G An assessment of risks to Customer Supply due to an increased incidence of Extreme Weather Events

Assessment of Risks to Customer Supply

Background

On 28 April 2009, the Ministerial Council on Energy (MCE) directed the Australian Energy Market Commission (AEMC) to conduct a review of the effectiveness of National Electricity Market (NEM) security and reliability arrangements in light of extreme weather events (MCE Direction). The MCE Direction includes a requirement to examine the current arrangements for maintaining the security and reliability of supply to end users of electricity and provide a risk assessment of the capability of those arrangements to maintain adequate, secure and reliable supplies.

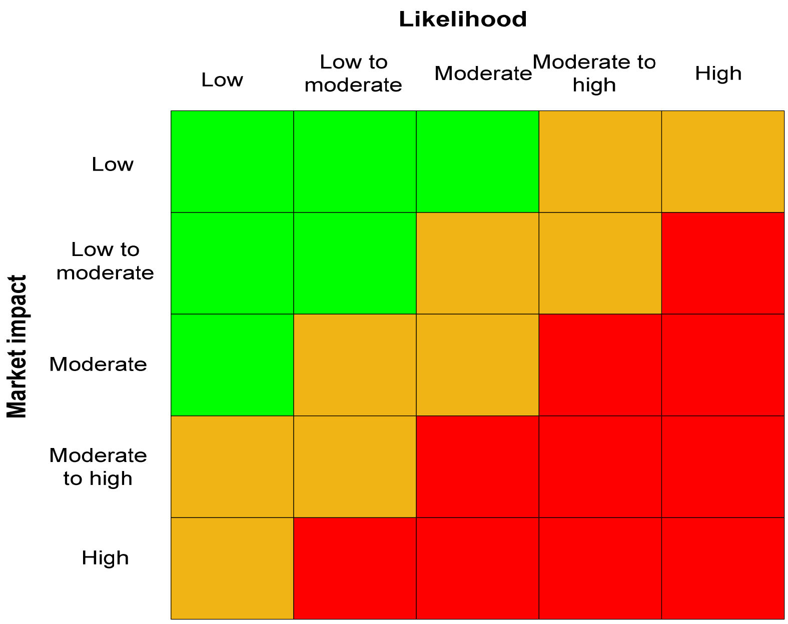
Approach to the risk assessment

In this section we provide a structured summary of the risks identified during this review, and their severity. We considered the issues in terms of the current level of risk and under the assumption that extreme weather events become more frequent.

The primary focus is on generation and transmission incidents, and their impact on the reliability of supply as seen by end use customers. In addition, both risks to the operational of the generation and transmission sectors are considered, as well as risk to the investment necessary to maintain ongoing reliable supply to customers.

We provide a risk assessment "traffic light" indication of the level of the risk identified. The below matrix sets out how we derived the traffic light coding depending on the level of the market impact and likelihood of the risk.

