

6 TRANSMISSION SYSTEM PERFORMANCE

This chapter describes the performance of the transmission network in terms of forecast power flows, compliance with planning standards, and short circuit levels.

6.1 FORECAST POWER FLOWS

The power flow at any given time depends on demand levels and the output from each generator. There are many possible combinations of generator outputs (i.e., dispatches) that could meet the system demand requirements. Table D-5 in Appendix D includes the generator dispatches that were used for this power flow analysis. All wind farms, both transmission connected and embedded, are assumed dispatched at 35% of their rated capacities, which equates approximately to their average expected output.

The dispatches show one possible combination of generation output for each year and demand scenario. In reality there are a very large number of possible combinations. In examining network performance and grid capability for new generation and demand, a range of generation dispatches is considered.

The 1,643 MW of planned generation that is expected to be connected by 2007 will provide a large capacity margin above peak demand levels. Whether or not these capacity additions are adequate depends on the availability of all generation units, as discussed in the *Generation Adequacy Report 2005-2011*. Notwithstanding the adequacy issue, the increased capacity creates a greater level of generation dispatch variability with which the grid must cope.

Network diagrams are included in Appendix J showing indicative active (MW) and reactive (Mvar) power flows on each circuit, and per unit voltage at each grid bus. Three diagrams are included for each of the three years 2005, 2008 and 2011, showing power flows for summer peak, summer night valley and winter peak conditions. The diagrams provide indicative circuit loadings for these peak and valley times.

The power flow diagrams indicate that with an intact network (i.e., no network outages) all flows are within circuit capacities and voltage profiles are within standards.

The network must also be capable of remaining within standards following loss of a circuit or generator. The power flow diagrams are not intended, however, to illustrate post-fault problems on the grid. The number of potential faults and system conditions make it impractical to provide power flow diagrams for each situation.

6.2 COMPLIANCE WITH PLANNING STANDARDS

Figure 6-1, Figure 6-2 and Figure 6-3 indicate the areas of the network likely to be outside thermal, i.e. circuit loading, and voltage standards in 2005, 2008 and 2011 based on the assumptions on transmission reinforcements, demand and generation outlined in Chapters 2 to 4. These areas are highlighted by orange shading on the maps.

These figures illustrate how the network performs against planning standards. It should be noted however that some incidents, such as a fault on a transformer or cable, may take a long time to repair and could temporarily change the performance outlook. A lengthy outage of a transformer or cable could weaken the network which could impact on system flexibility and on generation constraints.

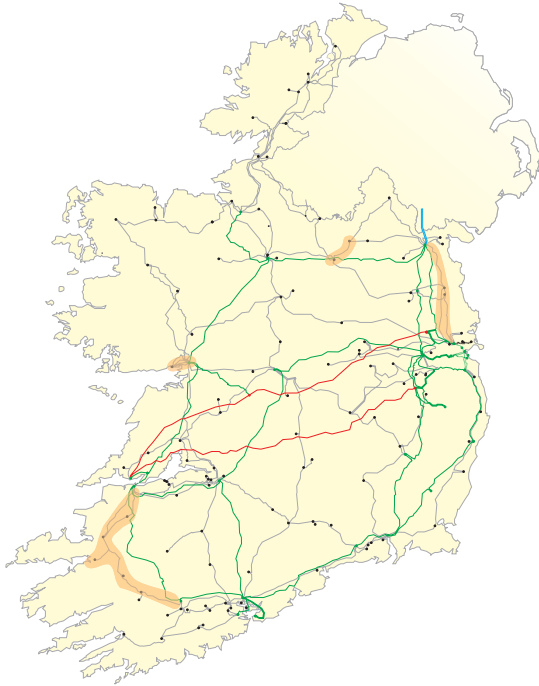


Figure 6-1 Network Performance against Standards in 2005

The 2005 snapshot shown in Figure 6-1 indicates that a small number of areas are outside standards. These areas are outside standards only during the period when a local circuit is out of service for maintenance. The TSO is already progressing projects to address all these problems. These are all expected to be in place by 2008.

Figure 6-2 shows that new areas are outside standards in 2008, illustrating the ever-changing demands on the grid and the need for continuous development. Some of the areas will be outside standards because of the connection of large generators to the network.

