2 THE ELECTRICITY TRANSMISSION NETWORK

2.1 OVERVIEW OF THE ELECTRICITY TRANSMISSION NETWORK

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. The national grid is electrically connected to the transmission system of Northern Ireland by means of one 275 kV double circuit connection at Louth and two 110 kV connections at Letterkenny in Co. Donegal and Corraclassy in Co. Cavan.

The 400 kV and 220 kV networks form the backbone of the grid. They have higher capacity and lower losses than the 110 kV network. The 400 kV network provides a high capacity link between Moneypoint generation station and Galway on the west coast and Dublin on the east. The 220 kV network comprises a number of single circuit loops around the country. Typically large generation stations (greater than 100 MW) are connected to the 220 kV or 400 kV networks.

The 110 kV[1] 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 every county in the Republic of Ireland.

The transmission system generally comprises overhead lines, except in limited circumstances, such as in the city centres of Dublin and Cork, where underground cables are used. Table 2-1 presents the total lengths of overhead lines[2] and cables at the different voltage levels. Revision of individual line lengths are subject to confirmation following completion of network development projects.

Table 2-1 Total Length of Existing Grid Circuits as at December 31st 2006

Voltage Level	Total Line Lengths (km)	Total Cable Lengths (km)
400 kV	439	0
275 kV	42	0
220 kV	1,729	100
110 kV	3,848	50

[1] 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 distribution network in Dublin are not included in this Transmission Forecast Statement.

[2] Some lines may contain short sections of cable.

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 as at December 31st 2006[3]

Voltage Level	Capacity (MVA)	Number of transformers
400/220 kV	2,050	4
275/220 kV	1,200	3
220/110 kV	8,814	46

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 as at December 31st 2006[4]

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 EXISTING CONNECTIONS WITH NORTHERN IRELAND

As illustrated in Figure 2-1, the national grid is connected to Northern Ireland via three 275[5]/220 kV transformers in Louth station, one 600 MVA unit and two ganged[6] 300 MVA units, connected to a double circuit 275 kV line running from Louth to Tandragee in Co. Armagh. In addition to the main 275/220 kV double circuit, there are two 110 kV connections, one between Letterkenny in Co. Donegal and Strabane in Co. Tyrone, and the other between Corraclassy in Co. Cavan and Enniskillen in Co. Fermanagh. The purpose of these 110 kV circuits is to provide support to either system for certain conditions or in the event of an unexpected circuit outage. Phase shifting transformers in Strabane and Enniskillen are used to control the power flow under normal conditions.

[3] Transformer details are provided in Tables B-6, B-7 and B-8 in Appendix B.
[4] Details of existing reactive compensation devices are provided in Table B-10 in Appendix B.
[5] The transmission system in Northern Ireland is operated at 275 kV and 110 kV.
[6] Plant connected in parallel through common switchgear.

While the design capacity of each of the 275/220 kV cross-border circuits is 600 MVA, the actual capacity of the circuits to accommodate transfers between the two systems at any time depends on the prevailing system conditions on either side of the border, including the ability to deal with system separation.

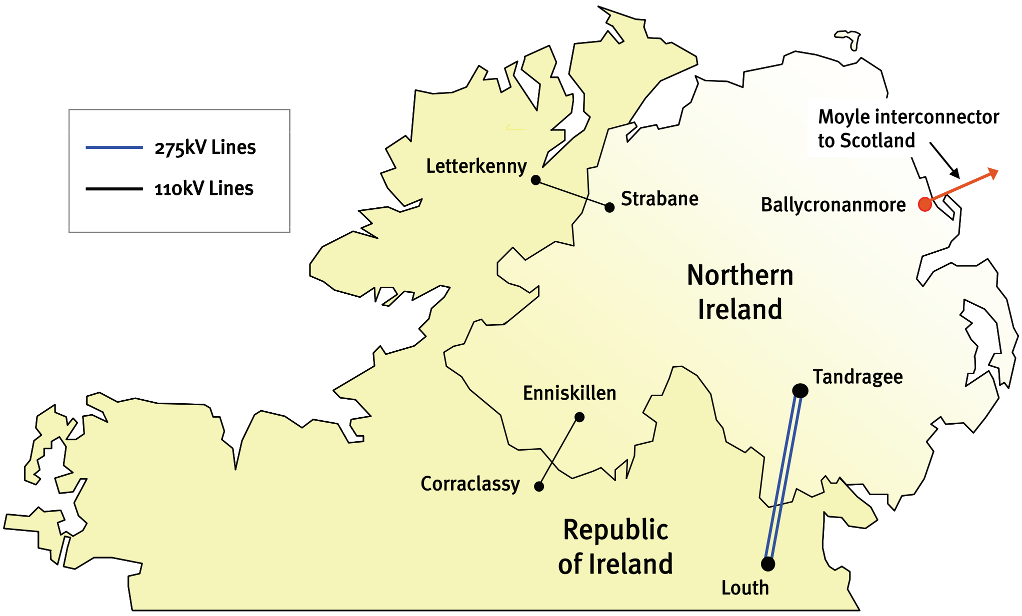

Figure 2-1 Existing Cross-Border Circuits

2.3 PLANS FOR TRANSMISSION SYSTEM DEVELOPMENT

The Transmission System Operator (TSO) will publish *Transmission Development Plan 2007-2011* later in 2007, following a period of public consultation. The report will detail the transmission development projects that have been initiated by the TSO in addition to a discussion of further developments that may arise in the period of the plan.

