset so that although it comes into contact with threats such as flood waters or high winds during flooding and cyclone events, no permanent damage is caused, structural integrity is maintained and, where operational disruption occurs, normal operation can resume rapidly after the threat has receded.

This Guideline is aimed at ensuring that Queensland will have in place a resilient electrical infrastructure network that will be able to recover to normal operation as soon as possible after the threat of flooding or a cyclone has receded. In doing so this Guideline provides key considerations in relation to the following:

- Electricity distribution
- Land use planning
- Emergency management and planning
- Building and design
- Community education

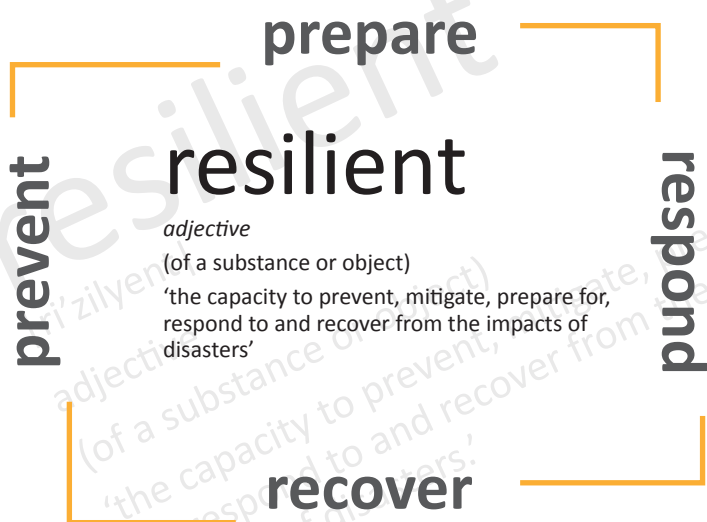


Figure 5: Cycle of resilience

1 Council of Australian Governments, 2009 ‘National partnership agreement on natural disaster resilience’

2 Ciria, 2010 ‘Flood resilience and resistance for critical infrastructure’

### Considerations

#### Electricity distribution



- Review the electricity network to identify and rectify any vulnerabilities following a flooding or cyclone event.
- Design and locate major electrical infrastructure in flood prone areas, that withstand a minimum 0.5% AEP.
- Design and locate major electrical infrastructure to withstand (where possible) cyclonic conditions.

#### Land use planning



- Continued consideration of *State Planning Policy 01/03 – Mitigating the adverse impacts of flood, bushfire and landslide (SPP1/03)*
- Consideration by local governments to the long term resilience of the settlement and land use patterns in the course of preparing the strategic planning frameworks for new *Sustainable Planning Act 2009* compliant planning schemes.
- Electricity distributors and local governments liaise to highlight major and priority components of the network, allowing for greater protection.
- Ensure better protection of minor electrical infrastructure in future events by reviewing a level of immunity in private developments i.e. through the development assessment process.

#### Emergency management and planning



- Businesses are encouraged to have a Business Continuity Plan (BCP) in place that takes into consideration the impacts of potential loss of power and a checklist for the critical BCP components.
- Ongoing vegetation management programs to be implemented to ensure that trees and branches are kept away from powerlines.
- Electricity distributors continue to have early and ongoing representation in disaster management groups (both local and statewide) in future flooding and cyclone events.
- Distributors, with local and State governments, to determine the appropriate strategies to be included in contingency plans for the most efficient restoration of power supply for critical infrastructure sites.

#### Building and design



- In new high rise buildings raise electrical equipment, where possible, to improve resilience and provide greater protection.
- When retrofitting existing buildings, at a minimum the low voltage switchboard should be configured to allow generation connection.
- Potential review of existing regulations in order to (where possible) consider how design outcomes can be better regulated to ensure that electrical equipment in high rise buildings is designed to be more resilient.

#### Community education



- Understand reasons for disconnection of power supply in flooding or cyclones in order to manage expectation in future events.
- Ensuring electrical safety practices are undertaken before, during and after flooding and cyclone events.
- Where possible and known, homeowners are recommended to ensure greater resilience by locating, at least, their switchboards above the Defined Flood Level (DFL).

## 4 – Electricity distribution



Despite the many successes of the electricity distributors in responding to the events of summer 2010/2011, there is still room for improvement.

### Placement

Electricity distributors should locate, where possible, major electrical infrastructure including substations outside flood and cyclone prone areas. Strategic placement of assets is a critical factor and as long as electricity distributors continue to make informed decisions about the placement of major electrical infrastructure assets, this will serve to improve the resilience of Queensland's electricity network. However, where potential risks to substations cannot be avoided by locating infrastructure outside hazard areas, electricity distributors should implement the following recommendations to achieve greater short term, long term and ongoing resilience.

### Load control and switching

By having appropriate control of network supply the risk of outages can be managed. Distributors should ensure that substations at potential risk have supply switching capabilities so that the majority of customers continue to have supply where it is safe to do so.

### Review of network

Following flooding or a cyclone, it is recommended that electricity distributors review their networks to highlight vulnerabilities and problems that were identified during the event.

