5 TRANSMISSION SYSTEM PERFORMANCE

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

As stated in Section 1.1 of Chapter 1, the analysis of network capability for new generation and demands was carried out for the years 2007, 2009 and 2012 in this Transmission Forecast Statement. The analysis of system performance against planning standards and forecast power flows was additionally carried out for 2006 as this provides useful information on the current state of the network.

5.1 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-4 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. As stated in Section 1.3 in Chapter 1, zero flows were assumed across the interconnectors with Northern Ireland, with the exception of the winter 2012/13 studies.

Each dispatch shows 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. Planned additions of generation, as detailed in Tables D-2 and D-3 in Appendix D, create a greater level of generation dispatch variability with which the grid must cope. For example, in 2007 the planned installed capacity of 7407 MW may be dispatched to meet demand levels ranging from 1782 MW to 4951 MW.

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 provide indicative circuit loadings for summer peak, summer valley and winter peak conditions for each of the four years 2006, 2007, 2009 and 2012. 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.

5.2 COMPLIANCE WITH PLANNING STANDARDS

Figure 5-1 and 5-2 indicate the areas of the network likely to be outside thermal, i.e. circuit loading, and voltage standards in 2006, 2007, 2009 and 2012 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.

The 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 underground 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.

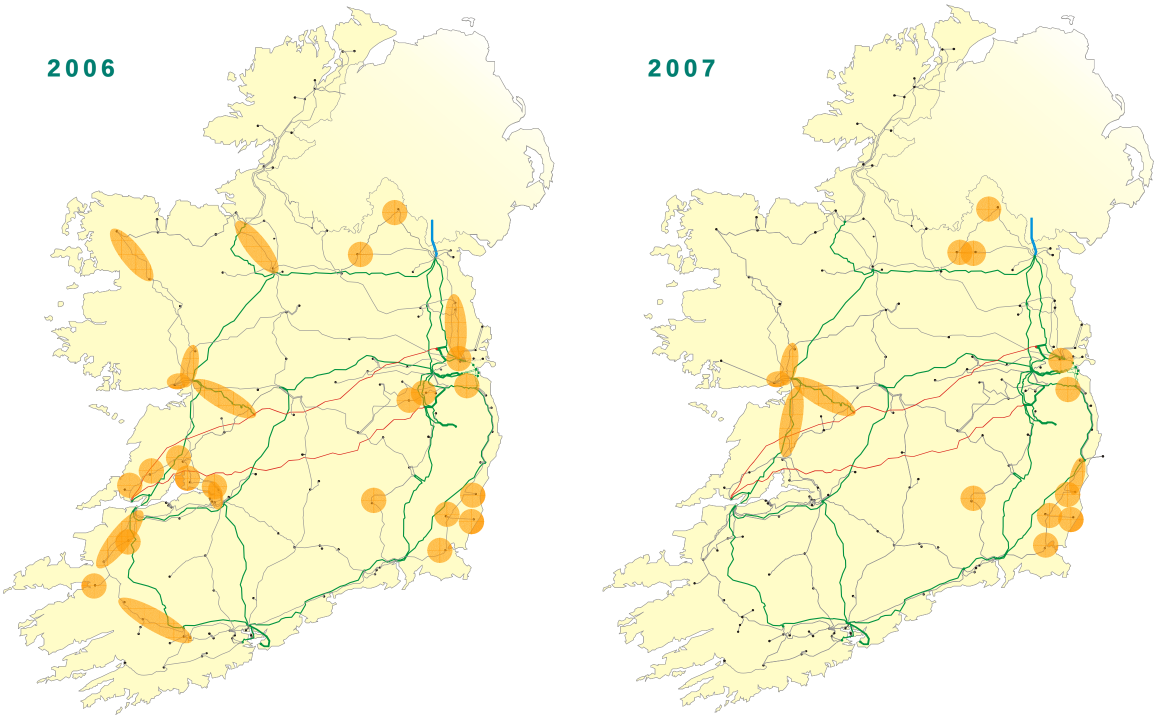

Figure 5-1 Network Performance in 2006 and 2007

The 2006 snapshot shown in Figure 5-1 indicates that a number of areas are outside standards pending completion of ongoing projects. Figure 5-1 shows that the network performance is expected to improve in 2007 when these reinforcements are completed. The analysis for 2009 and 2012 shows a growing number of areas outside standards, illustrating the ever-changing demands on the grid and the need for continuous development. The TSO has plans in place to address many of these problems and is actively considering options for addressing other 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 or a delay in the completion of a transmission project, may 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.

