7 TRANSMISSION SYSTEM CAPABILITY ANALYSES

This chapter describes the analyses carried out to determine the capability of the grid to accommodate changes in generation and demand at various parts of the network. The results of these analyses, together with information in other chapters, provide the basis for the statements of opportunity in Chapters 8 to 10.

The analyses were carried out for three specific years.

- **2005**: This is the first year of the seven-year period of the Forecast Statement. The information for this year gives developers an indication as to the opportunities that exist now prior to planned changes in generation and transmission infrastructure.
- **2008**: This is the mid-year of the seven-year period. Because of typical lead-times for construction of generation or demand plant, results for this year represent the beginning of the period of interest for developers at a pre-feasibility stage wishing to connect to the transmission system.
- **2011**: This covers the final year of the Forecast Statement, which extends to winter 2011/12.

The summer and following winter of each year were studied. The base case dispatches used for the studies are presented in Table D-5 in Appendix D.

The locations analysed for new generation and demand have been carefully reviewed this year based on feedback from industry sources. The chosen stations have been tailored to match more closely the needs of customers. One set of stations has been chosen for the analysis of new generation, whereas a different set of stations was chosen for the analysis of additional demand, as illustrated in Chapters 8 and 9 which address network capability for new generation and new demand respectively. It is intended that this new approach will make the results more meaningful.

It should be noted that the results of these studies are dependent on the assumptions made about generation and demand, and on the completion dates of network development projects as described in previous chapters. Factors that may influence the results are discussed in Section 7.6.

7.1 TRANSFER CAPABILITY FOR NEW GENERATION

This section deals with the analysis of the grid's capability to accommodate increased flows, additional to the anticipated flows, which would arise following the connection of a new generator. The results of the analysis, presented in Chapter 8, set out the Incremental Transfer Capability (ITC), which is a measure of the transfer capability remaining in the physical grid for further commercial activity, over and above already anticipated uses.

Incremental Transfer Capability is directional in nature. For instance, the ITC from Dublin to Cork is entirely different to the ITC from Cork to Dublin. In general, incremental power transfers arising from the connection of generation in areas short of generation are less likely to require reinforcements than transfers from areas with excess generation. Connection of generation in areas short of generation helps to reduce line loadings, and hence allow increased utilisation of the grid.

It is important to consider small localised increases in generation, in addition to the far-reaching affects of large new generator connections. Typically large generators greater than 100 MW connect to the 220 kV network while smaller generators connect at 110 kV. To capture these different levels of concern about grid capability, the TSO carried out analysis of generation connections to a large number of stations at diverse locations on both the 110 kV and 220 kV networks.

The method of analysis used to assess the transfer capability for connection of new generation at the selected stations is detailed in Appendix F. The following provides a summary of the method.

When a new generator connects to the grid its output displaces that of other existing generators, creating an incremental power transfer between the new generator and the displaced generation. The method for study, therefore, involves modelling a transfer in power between potential areas for new generation and areas with existing generation i.e., Dublin, mid-west (Moneypoint and Tynagh), south-west, and south-east. The maximum transfer level is reached when the first overload or voltage outside standards occurs. Only problems that are significantly exacerbated by the transfer are relevant to the analysis.

A subset of the Transmission Planning Criteria (TPC) was tested in determining the ITCs. The results may, therefore, be optimistic in some cases. Among the standards not tested in this analysis are voltage, dynamic stability and trip-maintenance combinations i.e., contingencies involving an unplanned line outage during the planned maintenance of another circuit. In the case where the new generator causes a trip-maintenance problem, it may be possible to constrain off generation during the maintenance outage or to carry out the transmission maintenance when generation in the area is out for maintenance or otherwise not running. Dynamic stability difficulties on the Irish system that have arisen in the past have been overcome by the use of suitable control equipment. However, the arrival of new generation, interconnection or large cluster of wind farms could significantly change how dynamic issues would be addressed. The connection of new generation with reactive power capability does not generally cause a voltage problem.

The impact on short circuit levels of new generation at potential sites is considered separately in Section 8.4 in Chapter 8.

7.2 TRANSFER CAPABILITY FOR NEW DEMAND

The grid is planned to meet forecast demands at all stations in the country. The demand forecast for each 110 kV station is a proportion of the overall system demand forecast based on historical demand distributions. Future demand customers that have signed connection agreements are also included in station demand forecasts.

While additional demands above the forecast levels are not explicitly catered for in network plans, there may be capacity for such additional demand inherent in the network at certain locations. New demands can generally locate in an area that has excess generation capacity as this will reduce power flows out of the area. Alternatively, the addition of transmission infrastructure generally provides a step increase in network capacity which may permit demands higher than forecast levels.

Figure 7-1 illustrates the demand profile for a representative station. The blue line represents the demand forecast at the station. The green bars represent a new step increase in demand. The analysis carried out for this Forecast Statement examines the grid's capability to accept such increased demand above forecast levels at selected 110 kV stations. The selected 110 kV stations, which feed principal towns and demand centres distributed throughout the country, are shown in Figure 9-1 in Chapter 9. The results of this analysis are useful in identifying opportunities for the connection of new or increased demand of a size typical of industrial development in Ireland.