**Electricity distributors should locate, where possible, major electrical infrastructure including substations outside flood and cyclone prone areas.**

## Resilience in action:

*After the major flood in SEQ in January 2011, ENERGEX identified a vulnerability in the western Brisbane suburbs of Bellbowrie, Moggill and Anstead where many customers were disconnected from electricity supply (despite not being directly affected). Since the event, ENERGEX has reconfigured the electricity supply network to ensure that the majority of unaffected customers can be supplied with stand-by generation.*

## Flood prone areas

### Major substation design

Substations that supply areas that are subject to flooding are not required to function effectively during a flood event (power and water don't mix). It is however vital that they function immediately after the event. As required by SPP1/03 for community infrastructure, it is recommended that substations in flood prone areas, at least, ensure that the sensitive electrical equipment on site, for example transformers, control cabinets, neutral earth reactors and switch gear, are above 0.5% AEP flood levels. As seen in Figure 6, while the entire substation is not raised above the 0.5% AEP flood levels, the sensitive electrical equipment is raised to ensure greater resilience and ability to return to normal operation as soon as the threat of the flood has receded. This has occurred for major substations built after SPP1/03 and this resulted in impacts being largely restricted to older substations.

### Distributor substations (in CBD)

For a distributor to ensure the resilience of its network, it needs to be able to ensure that the electricity supply to the building (generally 11kV), the switchgear and transformers (generally 11kV/low voltage) are located and designed above the Defined Flood Level. Distributors do not currently have the ability to enforce this. Traditionally substations have been placed in basements rather than ground level (or above) due to the desire not to use prime retail space. A change to location of these substations in CBD situations would improve the resilience of substations against future events.

Figure 6: Example of resilient substation design with all sensitive electrical equipment raised above the flood level



Photo 1: Example of an older, non-resilient substation design

## Powerlines

For major powerlines, distributors should ensure that the Defined Flood Level (DFL) for an area is taken into account during the design of the service. The linear nature of powerline corridors means that it is often impossible to avoid areas below the DFL. Where this is not possible, the poles/towers in the flood prone area should be designed to withstand the impacts of a flood event.

This approach will resolve the “Dry Islands” scenario where there are powerlines going through flood prone areas that have to be switched off, that supply predominantly unaffected premises. Where this is practical and cost effective, this should include:

- Ensuring the network’s ability to switch off flood affected powerlines that are “spurs” (preferably remotely).
- Reconfigure powerlines into “wet” and “dry” lines to limit the number of 11kV powerlines affected by a flood event (so that the network is structured so that “wet” powerlines only need to be switched off). While this would still result in some unaffected premises losing supply, the number and duration of impact would be greatly reduced.

## Cyclone prone areas

### Australian Standards

With regard to structures in cyclone prone areas, electricity distributors are required to design substations in accordance with *AS 1170.2 – Structural Design Actions: Part 2 Wind Action*. This Standard was prepared by the Joint Standards Australia/ Standards New Zealand Committee (the Joint Committee), BD- 006, General Design Requirements and Loading on Structures.

The objective of this Standard is to provide direction for use in the design of structures subject to wind action. It provides a detailed procedure for the determination of wind actions on structures, varying from those less sensitive areas to wind action to those for which dynamic response must be taken into consideration.

The Joint Committee is considering possible amendments to the Standard after the recent severe wind events, including Cyclone Yasi. The review of the Standard as a result of the recent cyclone events is recommended and is considered to contribute to greater resilience of substations in cyclone prone areas in future events.

### Key electrical infrastructure assets

It is recommended that investment in underground infrastructure and bundled overhead lines continues in cyclone prone areas of Queensland where it is safe to do so and in a similar manner to the Cyclone Area Reliability Enhancement (CARE) Program being run by Ergon Energy.

It is important to recognise that underground powerlines are not suitable for all locations. In particular, this relates to areas that are prone to storm tide inundation. In these locations, overhead bundled cable may be more appropriate, as seen in Photo 2.

It is recognised that it can be extremely expensive to transfer electrical infrastructure underground, however it is recommended that where appropriate and subject to budgeting and a works program, consideration should be given to undergrounding electrical infrastructure.



Photo 2: Courtesy of Ergon Energy - Highway through Cardwell post Cyclone Yasi, featuring overhead bundled cable

## Additional considerations

### Ongoing actions

Electricity distributors are recommended to undertake the following actions to ensure that ongoing improvements are made to the resilience of electrical infrastructure in Queensland:

- Annual reviews of emergency plans and BCPs.
- Annual reviews of Summer Preparedness Plans to ensure these documents reflect up to date data and incorporate best practice approaches for natural hazard resilience and mitigation and emergency response practices.
- Review maintenance issues to improve the vulnerability of assets in floods and cyclones including vegetation management in collaboration with relevant local governments.
- Strengthen relationships with local governments to ensure better communication between electricity distributors and local governments during floods and cyclones.



Photo of powerlines damaged by fallen vegetation in Tully Heads, courtesy of Ergon Energy

## 5 – Land use planning



Land use planning has a critical and ongoing role to play in ensuring that planning, from the strategic planning framework down to the site based detailed development assessment level, consider better protection of electrical infrastructure in flooding and cyclones. Efficient land use planning will also assist in ensuring minor electrical infrastructure in private homes and businesses will be better protected, which is a significant component of the statewide electricity network.

