2 THE ELECTRICITY TRANSMISSION NETWORK

2.1 OVERVIEW OF THE ELECTRICITY TRANSMISSION NETWORK (GRID)

The national grid plays a vital role in the supply of electricity, providing the means to transport power from the generators to the demand centres using a system comprising 400 kV, 220 kV and 110 kV networks. Table 2-1 presents the total lengths of overhead lines and cables at these different voltage levels.

Table 2-1 Total Length of Existing Grid Circuits at December 2004

Voltage Level	Total Line lengths (km)[1]	Total Cable lengths (km)
400 kV	439	0
220 kV	1,729	94
110 kV	3,907	6

The 110 kV[2] lines, which constituted the entire transmission system prior to the 1960s, provide parallel paths to the 220 kV system. It is the most extensive element of the grid, reaching into each county in Ireland.

The 220 kV network is the backbone of the grid. It has a higher capacity and lower losses than the 110 kV network. It comprises a number of single circuit loops around the country. The 220 kV circuits in combination with the 110 kV circuits provide the main paths for transporting bulk power around the country. Typically large generation stations (greater than 100 MW) are connected to the 220 kV or 400 kV networks.

The 400 kV network mainly transports power from the Moneypoint generation station on the west coast. The Oldstreet 400 kV station, connected into the original Moneypoint-Woodland and 400 kV line in 2003, provides a path for some of the power from Moneypoint to Galway and to the north-west of the country and away from Dublin.

The transmission system generally comprises overhead lines, except in limited circumstances, such as in the centre of Dublin and Cork cities, where underground cables are used.

Transformers are required to link the different voltage networks, providing paths for power to flow from the higher to the lower voltage networks. The total transformer capacity between the different voltage levels is presented in Table 2-2.

Table 2-2 Total Grid Transformer MVA Capacity

Voltage Level	Capacity (MVA)	Number of transformers
400 / 220 kV	2,000	4
275[3] / 220 kV	1,200	3
220 / 110 kV	10,939	42

1 Some lines may contain short sections of cable.

2 A number of radial 110 kV lines around the country and the 110 kV lines and cables within Dublin City are currently operated by the Distribution System Operator (DSO). The DSO licence is held by ESB Networks. Details of the Dublin network are not included in this Forecast Statement.

3 The interconnector at Louth includes transformers to connect the 220 kV system with the 275 kV system in Northern Ireland.

Reactive compensation devices are used to improve network voltages in local areas. Existing reactive devices connected to the grid include shunt capacitors, static var compensators (SVCs) and shunt reactors. Table 2-3 shows the total amounts of each type. Capacitors and SVCs help to support local voltages in areas where low voltages may otherwise occur. Shunt reactors suppress voltages in areas where they would otherwise be too high, most likely during periods of low demand.

Table 2-3 Total Reactive Compensation

Voltage Level	Type	Capacity (Mvar)	Number of devices
400 kV	Line Shunt Reactor	160	2
220 kV	Shunt Reactor	100	1
110 kV	Static Var Compensator	90	2
	Switched Shunt Capacitor	575	26

2.2 DEVELOPING THE TRANSMISSION NETWORK

The TSO plans the development of the transmission network with the objective of achieving the co-ordinated development of a safe, secure, reliable, efficient and economical system for the transmission of electricity. The planning process involves a number of steps as illustrated by the simple flow chart in Figure 2-1.

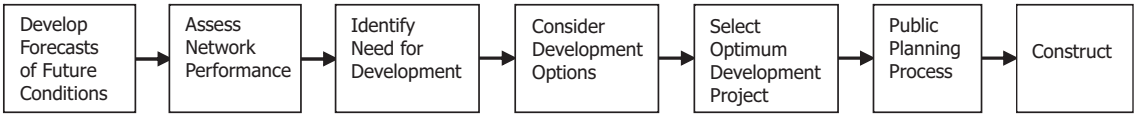

Figure 2-1 Simple Flow Chart of the Development Planning Process

The principal factors that drive the need for network development include:

- Demand growth;
- New generation connections;
- Generation retirements;
- New connections of demand or distribution stations;
- New interconnectors;
- Changes in relative generation costs;
- Changes in transmission planning standards;
- Ageing of equipment and consequent need for refurbishment.