The analysis for 2011 shows a growing number of areas outside standards, indicating the need for further long-term investment. The TSO has plans in place to address some of these problems and is actively considering options for improving the other known future network problems.

Areas of the network not shaded in the diagrams are expected to be within standards based on current assumptions. However, changes to those assumptions, particularly the connection of a large generator or demand, will significantly impact on network performance potentially putting

some of these areas outside standards. In such cases, further investment will be required to restore the network to standards.

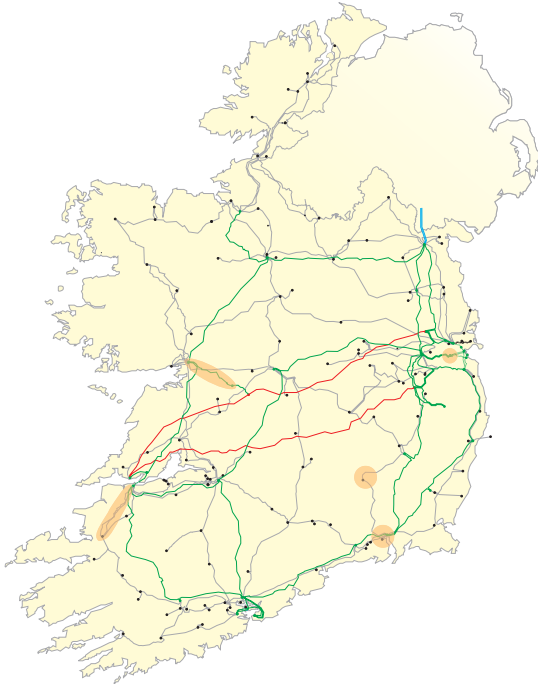


Figure 6-2 Network Performance against Standards in 2008

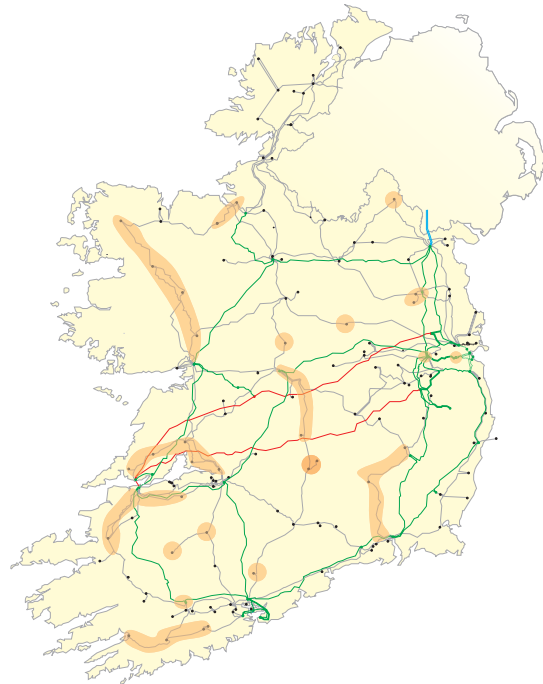


Figure 6-3 Network Performance against Standards in 2011

6.3 SHORT CIRCUIT LEVELS

All network equipment must be capable of carrying the currents that may occur in the event of a short circuit fault. In particular, circuit breakers must be capable of opening to isolate a fault, thereby minimising risk to human life, preventing damage to transmission equipment, and maintaining system stability, security and quality of supply.

The transmission system is designed and operated to maintain short circuit levels below the standard equipment ratings listed at each voltage level in Table 6-1. In designing the system a 10% margin for safety is applied, so that 220 kV short circuit levels, for example, will be kept below 36 kA.

Table 6-1 Short Circuit Levels - Standard Equipment Rating

Voltage Level		Standard Equipment Short Circuit Rating
400 kV		50 kA
220 kV		40 kA
110 kV	In Dublin	26 kA
	Outside Dublin	25 kA

Local short circuit level is a factor to be considered in the connection of new generation or demand. The Grid Code requires that users connecting to the transmission system design their plant and apparatus to withstand the short circuit levels set out in Table 6-1. Changes in the network or the addition of generation can bring about an increase in the short circuit levels at a station nearby. Where the forecast levels would exceed the rating of a circuit breaker or other equipment, it would be essential to replace the equipment with higher rated plant or take other measures to reduce the short circuit levels.