### Statewide planning mechanisms

State Planning Policy 1/03 - *Mitigating the adverse impacts of flood, bushfire and landslide (SPP1/03)* is a statewide planning policy and has effect in the assessment of development applications, in the making and amending of local government planning schemes and in the consideration of community infrastructure. SPP1/03 encourages local governments across the State to adopt and identify natural hazard management areas (flood). It is recommended that local governments continue to ensure that SPP1/03 is considered in all land use planning decisions. The Authority has prepared a draft Guideline **Planning for stronger, more resilient floodplains** which provides further advice for Councils in the consideration of SPP1/03 and the potential adoption of natural hazard management area (flood). Refer to [www.qld.gov.au/floodcheck](http://www.qld.gov.au/floodcheck).

The *Queensland Coastal Plan* is a new statewide planning document which applies to the Queensland coastal zone. The plan has two parts: the State Policy for Coastal Management, containing policies for coastal land managers and the State Planning Policy for Coastal Protection, for planning and assessment decisions made under the *Sustainable Planning Act 2009 (SPA)*. Under the Coastal Plan, adaptation planning guidelines for local governments are being prepared to assist councils in addressing risks faced by communities over the long-term. It is recommended that local governments in the coastal zone commence preparation of adaptation plans to minimise the exposure of communities to the risk of adverse coastal hazard impacts. This includes the better protection of critical infrastructure including electrical as it relates to development in the coastal zone.

### Strategic planning

In the course of preparing the strategic planning frameworks for new SPA compliant planning schemes, consideration should also be given by local governments to the longer term resilience of the settlement and land use patterns within the local government area to these events. While it is acknowledged that this is a matter to be implemented over the long term, the preparation of these new planning schemes offers the unique opportunity now to ensure the strategic planning frameworks include consideration of resilience in directing future growth, infill and land use compatibility in these areas specifically in relation to natural hazards.

### Coordination

For both flooding and cyclone prone local government areas, it is recommended that local governments and electricity distributors coordinate their planning activities to highlight major and priority components of the electrical infrastructure network. This coordination could result in the development of a database, for example a Geographical Information System (GIS) layer, that identifies key electrical infrastructure assets across the local government area. Once these assets are known, it is important that local governments ensure these assets are protected from the impacts of flooding and cyclones development through making informed land use planning decisions.

### Development assessment

It is important to consider the location and design of electricity infrastructure in relation to development occurring in flood prone areas. There are two main scenarios that need to be considered: new development and existing development commitments.

#### Proposed new development (including Building Works)

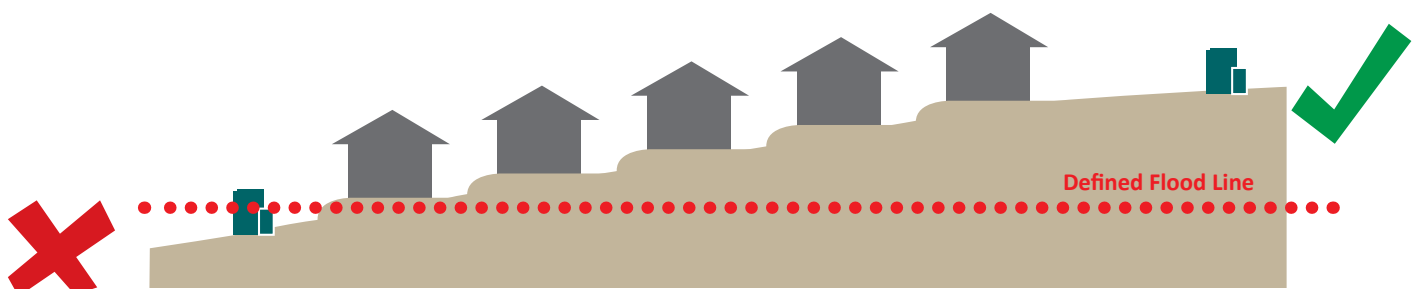
There needs to be consideration of new developments (particularly high rise buildings and other major developments that require a substation on-site) and new subdivisions (large enough to be supplied from a pad mount transformer). Refer to section 7 'Building and Design'.

For proposed subdivisions that are large enough to be supplied from a pad mount transformer it is crucial that local governments and developers work together to design an efficient layout. Typically, in these cases the pad mount transformers have been placed on the least valuable part of the land which is usually low lying and therefore more likely to be affected by flooding. It is recommended that local governments require developers of new large lot subdivisions to locate electrical infrastructure above the DFL, or if the DFL is unknown to at least in an area that is considered less likely to flood (See Figure 7).

#### Existing development commitments (where construction has yet to commence)

Where there are existing development commitments, it is important that local governments and developers consider opportunities for developments that have yet to gain building approval to be re-designed (where possible) to ensure greater resilience in future flooding and cyclone events. It is recognised that this can bring significant cost and therefore this needs to be considered as part of a cost/benefit analysis however, this cost needs to be considered in respect of downtime, loss of rent and repair bills.