It should be noted that the impact of these various factors on system power flows may interact adding a degree of complexity to the planning process. This Forecast Statement includes the TSO's forecasts of demand, generation, distribution stations and interconnection in Chapters 3 to 5 and associated appendices.

The requirement for grid development is determined when simulation of the future conditions indicate that the transmission planning standards would be breached. These reliability standards, which are in line with international standards, are set out in the Transmission Planning Criteria (TPC) and can be accessed on the ESB National Grid website, www.eirgrid.com (under About Us / Publications). They include standards for voltage range and deviations, thermal overloads of grid equipment, dynamic stability and short circuit levels. The grid must operate within these specified standards for intact network conditions, and following an unexpected outage of any circuit or generator. This also applies during the maintenance outage of any other line, cable, transformer or generator. It is assumed that planned maintenance is carried out in the March to September period, when demand is lower than in the winter months.

Where the need for grid development is identified, consideration is given to a number of possible options. Selection of the optimum project involves the consideration of many factors including:

- economics of alternative development options;
- transmission operations, maintenance and protection;
- co-ordination with the distribution function;
- environmental aspects;
- flexibility and long-term benefit of options;
- lead-times and feasibility of options;
- synergy with refurbishment projects.

The challenge for the TSO is to find robust solutions that deliver the best long term value to the customer taking account of these factors and of the uncertainties in demand and generation projections. Uncertainty in generation not only relates to location and size of new connections but also to the operation of all connected generators.

Selected development projects are required to go through the public planning process before finally entering the construction phase. It is worth noting that the scope and expected timing of projects may require change following the public planning process or while in the construction phase.

2.3 PLANNED NETWORK DEVELOPMENTS

The TSO's development plans include projects required to facilitate demand growth and new generation and demand connections in compliance with the Transmission Planning Criteria (TPC). The planned network developments presented in this Forecast Statement are based on those projects that have been selected as optimum solutions to known network problems.

All information presented on network transfer capabilities and opportunities is contingent on the completion of these development projects in the assumed timeframe.

It should be noted that the information presented here is a snap shot of an evolving plan.

Under current forecast assumptions, further investment will be required before the end of the seven-year period to maintain standards in all parts of the network. While the TSO is considering other reinforcements, these are not at the stage of maturity required for inclusion in this statement. In addition, the connection of new generation or large point demands are likely to have a step change on network performance leading to further development requirements. The solutions are likely to be a combination of robust strategic developments and short term reinforcements to maintain flexibility in the system.

The following is an overview of the major network developments planned for the system. These are illustrated in the maps and schematic network diagrams in Appendix A. New generation connections and new transmission interface stations are described in Sections 2.4 and 2.5 respectively.

2.3.1 Flagford-Srananagh 220 kV Development

Srananagh 220 kV station, east of Sligo town, will be connected to the 220 kV network by an overhead line from Flagford, near Carrick-on-Shannon, thus extending the 220 kV network into the north-west. A number of 110 kV lines will be connected into the new station, making Srananagh a new hub for power flows into the north-west. The Flagford-Srananagh 220/110 kV project is needed to reinforce the network in this area of growing demand, and to reduce the risk of loss of supply at winter peak and during maintenance outages. This project is due for completion in mid 2006.

2.3.2 Gorman 220 kV Development

Gorman 220 kV station, near Navan in County Meath, will be connected into the existing Louth-Maynooth 220 kV line, and the Drybridge-Navan and Navan-Platin 110 kV lines. The new 220 kV station will enhance the capability of the higher capacity 220 kV network to transport power into this area, thus easing the stress on the 110 kV network between Finglas and the Navan / Drogheda area. The Gorman project is due for completion at the end of 2005.

In addition the two 110 kV lines from Finglas to Drybridge and Platin will be uprated to reduce overload problems on these lines.