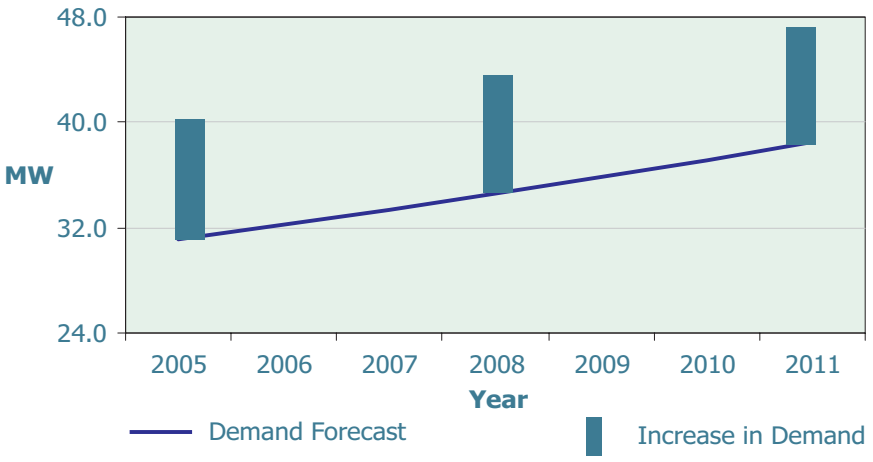

Figure 7-1 Analysis of Additional Demand above Forecast Levels

The method of analysis is detailed in Appendix F. In summary, when demand in an area increases, it must be supplied by an increased output from generation units. An incremental power transfer is created. The method for this study, therefore, involves modelling incremental power transfers between centres of existing generation and potential demand areas. The transfer level is reached when the first circuit overload or voltage problem occurs following a circuit or generator outage. Outages during the maintenance of key circuits were considered in

these studies. Dynamic stability problems were not assessed. It should be noted that only problems that are significantly exacerbated by the transfer are relevant to the analysis.

In assessing opportunities for new demands, the Forecast Statement considers the capability of the transmission grid only. The implications for generation adequacy of demand growth above the median forecast levels are dealt with separately in the TSO's *Generation Adequacy Report 2005-2011*.

7.3 TRANSFER CAPABILITY ANALYSIS FOR TRANSFERS WITH NORTHERN IRELAND

The capability to transfer power from and to Northern Ireland depends on a number of factors; the capacity of the interconnectors, the capability of the grids, system conditions in each jurisdiction and the ability of each system to cope with an unplanned system separation. This analysis deals with the capability of the grid to accommodate transfers between the two systems. Northern Ireland capability issues are dealt with in SONI's Seven Year Statement.

Power transfers are mainly carried on the main interconnector at Louth. Power imported at Louth replaces generation elsewhere in the system. The analysis of import capability therefore mirrors the analysis of the capability to accommodate generation at Louth.

Exports to Northern Ireland are achieved by an increase in generation in Ireland. The export capability was tested by adding generation at the same 220 kV stations that were examined for generation.

As in the case of the generation analysis, a subset of standards was applied. Among the standards not tested in this analysis are voltage, dynamic stability and trip-maintenance combinations. The results may, therefore, be optimistic in some cases.

7.4 TRANSFER CAPABILITY ANALYSIS FOR IRELAND-BRITAIN TRANSFERS

As stated in Chapter 5, the CER has engaged consultants to recommend a tendering process for the construction of one or two 500 MW HVDC (High Voltage Direct Current) interconnectors to Britain. Part of the consideration of any new interconnector is the selection of suitable connection point(s). The capability of the grid to accept imports and exports of 500 MW was tested at nine potential connection points located along the east and south coasts.

Analysis of the capability to import power from Britain is equivalent to analysing the capability to accommodate new generation and was carried out using the same method.

Exports are equivalent to large new demands. The analysis of export capability was carried out using the same method as for demands at 110 kV stations, with the exception that trip maintenance contingencies were not considered for this analysis. It is assumed that in certain cases exports over the interconnector could be reduced for short periods to allow essential maintenance.

7.5 POTENTIAL SYSTEM BOTTLENECKS

The transmission network is designed to provide a safe, reliable and economic transport service for power from source to demand. The Transmission Planning Criteria provides a planning framework by which a balance can be achieved between reliability and economy. Achieving this balance means that under certain circumstances some level of constraints or "bottlenecks" will exist in the system.

The TSO constantly reviews system performance as circumstances change. For example, the connection of new generation or demand to the grid additional to the current forecasts and assumptions, or new interconnection transfers, will alter the expected power flows. Bottlenecks will arise if the new power flows exceed planned grid capacity.

In designing out these bottlenecks the TSO will take account of the following:

- The extent of the bottleneck;
- The impact on system security;
- The overall economics of the operation of the system;
- The cost of the solution;
- The lead-time of the solution.

The analysis of transfer capabilities described above identified a number of potential system bottlenecks that could limit power flows arising from new generation or demand connections or interconnection transfers. These are listed in Table F-1 in Appendix F. The table includes a cross reference to the ITC results tables in Section 8.2 in Chapter 8 and Section 10.1 in Chapter 10, and a comment on current plans to remove each bottleneck or, in the absence of plans, the ease or difficulty involved in removing them.

7.6 FACTORS IMPACTING ON RESULTS

The results of the analyses described in this chapter, and in the appendices, are based on a set of assumptions about future demand growth, generation connections and transmission developments. The key forecast factors on which the results depend are dynamic and, therefore, the reality that emerges will not exactly match the forecasts. Consequently, the results, while reasonably indicative, should not be interpreted as definitive projections.

The factors likely to have an impact on the outcomes include:

- the signing of a connection agreement by a new generator;
- delays in connection of committed new generation;
- changes in the economy which give rise to consequential changes in the overall demand for electricity;

- changes in demand in a particular region or area, arising from new industry developments or closures;
- selection and construction of new reinforcement developments which may significantly increase network capacity.