Figure 7: Recommended and not recommended placement of padmount transformers supplying a subdivision development



## 6 – Emergency planning and management



### Business continuity/preparedness plans

Preparing for a natural disaster event is a crucial step in ensuring better understanding and performance during and after flooding or a cyclone. It is everyone's responsibility to be prepared for natural disasters, including businesses. The Department of Employment Economic Development and Innovation (DEEDI) has developed a basic template for a Business Continuity Plan (BCP) to ensure that businesses of all types and sizes are adequately prepared in Queensland for future natural disasters.

To access a copy of the Queensland Government Business Continuity Template visit: [www.business.qld.gov.au/documents/business\\_continuity\\_plan\\_template.doc](http://www.business.qld.gov.au/documents/business_continuity_plan_template.doc).

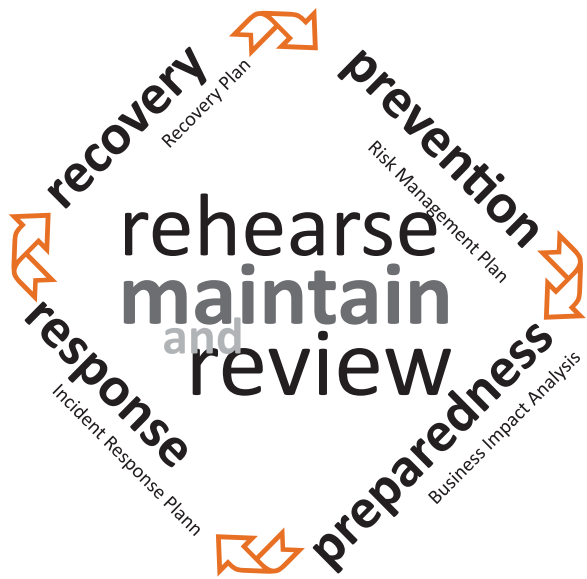


Figure 8: Business Continuity Planning Process

### BCP checklist

It is accepted that key industries will want power restored as soon as possible after an event. As has been outlined in this Guideline, there are a number of reasons why the power is sometimes required to be switched off and therefore businesses have a responsibility to ensure that they have their own preparedness plan in place.

It is essential that industry and businesses have a well defined and regularly reviewed BCP that has electricity supply as a priority component if this is a critical element of the business operations.

To ensure your business is adequately prepared it is recommended that your BCP at least includes the following components:

1. Risk management
2. Business impact analysis
3. Incident response plan
4. Emergency kit
5. Roles and responsibilities
6. Contact list
7. Events log
8. Recovery



### Resilience in action:

Through lessons learnt from Cyclone Larry, dairy farmers in North Queensland were well prepared for Cyclone Yasi. After Cyclone Larry it was 22 days until all dairy farmers on the Atherton Tableland could access the main power supply.

As a result of this previous event, the majority of farmers invested in backup systems that could run their dairy plant and milk vats during extended power outages.

Thanks to business continuity planning and investment, recovery from Cyclone Yasi was much easier on farmers across the Tableland, with only two farms having significant operational difficulties.

### Vegetation management

One of the most challenging aspects in relation to loss of power supply is tree damage to powerlines. Initial investigations revealed the bulk of the outages in some communities were caused by fallen trees, branches and vegetation coming into contact with powerlines.

Ongoing vegetation management programs implemented by electricity distributors regularly keep trees and branches away from powerlines. However, the destructive winds of Cyclone Yasi blew hundreds of trees, in some cases large distances, into powerlines as seen in Photo 3. In SEQ, major storms can also cause tall trees to bring down powerlines.

Tree planting policies and species lists are currently developed in collaboration with local governments as part of the Plant Smart program. Significant progress has been made in this area over the past few years. To further understand the extent of the impact of vegetation on the electricity network, Townsville City Council and Ergon Energy have engaged Greening Australia to prepare a report on tree damage as a result of Cyclone Yasi. This sort of collaborative work is encouraged and seeks to improve resilience of electrical infrastructure.

Smarter choices when planting near powerlines and in cyclone prone areas may be able to reduce the impact of storms and cyclones on the electricity network in the future. For further information visit: [www.ergon.com.au/community-and-our-network/trees-and-powerlines/plant-smart](http://www.ergon.com.au/community-and-our-network/trees-and-powerlines/plant-smart).



Photo 3 courtesy of Ergon Energy – Repairing the network in Tully

## Access

Adequate access was a major issue for electricity distributors during the events of summer 2010/2011 (as seen in Photo 4). Restricted access can create significant problems for electricity distributors in floods and cyclones as it can impede staff mobilisation, the movement of equipment and the supply of basics such as food and water. It is recommended that electricity distributors continue working with the Queensland Government through the State Disaster Coordination Committee (SDCC) to address the issue of access, particularly in relation to road closures and accommodation requirements, for future events.

## Critical infrastructure

The events of summer 2010/2011 highlighted the need for electricity distributors to work more closely with local governments and State government agencies to improve emergency planning and management in relation to critical infrastructure. It is recommended that the relevant bodies undertake a review to identify the power supply security of critical infrastructure including the following:

- evacuation centres
- medical centres
- schools
- water treatment facilities
- sewerage pumping stations
- telecommunication sites
- significant shopping precincts.

It is crucial that the relevant bodies work together to determine the appropriate strategies to be included in local government contingency plans for the most efficient restoration of power supply to critical infrastructure sites. Supply security for critical infrastructure sites should be given priority in each local government business continuity plan.