2.3.3 Corduff 220 kV Development

The 220 kV station at Corduff, near Finglas in north County Dublin, is nearing completion. It will be connected into the two Finglas-Woodland 220 kV lines. A number of the 110 kV lines currently connected to Finglas will be diverted to the new Corduff station thus taking load off the heavily loaded Finglas transformers and improving the reliability of supply to north Dublin. The Corduff project is due for completion at the end of 2005.

2.3.4 Lodgewood 220 kV Development

Lodgewood 220 kV station in County Wexford will be connected into the existing Arklow-Great Island 220 kV line and linked to Crane 110 kV station. This reinforcement development is required to ensure that adequate infrastructure is in place to meet the increasing electricity demand in the area and reduce the risk of loss of supply at winter peak and during maintenance outages. This project is due for completion in 2008.

2.3.5 Aghada-Raffeen 220 kV Circuit

The planned new 220 kV circuit from Aghada to Raffeen in Cork will be part submarine cable, part overhead line. It is expected to be completed in 2008.

2.3.6 Moneypoint-Tarbert 400 kV Circuit

Forecast Statement 2004-2010 discussed how the connection of generation was expected to use up spare capacity on the network creating a bottleneck for flows into the south west. A planned new submarine cable across the Shannon Estuary from Moneypoint in Clare to Tarbert in north Kerry will create a new path for power out of the Dublin-Moneypoint group of generators into the south-west, easing this bottleneck. It is expected to be completed in 2009.

2.3.7 A Second Tarbert-Tralee 110 kV Line

A second line from Tarbert to Tralee in County Kerry is required to lower the risk of line overloads and voltage collapse in the Tralee area. Without the new line, these problems could occur if one of the lines connecting Tralee tripped out unexpectedly while another line was out of service for maintenance. This project is due for completion in early 2006.

2.3.8 Looping of the Dalton-Galway 110 kV Line into Cashla

There are three 110 kV circuits between Cashla and Galway 110 kV stations. It is planned to loop the Dalton-Galway 110 kV line into Cashla station, thus providing a fourth 110 kV connection between Cashla and Galway. Dalton station will then be fed from Cashla instead of Galway. The reinforcement development is required to avoid a potential overload on the Cashla-Galway 110 kV lines during maintenance outage of one of the lines. This project is due for completion in late 2007.

2.3.9 Looping of the Blake-Cushaling-Maynooth 110 kV Line into Newbridge

It is planned to loop the Blake-Cushaling-Maynooth line into the Newbridge station, thus providing Newbridge with an extra two grid connections. The reinforcement development is required to avoid below standard voltages in the heavily loaded Newbridge / Naas area. This project is due for completion in early 2007.

2.3.10 Binbane-Letterkenny 110 kV line

A 110 kV line is planned from Binbane to Letterkenny in County Donegal to bring the network in the north of the county within standards. A new station will be built along the route of the line and a new line built from there to a new station at Gaoth Dobhair to support the local distribution network. The line is planned for completion by end 2009.

2.3.11 Second Arva-Shankill 110 kV line

A second 110 kV line from Arva to Shankill in County Cavan is planned for completion in 2008. This is required to avoid line overloads and to alleviate low voltage problems in the area.

2.4 CONNECTION OF NEW GENERATION STATIONS

Section 4.1, in Chapter 4, describes the future generators that have signed connection agreements. Table 2-4 shows the connection method for these generators.

With the exception of the new Tynagh and Huntstown generators, all generators will be connected at 110 kV.

Since the data freeze in December 2004, the West Offaly Power unit and the Ballywater wind farm have connected to the grid.