Figure 1: Traffic light risk key



Operational Risks

Risk	Impact on customer supply	Likelihood	Mitigation
Low reserves – LRC condition Low reserves condition caused by high demands (caused by hot, but not extreme, temperatures), possibly combined with reduced network capability and/or forced generating unit outages.	**Low** Provided reserves in a region remain positive then the load can be supplied. However, low reserves can lead to load shedding if further equipment failures or higher temperatures occur.	**Moderate to High** Low reserve conditions occur in one or more regions in most years. Increased numbers of extreme weather events would be expected to lead to more frequent low reserve periods	o Load forecasting to include long-term trend data, such as from the CSIRO. o Better forecasting and monitoring of generator performance at extreme temperatures. o Better forecasting and monitoring of network performance at extreme temperatures, including real-time monitoring of transmission line rating.
Low reserves – high demand Low reserves due to high demands caused, as a result of climate change, by high temperatures that are not forecast.	**Moderate** When demand exceeds supply (reserves are negative) some customers' load needs to be disconnected to restore system security.	**Moderate** Such events are triggered by extremely high temperatures and are, therefore, assumed to be more likely in the future.	o Load forecasting to include long-term trend data, such as from the CSIRO. o Any load shedding needs to be well managed to minimise impacts and restore load as soon as possible.
Low reserves – generation degradation Low reserves due to degradation of the generators capability caused by high temperatures. An example is the reduction of generator capability on 29 and 30 January 2009.	**Moderate** When demand exceeds supply some customers' load needs to be disconnected to restore system security.	**Moderate** Such events are triggered by extremely high temperatures and are, therefore, assumed to be more likely in the future.	o Better forecasting and monitoring of generator performance at extreme temperatures. o Any load shedding needs to be well managed to minimise impacts and restore load as soon as possible.
Low reserves – network degradation Low reserves due to degradation of the network capability caused by high temperatures. An example is the reduction of Basslink's transfer capability on 29 and 30 January 2009.	**Moderate** When demand exceeds supply some customers' load needs to be disconnected to restore system security.	**Moderate** Such events are triggered by extremely high temperatures and are, therefore, assumed to be more likely in the future.	o Better forecasting and monitoring of network performance at extreme temperatures, including real-time monitoring of the ratings of key transmission lines. o Any load shedding needs to be well managed to minimise impacts and restore load as soon as possible.

Risk	Impact on customer supply	Likelihood	Mitigation
Low reserves – heat wave Low reserves caused by high temperatures, due to: o high demand; o degradation of the network capability; and o degradation of generating unit capability.	**Moderate to High** The effects of high temperature on the demand combined with reduced generation and network capability can cause the need for significant amounts of load to be shed.	**Moderate** Extreme weather is, by definition, expected to occur infrequently but can be expected every 10 or 20 years, based on historical experience. Such events are triggered by extremely high temperatures and are, therefore, assumed to be more likely in the future.	o Generation and transmission capability needs to be adequately sized to meet long term reliability standards o MPC needs to be set to deliver necessary investment o Minimum reserve level calculations should model extreme temperature conditions, say at a 5% POE demand assessment o Reserve safety net may be used more often o Any load shedding needs to be well managed to minimise impacts and restore load as soon as possible.
Severe Multiple Contingencies Extreme temperatures can cause network equipment failures. Similarly, bush fires and lightning storms can cause multiple trips of transmissions lines in the same vicinity.	**High** This can cause major interruptions if the lines are associated with supplying a large load centre or form part of an interconnector. The extent of any interruption varies significantly with the associated circumstances. Extremely hot weather is the trigger for such events. This trigger usually works in combinations with degraded network and generator performance, and extremely high demand. The system security events on 16 January 2007 and 30 January 2009 are examples of such events.	**Moderate to High** High temperatures, bush fires and/or lightning storms occur somewhere in the NEM in most years. Such events are triggered by extreme weather conditions and are, therefore, assumed to be more likely in the future.	o Appropriate data collection in real time to manage system and maintain security, including monitoring of the power system, bush fires and lightning storms. o Prior analysis including establishing decision criteria for reclassifying non-credible contingencies as credible during extreme conditions. o Management of vegetation in easements. o Technical standards for network service providers and appropriate maintenance to ensure ongoing compliance. o Detailed design standards that incorporate a risk management approach o Well designed protection schemes, coordinated across network service providers o Emergency control schemes to limit impacts of potentially critical failures. o Any load shedding needs to be well managed to minimise impacts and restore load as soon as possible.