It is important to highlight that the 2010/2011 summer events saw a significant rise in the use of telecommunications and the internet, particularly social media, which should be considered as part of emergency plan reviews undertaken by telecommunication providers.

Additionally, there is a need to continue the conversations about identifying where emergency evacuation centres will be and to confirm the supply/emergency generation requirements, via LDMGs, prior to a disaster situation.

Restoration of power to critical infrastructure sites such as those listed above is crucial as this will ensure that, where possible, communities affected by floods and cyclones will at least be able to maintain basic services while repairs to the network continue.

## Local Disaster Management Groups (LDMGs)

While electricity distributors coordinated the allocation of generation to critical infrastructure sites with the LDMGs in the events of summer 2010/2011, discussions are being held with local government and State government partners to ensure enhanced business continuity and preparedness for the future.

It is crucial that in future floods and cyclones, LDMGs and electricity distributors have open lines of communication and continue to work collaboratively. This includes LDMGs ensuring that distributors are aware of crucial electrical services and assets within the local government areas prior to an event.

Distributors will turn off the power for safety reasons but this should occur in consultation with the LDMGs. Due to this crucial relationship between distributors and LDMGs during floods and cyclones, it is recommended that they continue to be representation of electricity distributors on all LDMGs and disaster committees around Queensland during floods and cyclones.



Photo 4 Flood inundation of a motorway in Goodna resulting in road closure courtesy of Queensland Government



Photo courtesy of Queensland Government - Brisbane business owner back on track after January 2011 event

**Business owners need to meet certain obligations under the *Electrical Safety Act 2002* and *Electrical Safety Regulation 2002*. As a minimum, this includes:**

- inspecting, testing and tagging electrical equipment and extension cords on a regular basis
- using safety switches in certain situations
- removing defective equipment from service
- removing safety switches from service if they are defective
- only using power boards which incorporate a safety switch or overload protection device
- having a licensed electrical contractor to install extra electricity outlets if necessary
- protecting extension leads and flexible cables from damage, e.g. using a flexible cover to provide protection against crushing or other damage in pedestrian and vehicle traffic areas.

Source: Ergon Energy

## 7 – Building and design



### Building and design in disaster areas

In a flooding situation, the electricity infrastructure that supplies a development must be located and designed to be as resilient as practicable during and after the event. The level of resilience is not only determined by the development's ability to withstand the flood event but also its ability to return to the same level of function after the flood event occurs in a timely and cost efficient manner.

### New buildings

Building owners need to be aware that flood inundation and other impacts on a building's electrical equipment can lead to costly repairs and significant impacts on the building.

### Elevation

The elevation of utilities and equipment within a building is a way of reducing the risk associated with flooding. By raising utilities and equipment above a DFL, water inundation of electrical equipment can be avoided and the equipment can be put back into use sooner as it will have sustained less or no damage during the event. See Figure 8 for examples of resilient and non-resilient electrical fit out designs.

### Is there generation connection available?

It is critical that when designing new buildings there is a connection for generation available and that this connection point is easily accessible. This will ensure that, where possible, in a flood or cyclone building owners and/or operators may be able to organise temporary power supply through the use of a generator.

### Resilient Materials

The use of resilient materials in construction can provide longevity to the structural integrity of a building. Materials such as solid timbers, steel and concrete are more resilient to flood waters.

### Equipment protection

Wet flood proofing is a method of component protection that aims to prevent flood water from inundating vital components within buildings in flood prone areas – meaning it allows for flood water to enter the building but protects the critical components from damage. Sandbagging water entry points and elevating equipment are methods of temporary wet flood proofing.

Dry flood proofing is another method of component protection where measures are taken to keep flood water completely outside a structure – meaning that water is not meant to enter the area where the equipment is stored and if it does, there is likely to be minimum damage. In relation to electrical infrastructure, sandbagging water entry points, creating water channels to redirect water flow and the use of portable diversion devices (inflatable levies and barriers) are ways of dry flood proofing.

### Retrofitting existing buildings

There may also be potential to retrofit existing services for greater resilience. The best outcome to ensure that electrical infrastructure is flood resilient is to ensure that the supply to the building is located above the DFL. In many instances this is cost prohibitive and the size of the equipment to be moved could mean significant construction works to make space available. This may not be an option in all circumstances (e.g. a heritage building). However where possible, a cost efficient option is to raise the low voltage switchboard above the DFL. Further resilience can be achieved in this case by ensuring that the raised low voltage switchboard also has an emergency generation connection point. This will ensure that the building is reconnected to power supply as soon as possible due to less damage being sustained.



Photo 5: Low voltage switchboard courtesy of Queensland Government

For existing buildings, where it is not cost efficient or possible to raise the low voltage switchboard (as seen in Photo 5), building owners should at least aim to ensure that there is an emergency connection point above the DFL and wet flood proofing which allows for a greater level of resilience to be achieved in the recovery stage.