Table 2-4 Connection Methods of Future Generators

Generator	Connection Method
Arklow Banks	New Arbank offshore 110 kV station located on the Arklow Banks, tail-connected into the existing Arklow 110 kV station.
Aughinish	New Sealrock 110 kV station tail-connected into the existing Aughinish 110 kV station.
Ballywater	New Ballywater 110 kV station tail-connected into the existing Crane 110 kV station.
Booltiagh	New Booltiagh 110 kV station connected into the Ennis-Moneypoint-Tullabrack 110 kV line.
Coomagearlahy	New Coomagearlahy 110 kV station tail-connected into a new Clonkeen 110 kV station, which will be connected into the Clashavoon-Knockearagh 110 kV line.
Derrybrien	New Derrybrien 110 kV station tail-connected into a new Agannygal 110 kV switching station, which will be connected into the Ennis-Shannonbridge 110 kV line.
Huntstown 2	Connected into the Corduff 220 kV station, due to be completed in 2005.
Mountain Lodge	Connected into the planned Ratrussan 110 kV station.
Ratrussan	New Ratrussan 110 kV station connected into the Louth-Shankill 110 kV line.
Tynagh	New Tynagh 220 kV station connected into the Cashla-Oldstreet 220 kV line.
West Offaly Power	Connected into the Shannonbridge station at 110 kV.

Five embedded wind farms listed in Table D-3 in Appendix D, Altagowlan, Black Banks 2, Caranne Hill, Geevagh and Moneenatieve will be connected to a new 110 kV station called Corderry, which will be connected into the Carrick-on-Shannon-Arigna-Cathaleen's Fall 110 kV line.

2.5 CONNECTION OF NEW TRANSMISSION INTERFACE STATIONS

Table 2-5 lists the planned new 110 kV distribution stations that are expected to be connected within the period of this statement. They are included in the appropriate network models according to their expected connection date. Details of the connections and dates are given in Section B.2 in Appendix D.

Table 2-5 Planned 110 kV Stations

Station	Code	Nearest Main Town or Load Centre	County
Athy	ATY	Athy	Kildare
Ballycummin	BCM	Raheen	Limerick
Banoge	BOG	Gorey	Wexford
Bunbeg	BUN	Gaoth Dobhair	Donegal
Great Connell	GCN	Newbridge	Kildare
Hartnett's Cross	HTS	Macroom	Cork
Kilmurry	KMY	Waterford Port	Kilkenny
Nenagh	NEN	Nenagh	Tipperary
Stevenstown	SVN	Balbriggan	Dublin

2.6 DETAILED NETWORK INFORMATION

Figure A-1 in Appendix A presents a geographical map of the grid at the end of December 2004. This is also available in A3 format in Appendix K.

The electrical characteristics and capacity ratings of the existing network are included in the following tables in Section B.1 of Appendix B.

- Table B-2 to Table B-5 list the electrical characteristics of the existing overhead lines and underground cables at the different voltage levels. The ratings shown are the maximum continuous ratings (MCR) in MVA for winter and for summer reference temperature conditions, 5ºC and 25ºC respectively.
- Table B-6 lists data for each existing transmission transformer. The data includes impedance values, maximum continuous rating and tap range. The voltage tapping range for each transformer is given as the percentage deviation from the nominal voltage ratio at the two extreme tap positions.
- Table B-7 includes the Mvar capacity data for existing reactive compensation devices.
- Table B-8 lists details of the phase shifting transformer at Carrickmines 220 kV station.

Figure A-2 in Appendix A presents a geographical map of the grid as forecast in 2011, including the planned developments. The schematic network diagrams in Appendix A show the existing grid and planned developments in 2005, 2008 and 2011. The diagrams indicate stations, circuits, transformers, generation, reactive devices and phase-shifting transformers.

The electrical characteristics and capacity ratings of planned network developments are included in the following tables in Section B.2 of Appendix B.

- Table B-9 to Table B-14 contain data for new lines and cables and changes to existing line and cable data resulting from planned network developments. These tables include a column to indicate whether each listed item of plant is being added, amended or deleted. Changes relating to a particular development project are grouped together.
- Table B-15 to Table B-18 list the details of the planned network transformers.

Section B.3 provides a description of all planned developments. Cross reference numbers to tables in Section B.2 are provided.

Electrical characteristics of future transmission plant or changes to the electrical characteristics brought about by planned developments are preliminary. Electrical characteristics will be reviewed when the plant is commissioned.