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TRANSMISSION SYSTEM PERFORMANCE



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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 flow of power on the Grid is determined by a number of factors. These include the location and amount of generation that feeds into it, the location and amount of demand that is drawn from it, and the configuration of the network. Forecasts of power flows are, therefore, largely dependent on the assumptions made regarding demand, generation, interconnection and the network.

- Chapter 2 describes, and Table C-1 in Appendix C lists, the forecast demand at each transmission interface station on the Grid.
- Chapter 3 describes the existing and forecast generation capacity connected to the Grid. The power flow at any given time depends on the output from each generator. There are many possible combinations of generator outputs that could meet the system demand requirements. Table D-3 in Appendix D includes the generator dispatches (i.e., outputs) that were used for this power flow analysis.
- Chapter 4 describes the physical characteristics of the existing and planned network.
- The power flow analysis assumed a zero flow over the interconnector, under normal conditions.

Appendix J includes network diagrams showing indicative MW and Mvar power flows on each circuit, and per unit voltage at each Grid bus. Three diagrams are included for each of the three years 2003, 2006, and 2009, 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 (with the exception of Trillick, Co.Donegal, in winter 2009/10). 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 makes it impractical to provide power flow diagrams for each situation.

6.1.1 Winter Peak Power Flows

The winter peak power flows illustrate the utilisation of the network at maximum demand conditions. Because of generation capacity shortages inherent in the assumptions, all but a few peaking generators are assumed dispatched at winter peak times. These power flows are, therefore, not subject to dispatch assumptions.

The flow of power on the circuits out of Dublin indicate that generation capacity exceeds the maximum demand in that area. Recent generation connections in Dublin have increased this imbalance. The excess power must be “exported” from the generation concentration in Dublin to the rest of the country. This transfer puts a strain on the Grid that will ultimately give rise to the need for increased network reinforcements.

6.1.2 Summer Peak Power Flows

The summer peak refers to the period from March to September, when the daily peak demand is typically 20% lower than the winter peak. Figure 2-1 in Chapter 2 shows that the daily demand profile in summer is different to the winter profile. While the winter profile is “peaky”, demand in summer tends to be steady throughout the day, with a slight rise occurring around noon. The power flows for summer peak are, therefore, indicative of flows throughout the typical summer day.

Because of higher ambient temperatures during summer, overhead line ratings are lower than in winter. Table B-1 in Appendix B lists the summer and winter ratings for lines and cables. These values show that line ratings reduce by between 15 to 30% in summer, depending on the type of conductor and line construction. The combination of maintenance outages and the lower line ratings tend to give rise to more post-fault overload problems in summer than in winter.

Maintenance of both generation and transmission plant occurs during the March to September period. For this reason, the generator dispatches may vary more in reality, resulting in different power flows to those shown.

6.1.3 Summer Night Valley Power Flows

The summer night valley refers to the annual minimum demand period, which invariably occurs during a summer night. The annual minimum demand is approximately 33% of the annual maximum demand. In general, there are no thermal or low voltage issues on the backbone transmission system at the minimum demand period. However, there may be issues concerning voltage control, especially in the Dublin area, where the underground cables generate Mvars, which contribute to high voltage levels. To manage the voltage profile for these minimum demand conditions, Moneypoint Unit 2 and the Moneypoint-Dunstown 400kV line were switched out.

Where a large generator (100MW or more) is connected at 110kV, capacity problems on the local circuits may be highlighted at minimum demand levels. Demand fed from the station, to which the generator is connected, consumes some of the power that is produced by the generator. The remainder of its output must be transported away from that station. At minimum demand levels the local consumption of the generators output is at a low level, with the result that more of the output must be transported away from the station.

6.2 COMPLIANCE WITH PLANNING STANDARDS

In 2003 a number of significant network development projects are due to be completed. These are described in Chapter 4 with details given in Appendix B. These developments will greatly improve the performance of the network. However, an analysis of the network against the thermal (i.e. circuit loading) and voltage standards for a snapshot in 2003 indicates that a number of network problems remain. Figures 6-1 and 6-2 indicate the areas of the network likely to be outside standards in 2003 and 2006, respectively. These problem areas are highlighted in orange.

The TSO expects that by 2006 the majority of currently planned network development projects will have been completed. Analysis shows that a number of areas will still remain outside standards. In particular, the network between Dublin and the border at Co.Louth is likely to experience circuit overloads in the event of the loss of a key circuit at peak times, or during maintenance outages of other key circuits in the area. The TSO is actively considering options for improving this and other known network problems.