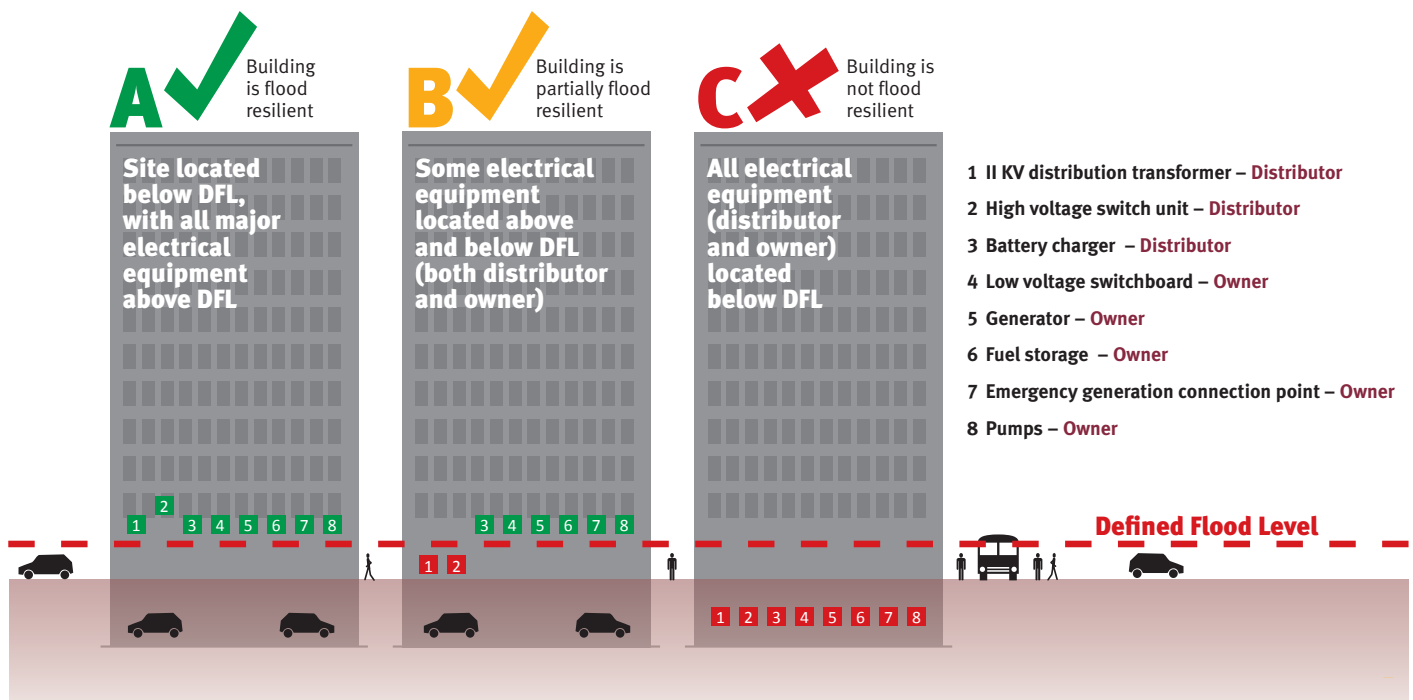


Figure 8: Scale of resilience of electrical equipment in CBD buildings

## 8 – Community education



### Why does the power go off?

Power is often required to be disconnected in floods and cyclones for safety reasons. Water and electricity do not mix and it is important that the electricity network is managed in flooding and cyclones to ensure that people do not sustain electricity-associated injuries during such events. While being without power can be an inconvenience, it is important to understand that this is done for the benefit and safety of everyone. Furthermore, pre-emptively disconnecting power ensures that electrical infrastructure sustains less damage during a flood or cyclone event meaning that power can be restored more quickly.

It is impossible to be precise in relation to the duration without power following cyclone impact, because circumstances vary widely due to factors such as intensity, location, population density, extent of infrastructure damage, tides at impact and weather before and after creating access difficulties. However, to assist in managing expectations about the approximate period of time power interruptions may occur during a cyclone, please consider the following general estimates:

- Category 4/5 – power restoration more than one month.
- Category 3 – power restoration up to a month.
- Category 2 – power restoration between one and two weeks.

For floods, it is more difficult to estimate the expected period of time that you may be without power as this depends on a number of factors including:

- The damage to the dwelling's electrical installations.
- The scale of the flooding event.
- The location of your house and the part of the network to which you are connected.
- The estimated time of the peak of the event and estimated time it will take for water to recede.

Due to the possibility that your household may be without power for an extended period (in the event of both flooding and cyclones), it is critical that you are adequately prepared.

### Electrical safety in floods and cyclones

This information has been sourced from the Department of Community Safety, Ergon Energy and ENERGEX. Electrical safety is critical for all people at all times. Natural disasters such as flooding and cyclones raise the risk of electricity-related incidents so a higher level of vigilance is needed. The following tips are recommended to prevent electrocution or injuries from electricity in the event of a flood or cyclone:

#### Before

- Install a surge protector in your home to help protect sensitive electronic equipment.
- If you are in a flood prone area, consider relocating your switchboard and any wiring in your home that may be below the DFLs.
- Tidy up unsecured objects around your home and yard and trim loose or dying branches. Call a professional tree trimmer if they're near powerlines.

- Ensure mobile phone batteries are fully charged and have a cord phone ready as cordless phone base stations do not work without electricity.
- Turn off and unplug electrical appliances including computers, TV, DVD and VCR aerial cables and move electrical equipment to higher ground.