Risk	Impact on customer supply	Likelihood	Mitigation
Cascading equipment failures – due to physical proximity The catastrophic failure of a single item of power system equipment can physically damage neighbouring equipment.	**Moderate** This mechanism relies on the physical proximity of the affected items of plant and, therefore, the effects would tend to be localised.	**Low to Moderate** The extent to which a single event can cascade depends on the historical design practices of the affected network businesses. Increased numbers of extreme weather events is likely to increase the likelihood of individual items of equipment failing, but not necessarily the probability of subsequent cascading failures.	o The probability of cascading equipment failures due to physical proximity can potentially be reduced by retrofitting blast shielding between adjacent items of equipment, where this is practicable.
Cascading equipment failures – electrical interactions A major incident in the power system can cause significant disturbances to the system voltages and frequency. Potentially these distances can cause some items of power system equipment to trip.	**Moderate to High** The cascading of generating units following a major disturbance to the power system voltage or frequency would further compound the severity of the incident, and would be likely to lead to customer loads being automatically disconnected.	**Low to Moderate** The regime for compliance of generators with technical standards has improved, thus reducing the risk of cascading failures. Increased numbers of extreme weather events is likely to increase the likelihood of individual items of equipment failing, but not necessarily the probability of subsequent cascading failures.	o Ongoing monitoring of technical performance of generators and network service providers.
Wind and storm damage Extreme winds, including cyclones, can cause physical damage to transmission lines.	**Moderate to High** The extent of any customer interruption depends on the extent of the damage, but a severe cyclone can cause a prolonged outages for an extended period while the damage is repaired.	**Low to Moderate** Damage caused by severe winds are rare but can be expected very few years, particularly in northern Queensland. If the numbers of extreme weather events increase then damage from such events therefore likely to increase.	o It is very difficult to avoid the damage associated with extreme winds, such as cyclones, other than to ensure that the appropriate standards are used for the design and construction of transmission line towers and electricity substation. .
Energy shortages due to drought Drought can cause energy limitations, for example due to low hydro generator lake levels and shortages of cooling water for inland thermal generators.	**Moderate to High** The extent of any customer interruption depends on the extent of the drought, but a severe drought could cause a prolonged period of reduced generation capability.	**Low to Moderate** A prolonged period of drought severe enough to significantly affect reliability would be unlikely. The recently developed EAAP assists stakeholders to foresee the impacts of droughts.	o Continuing to use the EAAP to assist stakeholders to foresee the impacts droughts and put contingencies in place. o Ongoing monitoring of the effectiveness of the EAAP.

Investment risks

Risk	Impact on customer supply	Likelihood	Mitigation
Degradation of generator output with extreme temperatures inadequately considered in planning	**Low to Moderate** Customer reliability will be reduced if the degradation of generator output is not fully considered as actual reserves would be lower than anticipated.	**Low** The recent experience on 29 and 30 January 2009 has brought this issue to planners'' attention**.**	o Assess the generator capability under extreme temperature conditions, for example at a 5% PoE temperature, when calculating the MRLs.
Degradation of network capability with extreme temperatures inadequately considered in planning	**Low to Moderate** Customer reliability will be reduced if the degradation of network capability is not fully considered as actual reserves would be lower than anticipated.	**Low** The recent experience on 29 and 30 January 2009 has brought this issue to planners'' attention.	o Assess the network capability under extreme temperature conditions, for example at a 5% PoE temperature, when calculating the MRLs.
Insufficient investment to deliver the generation necessary to meet extreme temperature demands Generator and network investors continue to assume the probability of extreme weather is based on historical probabilities.	**Moderate** Insufficient generator and network investment would mean that customer reliability would be reduced and the likelihood of customer interruption increased.	**Moderate** There does not seem to be a consensus on the extent to which extreme weather events are going to become more prevalent.	o On going education of stakeholders.

Risks Mitigation

Manage load shedding and load restoration – under-frequency

A severe under-frequency condition can arise following a multiple contingency that leads to a large deficit of generation. Examples of such contingencies include:

- the cascade tripping of multiple generating units can occur when one or more contingencies results in a power system disturbance that causes one or generating units to trip, which generally exacerbates the original disturbance thus possibly causing more generating units to trip. Cascading tripping of multiple generating units can only occur if the power system is not secure, a non-credible contingency occurs and/or some generating units fail to meet their technical performance standards; and

- the formation of an electrical island following the tripping of multiple transmission circuits. An electrical island can occur when one part of the power system, often a region, becomes electrically isolated from the remainder of the NEM power system. This can occur following the tripping of multiple transmission lines as a result of a non-credible contingency or a credible contingency during a period of maintenance. A deficit of generation within an electrical island can result if it was importing energy prior to the separation event.