Figure 6-1 Problem Areas in 2003

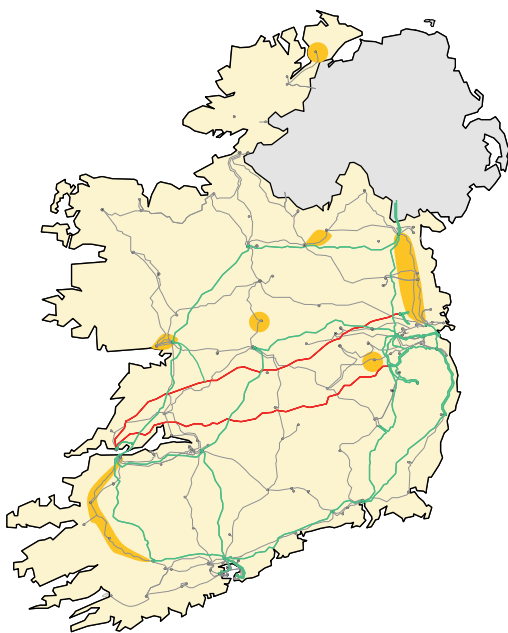
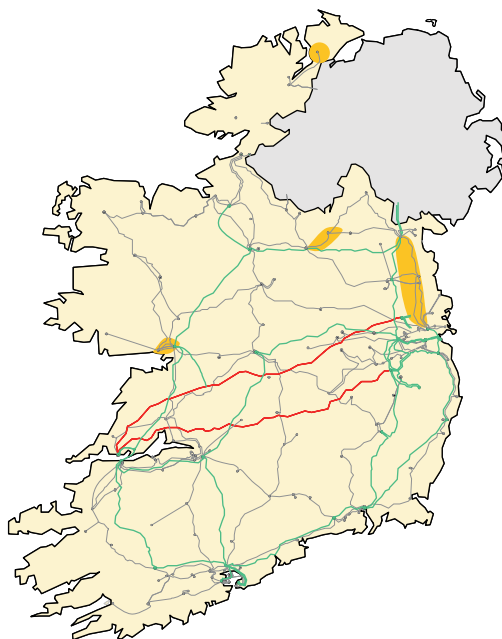


Figure 6-2 Problem Areas in 2006



6.3 SHORT CIRCUIT LEVELS

All network equipment must be capable of carrying the short circuit currents that may occur in the event of a 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 following:

- (a) 50kA on the 400kV system;
- (b) 40kA on the 220kV system;
- (c) 26kA on the 110kV system within the Dublin region;
- (d) 25kA on the 110kV system outside the Dublin region.

The Grid Code requires that users connecting to the transmission system design their plant and apparatus to withstand these short circuit levels.

In designing the system a 10% margin for safety is applied, so that 110kV short circuit levels in Dublin, for example, will not be permitted to exceed 23.4MVA.

Short circuit levels for all Grid buses are given in Appendix G for winter peak and summer night valley, for the years 2003, 2006, and 2009. These are calculated in accordance with international standards.

Appendix G includes RMS break fault currents and X/R ratios for both single-phase fault and three-phase fault analyses, as well as an explanation of these terms. In summary, the RMS break duty is an indication of the short-circuit levels that a circuit-breaker may have to break i.e., open. The X/R ratio is an indication of the proximity of the station to generation. A very high X/R ratio, as for Dublin stations, indicates that the station is close to concentrations of generation, and that peak-make duty may be a concern. The TSO is examining methods of calculating peak-make short-circuit levels.

The studies assume that the network is intact and that all circuits connected to a bus contribute to the fault. When assessing the duty of an individual circuit breaker, it is necessary to consider the most onerous condition for that breaker.

The generation dispatches for the winter peak and summer night valley studies are presented in Table D-3 in Appendix D. For the winter peak cases, all other generators are modelled as dispatched on at zero MW. This measure ensures a high infeed to faults from generator sources, in the studies.

The results in Appendix G indicate that in most of the country short circuit levels are relatively low, whereas, short circuit levels in Dublin are high because of the high concentration of generation in that area. In particular, the values for Inchicore, Finglas and Corduff 110kV buses, and Irishtown, Shellybanks, and Finglas 220kV buses are close to design rating in 2006. The inclusion of an imaginary generator in Finglas for the winter 2009/10 study indicates the problems that will arise if more generation connects in Dublin. Where the forecast levels would exceed the rating of a circuit breaker or other equipment, it would be essential to replace the equipment or take other measures to reduce the short circuit levels.

Local short circuit level is a factor to be considered in the connection of new generation or demand. This factor is particularly relevant in relation to 'disturbing' generation schemes such as wind farms. Wind farms can give rise to voltage deviation and flicker problems on the transmission system that may result in a limitation on the size of wind farm that could be connected, or lead to a requirement for system reinforcement to alleviate the problem. This is discussed further under opportunities for new generation in Chapter 9.