#### During

- Follow instructions from authorities, listen to a battery-operated radio for official advice and power restoration information, and be prepared to evacuate if necessary (where a battery operated radio is unavailable, the car radio may be useful for a short time).
- **Do not** check the state of your electrical appliances during a natural disaster event.
- **Do not** operate electrical appliances or switches while standing in water.
- If moving around your area in boats, be aware of reduced powerline height clearances as flood waters will make you closer to the powerlines and power poles can also move from the force of flood waters.

#### After

- Stay well away from fallen power lines. Always assume they are 'live' and dangerous. Report them immediately to Triple Zero (000) or the electricity distributor's emergency number.
- If you experience tingles or shocks from an electrical appliance or water taps or if you are hurt call Triple Zero (000), call your local electricity supplier to notify them and call your licensed electrical contractor to check your electrical wiring immediately
- Unplug and do not use all electrical appliances affected by water and have them inspected by a licensed electrical contractor before use.

Take extra care around your switchboard if it's outside and wear synthetic or rubber-soled shoes. If you are in any doubt about the switchboard's safety, stay clear and call your licensed electrical contractor.

### Generators

It is extremely dangerous to use generators in an enclosed place. Please ensure that if you use a generator in your home to provide temporary power supply that you do not place the generator in an enclosed place as this can lead to carbon monoxide poisoning, which may be lethal (see Figure 9).

**When using a generator you must ensure it is outside.**

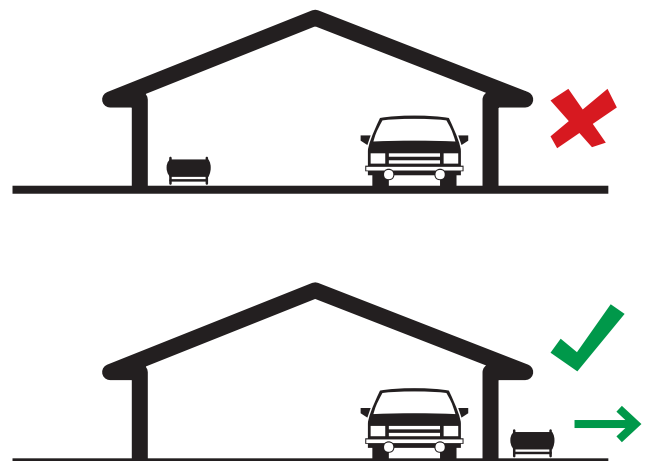


Figure 9: Correct location for home generators

**Do not** modify and plug generators directly into power points in the home or into any part of the distribution network. Plugging a generator into a power point will send electricity through the switchboard and into powerlines either on the ground or poles. That poses a significant safety risk to Electricity staff working on powerlines or neighbours cleaning up around fallen powerlines. Note:

- Appliances can be plugged directly into the generator but always read the manufacturer's instructions carefully.
- Use a heavy-duty extension cord rated for outdoor use.
- Always follow the manufacturer's recommendations for earthing the generator.

If you want to energise your household wiring, have a licensed electrical contractor install an isolating switch to provide a safe and permanent connection from your generator to your household wiring. This will prevent your generator from back feeding powerlines, avoiding a safety hazard to you, your family, neighbours, and power workers, and preventing possible damage to your generator when mains power is restored.

### Electrical equipment – mains power supply

As a homeowner in a flood prone area, it is recommended that where possible you ensure greater resilience of your own electrical utilities by locating your switchboard and meter boxes above the DFL, as seen in Figure 10. If the DFL is known, it should be specified by your relevant local government authority, usually through the local planning scheme.

It may also be beneficial to locate some power points above the DFL to provide power supply during the clean up operation when supply becomes available and it is safe to use appliances. This is a low cost solution that can greatly improve the resilience of the property after the event. A good location is at the switchboard. It may then be possible to supply power to that power point so that you do not need to use a generator in the cleaning process or to supply a fridge.

If you do choose to elevate your switchboard or meter box, it must be in a position that allows sufficient access for electricity distributors and/or qualified electricians who may need to access your equipment. The meter must be able to be read by a meter reader, which in some instances may need to be below the DFL and separate from the switchboard. Separating the meter and the switchboard in this case will allow the switchboard at least to be above the DFL.

The purpose of elevating electrical equipment in your home is to ensure that your equipment will not be inundated in a flooding event. It is important to understand that elevating the electrical equipment will not mean that you won't lose power. Rather, it will assist you in sustaining less damage to the electrical equipment in your house, which will ultimately mean you will be reconnected to power supply sooner.



Photo of repairs in Cardwell provided courtesy of Ergon Energy

### Preparedness

Regardless of the type of natural disaster your house may be susceptible to (flooding or cyclones) it is crucial that you are adequately prepared. It is important to plan ahead and be prepared so that during an emergency you and your household know what to do, where to go, how to keep in touch with each other and how to contact emergency services as required.

It is recommended that you undertake the following basic steps to ensure you are prepared for future natural disasters:

- **Prepare an emergency plan and prepare for evacuation.**
- **Develop your emergency plan** – with as many household members as possible to ensure everyone understands the risks and appropriate actions to take in an emergency.
- **Prepare an emergency kit** – this should include at least: food and water, medical and sanitation supplies, light, communications, clothing and footwear, tools and supplies and important documentation.
- **Prepare your home** – the best time to do this is before the event.