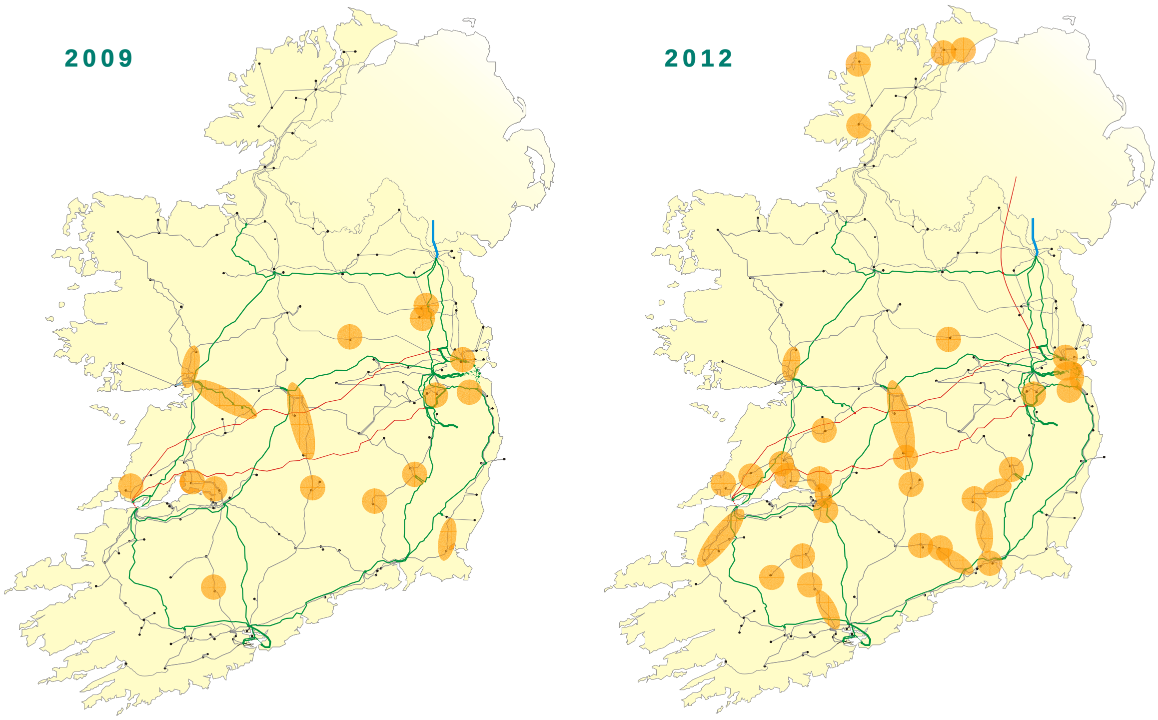

Figure 5-2 Network Performance in 2009 and 2012

5.3 SHORT CIRCUIT CURRENTS

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 personnel, 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 5-1. In planning the system a 10% margin is applied, so that 220 kV short circuit currents, for example, will be kept below 36 kA.

Local short circuit current 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 currents set out in Table 5-1. Changes in the network or the addition of generation can bring about an increase in the short circuit currents at a station nearby. Where the forecast currents 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 currents.

Table 5-1 Standard Equipment Rating and Maximum Design Short Circuit Currents

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

Short circuit currents 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 valley, for the years 2007, 2009 and 2012. 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 valley studies are presented in Table D-4 in Appendix D. For the calculations of short circuit currents 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 most critical potential 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 currents 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. These results correspond to total busbar short circuit current. The short circuit current that could flow through each individual circuit breaker may be less than the total busbar short circuit current.

Figure 5-3 presents the short circuit current results for the winter peak 2009 case as a percentage of standard equipment rating. Two percentage ranges are represented by different colours as indicated. The orange dots represent stations where short circuit currents may exceed 80% of the standard ratings and the purple dots between 50 and 80%.

The results indicate that in most of the country short circuit currents are relatively low, whereas short circuit currents at a number of stations in Dublin and at Tarbert are above 80% because of the high concentration of generation in those areas. The TSO installed reactors on the 220/110 kV transformer neutrals in the Tarbert station in 2006 to manage the short circuit currents there. Short circuit currents are also high at Louth, where the main interconnector to Northern Ireland is connected, and at Raffeen in Co. Cork.

The impact of new generation connections on short circuit currents near these stations is discussed in Section 7.3.2 in Chapter 7. The TSO will continue to monitor short circuit currents at these stations to ensure that they remain within safety standards.

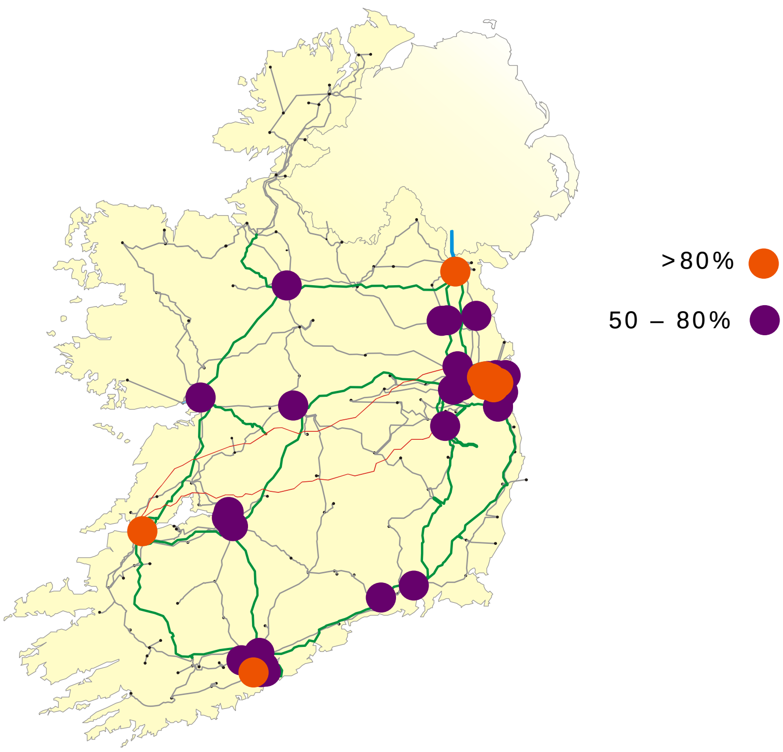

Figure 5-3 Grid Busbar Short Circuit Currents for Winter Peak 2009