IESIS
A MULTI-DISCIPLINARY ENGINEERING INSTITUTION

16 Robertson Street
Glasgow G2 8DS
Tel: 0141 248 3721
secretary@iesis.org www.iesis.org

Closure of Longannet represents a serious risk for Scotland.

In our developed world the Government has a very high level of responsibility to ensure the constancy of electrical power that underpins all our essential economic and well-being needs. The imminent closure of Longannet threatens all of us in ways which are, regrettably, not well-understood. As Scotland's most senior Engineering Institution we offer our strongest advice that this situation would significantly increase the likelihood of a crisis which will not only inconvenience the public but also has the potential to cost lives and create economic harm.

Scotland currently enjoys a position of being a net exporter of electrical energy to England and Northern Ireland. The loss of Longannet not only threatens this position but it also increases the risk of instability of the electricity grid in Scotland. This could result in a loss of power not just locally but in a total shut down of the Scottish electricity network. Such a situation would likely result in many hours/several days recovery period with concomitant losses to our ability to respond to those in dire need whilst simultaneously impacting on our economy. As responsible Professional Engineers we feel compelled to bring these matters to the attention of the public.

To summarise: closure of the Longannet coal fired power station in March 2016 (as intimated by the owners) could lead to the following undesirable events:

1. There could be insufficient generation available to meet peak demand in Scotland.
2. The electricity system in Scotland could fail due to system operation problems such as voltage control and other instability difficulties.
3. It could take greater than 24 hours to reinstate supply from a 'black' condition in Scotland.

Before Longannet can be allowed to close, the probability of occurrence of all these events must be deemed to be at an acceptable level in relation to the consequences if they occurred. Adequate information on which to make such a judgement is not available in the public domain.

The closure of Longannet should be viewed as a wake-up call for proper assessment of thermal generation capacity in Scotland that is essential for the satisfactory performance of the Scottish system.

Questions and answers

1 What is meant by 'risk'?

'Risk' can be defined as the combination of the consequences and the probability of occurrence of an undesirable event.

2. What are the potential consequences of power failure in Scotland

Problems when electricity supply is down include:

- Likelihood of civil disturbance increases as duration of blackout increases.
- Most gas appliances require electricity for control purposes and would not be available in a blackout.
- Limited potential for cooking.
- Limited potential for heating – the incident would be most likely at a time of low temperatures. Some vulnerable people would die.
- Limited potential for lighting in homes and none in the streets.
- Supply of oil will be compromised.
- Petrol pumps do not work.
- Rail services do not operate.
- Communications are limited.
- Water supplies may be compromised where they rely on pumping.
- Supermarkets cannot operate because the tills do not work.
- Businesses - particularly those that rely on computers - have to limit their operations.
- Important data can be lost if a server shuts down unexpectedly. Financial services, an important part of the economy, would not be able to function

Some of these consequences can be tolerated if the blackouts are infrequent and short lived e.g. for a few hours. If the blackouts last for extended periods e.g. for over a day, emergency power services start to be compromised.

3. What is a 'black condition'? What is the probability of a black condition in Scotland? How would we recover from this if it happened?

Occasionally, generators or parts of the transmission system have to be switched out because of faults and this may cause a local 'blackout' (i.e. the national grid is unable to provide any electrical power in the area). If there is a shortage of generation to meet demand in large parts of the country or the whole of GB then a major 'black condition' could result if the System Operator does not shed demand quickly. In the past the likelihood of a major black condition was low but thermal generators across the country are closing down and with an increase in intermittent generation (wind and solar) there is an increase in the probability of such events.

If Longannet closes there will be insufficient thermal generation capacity to meet peak demand in Scotland and reliance will be placed on importing power from England. The probability of such imports from England being available is not known but it seems certain that such dependence will result in an increase in the probability of ~~a~~ blackouts in Scotland.

The present strategy for restarting the Scottish system from a black condition would be that that hydro power from Cruachan would start Longannet and then the other generators

could be restarted. In the absence of Longannet import power would be required via the interconnectors and the process would take significantly longer.

Another risk in relation to black start in Scotland is that a major proportion of thermal generation in Scotland is from nuclear power stations. If they have to be shut down they cannot, for technical reasons, be re-started quickly. The National Grid report[1] quotes a period of 24+ hours for recovery from a black start in Scotland in the absence of Longannet. It would sensible to have an estimate of what that '+' could be.

4. What can we learn from the experience of blackouts in other countries?

In a blackout in New York in July 1977 there was an outbreak of looting, fire raising and civil disturbance. As a result of experience of blackouts over many years it was found necessary to impose tight regulation on electricity supply in North America. It is important to take account of the North American experience in relation to regulation of the electricity system[2]. It is evident that tight regulation is also needed for the GB and the Scottish systems.

5. There is a lot of wind generation capacity in Scotland. Why will that not replace the loss of thermal generators in meeting peak demand?

Wind power is very unreliable as compared with power from thermal generators. Peak demand can occur when an area of high pressure sits over the whole of the UK (even over the whole of Western Europe). Such a condition in winter tends to result in low to very low temperatures and low to very low wind speeds. Thus, intermittent generation (wind and solar) makes a much less reliable contribution to security of supply than thermal or hydro plant.

An important question is 'If we have 5 GW of installed wind generation capacity in Scotland, how much of that can be treated as the equivalent of thermal capacity. Some people say that the wind capacity should be ignored in calculations for meeting peak demand. Others say that over 20% of it can make a contribution.