For further assistance relating to disaster preparation and evacuation planning including a checklist to prepare your own evacuation plan visit [www.emergency.qld.gov.au/emq/css/beprepared.asp](http://www.emergency.qld.gov.au/emq/css/beprepared.asp)

Source: Department of Community Safety

### Is your electrician licensed?

Check here: [www.deir.qld.gov.au/elis/](http://www.deir.qld.gov.au/elis/)

For more information on electrical safety in flooding and cyclones visit:  
[www.justice.qld.gov.au/corporate/floods](http://www.justice.qld.gov.au/corporate/floods)

or contact:

Ergon Energy on 13 10 46

ENERGEX on 13 12 53

Essential Energy on 13 20 80

Electrical Safety Office on 1300 650 662

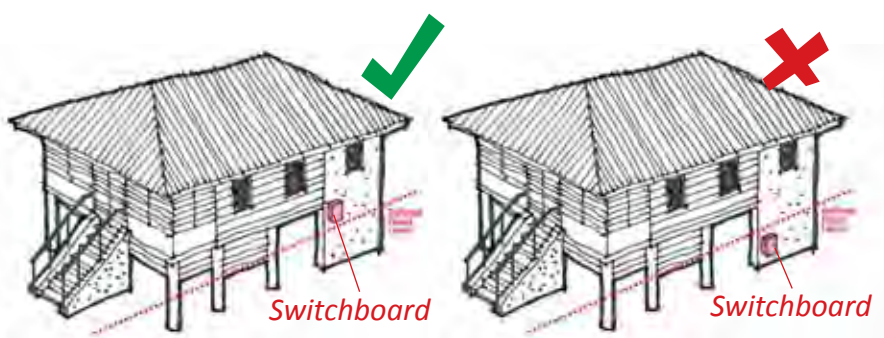


Figure 10: Preferred positioning for dwelling switchboard

# Resilience in action – regulatory amendments

## Amendment to the Queensland Development Code

*The Australian Building Codes Board has recently released a new Draft National Standard for Construction of Buildings in Flood Hazard Areas (draft Standard). The draft Standard is scheduled to be included in the 2013 version of the Building Code of Australia.*

*The draft Standard provides specific performance requirements and deemed-to-satisfy provisions for the design and construction of new buildings, including new additions, in designated flood hazard areas. In Queensland, flood hazard areas are designate by Local Governments.*

*To ensure the new standards are implemented as soon as possible in Queensland, the Government is accelerating amendments to incorporate the new draft Standard into the Queensland Development Code (QDC). The accelerated amendment to the QDC includes a provision (section 2.12.2 Electrical) which specifies that electrical services are to be either located above the flood hazard level or constructed in a flood proof manner.*

*This fast tracked regulatory amendment supports the intent of this Guideline by increasing regulation of the placement and function of electrical services which will improve the resilience of Queensland's electrical infrastructure in future flooding events.*

## Brisbane City Council's new draft condition

*In response to the flooding events on January 2011, Brisbane City Council (BCC) has prepared a new draft condition for all new construction and substantial improvements of basements below the 100 year ARI flood level (and/or Brisbane River Defined Flood Level) to ensure the structure is suitably waterproofed with walls and floors substantially impermeable to the passage of water.*

*Specifically, the new draft condition states that 'no essential electrical services (e.g. electrical switchboard or lift controls) are to be located in the basement unless situated above the DFL or 100 year ARI flood level'.*

*BCC's new draft condition supports the key considerations highlighted in this Guideline through ensuring better protection of minor electrical infrastructure in future events by enforcing a level of immunity in private developments through the development assessment process.*



Brisbane CBD

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## Suncorp Stadium

During the January 2011 floods, Suncorp Stadium incurred major damage to essential equipment servicing the Western Stand including:

- The main switchboard, 13 supporting switchboards and EnergeX sub-station
- The fire control and EWIS system
- Eight elevators

The building distribution room which housed major operating systems that provided key services to the Stadium, including:

- CCTV
- In-house television network
- Access control
- Lighting control
- PABX
- Ticketing control system
- Building management system
- Core network



## Resilience in action – reconstruction works

*To ensure that the Stadium was as resilient as possible to any future flood inundation, the following reconstruction work has taken place:*

*The main switchboard room has been elevated above the flood level so that this switchboard can continue to operate via generator power until mains power is reinstated to the building. This would result in no loss of power to the Stadium. Supporting switchboards have also been elevated.*

*The fire panel and EWIS system has also been raised above the flood level to ensure the Stadium continues to be connected to Queensland Fire and Rescue Service and fire alarms monitored at all times.*

*The building distribution room has been constructed above the flood level so that all main operating systems of the Stadium will function uninterrupted during any future event.*

*Utilised flood resistant materials wherever practical including block walls and elevated and relocatable fixtures and fittings.*

*While the Stadium was able to hold events within four weeks of the flood, the damage to the electrical equipment meant that the Stadium had to rely on temporary facilities, including generator power and temporary services and operating systems for six months until permanent repairs were completed.*