Short circuit levels were calculated for all grid buses in accordance with international standards. The analysis was carried out for single-phase and three-phase faults for winter peak and summer night valley, for the years 2005, 2008 and 2011. A description of the calculation method and the results are given in Appendix E as well as an explanation of the terms used.

The generation dispatches for the winter peak and summer night valley studies are presented in Table D-5 in Appendix D. For the calculations of short circuit levels at winter peaks, all other generators are modelled as dispatched on at zero MW. This measure ensures a high infeed to faults from all local generator sources in the studies ensuring that the potentially most critical scenario is considered for the calculation of short circuit currents at each bus.

The results in Appendix E include RMS break currents, peak make currents and X/R ratios. In summary, the RMS break is an indication of the short circuit levels that a circuit breaker may have to break i.e., open. The peak make fault current is the maximum current that a circuit breaker may have to make i.e., close onto, at the instant of the fault. The X/R ratio is dependent on the proximity of the station to generation. A very high X/R ratio, as for Dublin stations, arises from the fact that the station is close to concentrations of generation and leads to high short circuit currents particularly peak make currents.

The studies assume that the network is in the normal intact condition (as indicated in the Power Flow diagrams) and that all circuits connected to a bus contribute to the fault. Note that the results correspond to total busbar short circuit current and do not necessarily represent the short circuit current that could flow through each individual circuit breaker, which could be less than those presented.

Figure 6-4 presents the short circuit level results for the winter peak 2008 case as a percentage of standard equipment rating. Three percentage ranges are represented by different colours as indicated. The orange dots represent stations where short circuit levels may exceed 80% of the standard ratings.

The results indicate that in most of the country short circuit levels are relatively low, whereas short circuit levels at a number of stations in Dublin and at Tarbert are high because of the high concentration of generation in those areas. Since the data freeze at the end of December 2004, the TSO has put plans in place to reduce the short circuit levels at Tarbert by installing reactors on the 220 / 110 kV transformer neutrals in the station. Short circuit levels are also high at Louth, where the main interconnector to Northern Ireland is connected, and at Raffeen in County Cork.

The impact of new generation connections near these stations is discussed in Section 8.4 in Chapter 8. The TSO will continue to monitor short circuit levels at these stations to ensure that they remain within safety standards.

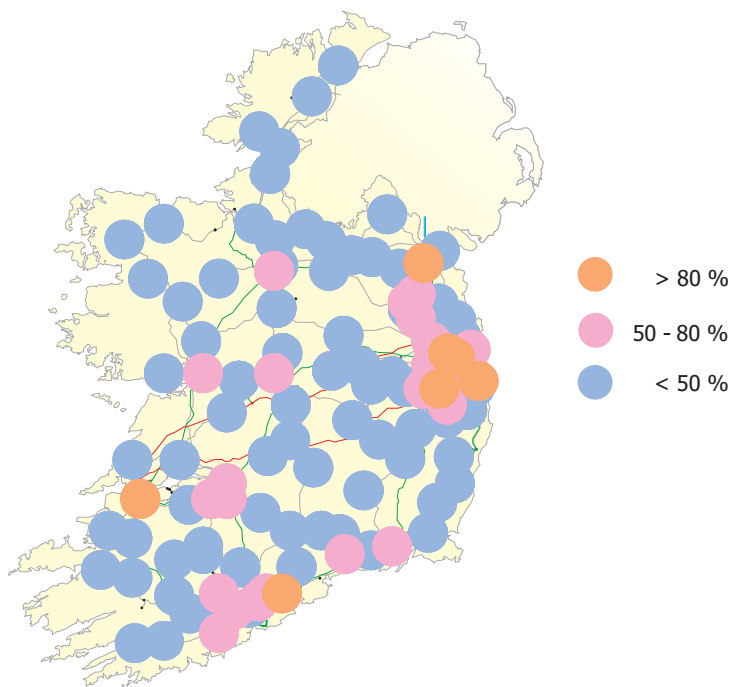


Figure 6-4 Grid Busbar Short Circuit Levels for Winter Peak 2008