An appropriate method is to combine the probabilities of availability of all sources of generation in one analysis and to compare this with an accepted standard probability for security of supply - see answer to Question 6.

6. What do we know about the probabilities of occurrence of undesirable events?

Pre-privatisation Prior to privatisation of the system in 1990, the GB electricity system was managed so that the risk of not meeting system maximum demand would occur not more frequently than 4 years in 100. This criterion in combination with the method of estimating the probability resulted in an acceptable level of security of supply.

Post privatisation in 1990, there was an allowance for capacity in the market arrangements (the Pool) but with the introduction of the New Energy Trading Arrangements (NETA) in 2001 it was assumed that the market in electricity would guarantee a suitable amount and mix of generation to meet demand. Several issues make this a false assumption: there is no mechanism in the market that can allow accurate assessment of the risk to security of supply; the lead time for the provision of new plant is long – i.e. 6+ years - and therefore

[1] http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=40185

[2] http://www.iesisenergy.org/pr/NERC.pdf

markets cannot react quickly to events that show the need for, or benefit from, new plant; meeting peak demand is a public good issue that markets do not address; it is probably to the advantage of generating companies to have tighter margins for security of supply than customers would prefer (i.e. when supply is tight prices increase).

Energy Market Reform (EMR) The UK Energy Act of 2013 introduced a Capacity Mechanism[3]. This mechanism allows firms to bid to provide generation capacity to support a standard of three hours loss of load expectation each year. We do not know if this represents a higher or lower risk than the previous 4 incidents in 100 years criterion.
The first capacity auction was held in 2015 and was reported to have been successful. While this capacity mechanism is a step in the right direction, it is a broad brush approach that does not address the probability of regional failures such as what might happen in Scotland if Longannet is closed down.

Transmission security The National Grid Company (NGC) published a report in March 2015[1] that discusses the effect of closure of thermal generation plant in Scotland. With Longannet closed, to satisfy peak demand, import of power from England and Wales would be required. NGC state that the transmission system is likely to be able to cope with such a situation but do not make any statement about the probability of generation from England & Wales being unavailable for this purpose.

Capacity security Since (a) in the absence of Longannet there would not be sufficient thermal capacity in Scotland to meet peak demand and (b) a contribution from wind generation for this purpose has to be largely discounted – see Question 5 - capacity imports would be needed to meet peak demand. What is the risk that sufficient import capacity would be unavailable? Has this risk been evaluated? We do not know the answers to these questions.

Operational failures There are strict standards for voltage and frequency levels on the Grid. Frequency is a whole grid issue but voltage problems can cause local or regional breakdowns in supply. One of the issues in voltage control is the need for reactive power[4]. This can be provided by thermal generators but is not normally available from wind generators. Other means of providing reactive power are being installed by NGC. No information about the probability of Scottish system failures due to voltage control problems and other operational problems in the absence of Longannet is available.

7. Who is responsible for assessing the likelihood of failure of the electricity system

As far as we know most calculations about the performance of the electricity system are carried out by the NGC. These relate to the information needed by the NGC for its own operations and to contracts from Ofgem and DECC.

It is important to realise that NGC is responsible for working with the generation capacity that is available and does not have responsibility for ensuring that the available capacity is adequate. The previous Minister of State for Energy and Climate Change, Ed Davie, stated that he was responsible for security of supply. The Distribution Network Operators, Scottish Power and Scottish and Southern Energy, are responsible for security of the distribution systems under their management

[3] https://www.gov.uk/government/publications/2010-to-2015-government-policy-uk-energy-security/2010-to-2015-government-policy-uk-energy-security

[4] http://www.iesisenergy.org/pr/Reactive-control.pdf

8. Safety critical system What is it? Should the electricity system be treated as safety critical? How might this be done?

A safety critical system is one for which any failure or design error has the potential to lead to loss of life. The electricity system meets this criterion but the present arrangements for regulating it do not conform to the standards adopted for other safety critical contexts. For example, a design for a long span bridge is required to be subject to a 'Class 3 check' where the original design is passed on to another consultancy firm that assesses the safety of the bridge on the basis of a new set of calculations.

An equivalent approach for assessment of risk for the electricity system should be adopted. This would require that another competent entity works on a model of the grid so as to repeat the assessment of probabilities of events. Results from this model would be compared with those from the initial assessment and discrepancies eliminated or explained. The requirement for a Class 3 check approach does not imply that the original work is sub-standard. It does recognise the potential for errors in predictions for situations of complex uncertainty.

9. What is the way forward?

The risks involved in the electricity system should be assessed using the most advanced methods available. In view of the safety critical nature of the context - see Question 8 - an independent review of the methods used by the Government to ensure security of supply of the electricity system, and a reconciliation of this to the pre-privatisation standard, is urgently needed

10. What is IESIS?

IESIS is a multidisciplinary engineering institution established in 1857. We seek to 'provide high quality advice to government and all relevant bodies on matters of public policy that would benefit from an engineering perspective'.

This press release has been prepared by the Institution's Energy Strategy Group that consists of engineers from a range of disciplines. The main expertise in relation to power system engineering for the preparation of this document came from:

- Sir Donald Miller FREng, FIET, FRSE, Chairman of Scottish Power 1982-92
- Colin Gibson CEng, FIET, Power Network Director of the National Grid Company 1993-97
- Iain MacKenzie CEng, FIET, Control Development, Grid System Operations, SSEB/Scottish Power 1980-99

IESIS contact information:
Tel: 0141 248 3721
Email: secretary@iesis.org

www.lesis.org
www.iesisenergy.org

18.11.15 IM