Customer load is automatically shed during an extreme under-frequency event in order to balance the generation and load. The loads that are shed are pre-determined in order to minimise the economic and social impact of the under-frequency.

We recommend that the schedule of loads to be shed during under frequency events is periodically reviewed to ensure that severe under-frequency events are both managed:

- in a technically effective manner; and

- to minimise the economic and social costs.

Manage load shedding and load restoration – reliability incidents

Under the current Reliability Standard small amounts of load shedding are permitted to avoid excessive costs. Therefore, thought should be given to the appropriate management of load shedding and the subsequent restoration of load. Approaches could include:

- common standards between the NEM regions;

- finer resolution of load blocks and better discrimination of loads, which can be achieved by shedding at a lower voltage (say 11 kV);

- more use of smart meters and smart gird would improve the control and management of load; and

- payment mechanisms, such as the short-notice RERT, to facilitate more efficient allocation of shedding.

Improved protection and network control systems

We consider that there may be potential improvements to the protection and control systems in the NEM's transmission networks to better manage system security events. Examples of where we consider further review may be warranted include:

- greater use of emergency control schemes – NSPs should review their networks to determine whether emergency control schemes should be developed to manage selected low probability but high impact contingencies.[1] In each case an economic assessment of the scheme would be required to determine whether the benefits of the scheme in terms of reduced load interruptions is likely to exceed the implementation and operating costs. An example where an emergency scheme may be cost effective would be multiple high capacity transmission lines share the same corridor in a bush fire prone area.[2]

- increasing the scope of credible contingencies – the various potential contingencies that have been recorded in the NEM should be reviewed to determine whether the scope of contingencies defined as credible should be expanded. For example, bus trips at critical substations could be treated as credible contingencies if statistical observations support this, or alternatively treated as protected contingencies (see above) due to the potentially high impact of bus faults.

- more re-synchronisation points in the network – reconnecting an islanded portion of an interconnected AC power system can only be performed at preselected points in the network using synchronisation equipment. Including more re-synchronisation points in the networks would increase the flexibility of the system operators and potentially improve the rate at which the network is reconnected and the loads are restored.

---

[1] Low probability but high impact events that are managed using emergency control schemes could be termed "Protected Contingencies". Such control scheme could including the automatic shedding of selected loads in the event of the protected contingency in order the prevent much more extensive supply interruptions.

[2] AEMO is required to operate the NEM power system in a secure operating state. That is, the power system is operated such any single credible contingency (such as the tripping of a transmission line or generating unit) does not cause interruption to customer loads. Therefore, the tripping of multiple transmission lines is normally regarded as a non-credible contingency, however, AEMO has the power to re-classify the tripping of multiple transmission as a credible contingency presence of bushfires. However, it is not easy to assess the risks of bushfires and AEMO may not re-classify the tripping of multiple transmission as a credible contingency if the risks appear low. It should also be noted that the reclassification of a non-credible contingency as credible reduces the transfer capability of the network which can have a significant market impact that may include requiring customer load to be shed.

Generator Connection Classification

Proponents of new generating units, (or existing generating units that are modifying their connection arrangements), often adopt the lowest cost option which would include little redundancy. This is because the additional benefits to the Generator of a high cost, but more flexible, connection may not exceed the additional cost.

However, in some cases the greater number of switching options would lead to better power system reliability. Note that the higher cost connection also provides improved network access to the generating unit, making the connection negotiation potential complex.

Blast protection

The probability of cascading equipment failures could be reduced by installing more blast protection if statistical observations and USE consequences support it.

This may not be practical in all cases, depending on the substation design.

Designing to High Temperatures

It is possible to require plant to be designed to be tolerant of extreme temperatures.

- Might be feasible to apply this kind of requirement only to new plant.
- Would need to consider whether such measures could increase the cost of plant enough to affect its feasibility as an investment.
- May be easier to incorporate into network standards than generator investments, which face quite a different incentive regime.

However, requiring new generators to invest in more expensive equipment may not provide the most economic overall outcome. Therefore, an economic cost-benefit test would be required before any changes to the technical standards could be recommended.