The 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 Transmission Forecast Statement (TFS) 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. Further investment is likely to be required before the end of the period of the plan 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 400 kV and 220 kV network developments planned for the system at the end of December 2006, when data was frozen in order to permit TFS analyses to be carried out. The *Transmission Development Plan 2007-2011* will include details of these and of significant 110 kV reinforcement projects planned for the system. The planned developments are illustrated on a map and on the 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. At the time of the data freeze, it was assumed that this project would be due for completion in 2007.

2.3.2 Poolbeg Inter-Bus Reactor

Due to rising short circuit levels in Dublin it will be necessary to re-arrange connections between 220 kV stations in the city. In addition a reactor is planned for the Poolbeg 220 kV station. This will act to limit short circuit levels while maintaining adequate reliability in Dublin. The project is expected to be completed by 2008.

2.3.3 Lodgewood 220 kV Development

Lodgewood 220 kV station in Co. 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 2009.

2.3.4 Aghada-Raffeen 220 kV Circuit

The planned new 220 kV circuit from Aghada to Raffeen in Co. Cork will be part submarine cable, part overhead line. It is expected to be completed in 2009.

2.3.5 Moneypoint-Tarbert 400 kV Circuit

A planned new submarine cable across the Shannon estuary from Moneypoint in Co. Clare to Tarbert in north Co. Kerry will create a necessary new path for power out of the Dublin-Moneypoint group of generators into the south-west and a path for power out of the south-west to the 400 kV network. It is expected to be completed in 2009.

2.3.6 400 kV station near Nenagh

A new 400/220 kV station in the vicinity of Nenagh, Co. Tipperary, is planned to provide another path for power from the Dublin-Moneypoint group of generators into the south-west. The station will be connected into the existing Dunstown-Moneypoint 400 kV line and existing Killonan-Shannonbridge 220 kV line. It is expected to be completed in 2011.

2.3.7 400 kV line to Northern Ireland

A new 400 kV line between the national grid and Northern Ireland is currently being progressed by the TSO and Northern Ireland Electricity (NIE). The line will connect into a new 400/220 kV station, probably located in Co. Cavan, provisionally referred to as the Mid-Cavan station elsewhere in this TFS.

In the event of a loss of the existing 275 kV double circuit connecting the national grid to Northern Ireland, the pre-fault transfers would be directed across the Letterkenny-Strabane and Corraclassy-Enniskillen 110 kV cross-border circuits. In this instance, to guard against damage to these lines, protection equipment will switch out the 110 kV circuits resulting in separation of the two systems.

System separation, depending on the pre-separation flow on the Louth-Tandragee 275 kV double circuit, may result in a generation surplus on one system and a deficit on the other. The system with a supply deficit may be required to disconnect demand customers. The system with the supply surplus may have difficulty stabilising the system frequency. The impact of potential system separation on each system can result in constraints on the amount of power that can be transferred between the two systems.

The new circuit will provide an alternative high capacity path for power flows in the event of the loss of the existing circuits. It will therefore overcome the system separation issue and alleviate constraints on power transfers between the two systems, which would be expected to increase upon introduction of the Single Electricity Market in November 2007. The project is expected to be completed in 2012.

2.3.8 400 kV line from Woodland to Mid-Cavan

A 400 kV line is planned from the existing Woodland 400 kV station northwards to the planned Mid-Cavan 400/220 kV station. Together with the planned 400 kV line from Mid-Cavan to Northern Ireland this will further strengthen the link between the two transmission systems. It is expected to be completed in the second half of 2012.

2.3.9 East-West Interconnector

In July 2006, the Department of Communications, Marine and Natural Resources requested that the Commission for Energy Regulation (CER) arrange a competition to secure the construction of a 500 MW East-West interconnector between Ireland and Great Britain. The CER was also requested to instruct the TSO to carry out the technical work of selection of a sub-sea route and other sites for the construction of the interconnector and necessary grid reinforcement works. The interconnector is expected to be in place by 2012.

Since the data freeze, the CER approved the choice of Woodland as the connection point on the Irish system for the interconnector, as recommended by the TSO. The connection point to the British transmission system has yet to be finalised.

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.

Table 2-4 Planned Connection Methods of Future Generators

Generator	Planned Connection Method
Athea	New Athea 110 kV station tail-connected into Trien 110 kV station
Coomacheo	New Coomacheo 110 kV station tail-connected into Clonkeen 110 kV station
Meentycat Wind Farm (Extension)	Connected into existing Meentycat station at 110 kV
Moneypoint Wind Farm	Connected into existing Moneypoint station at 110 kV
Mountain Lodge	Connected into existing Ratrussan 110 kV station
Pallas	Connected to a new Clahane 110 kV station, itself connected into the Tralee-Trien 110 kV line

In addition to the connections in Table 2-4, two embedded wind farms listed in Table D-3 in Appendix D, Ballycadden and Knocknalour, will be connected into a new 110 kV station called Ballycadden. This station will be connected into the planned Lodgewood 220/110 kV station by means of a 110 kV line.

It should be noted that a termination agreement for the 60 MW Arklow Banks wind farm was executed in December 2006. As such, this project will not now go ahead.

Since the data freeze at the end of December 2006, the Huntstown 2 combined cycle gas turbine (CCGT) and the Glanlee wind farm have connected to the grid. The Huntstown 2 CCGT was tail-connected into Corduff 220 kV station by means of a 220 kV cable and the Glanlee wind farm was connected into the new Glanlee 110 kV station, which itself is tail-connected into the Coomagearlahy 110 kV station. Connection agreements were signed for the connection of two new CCGTs, totalling 876 MW, in Co. Cork. Given that in June 2006 the CER directed the TSO to proceed on a working assumption that system capacity equivalent to more than 800 MW of conventional generation plant should be held in reserve in the south-west region, the Aghada and WhiteGen CCGTs were included in network models from 2010 onwards. As no shallow connection method had been finalised for either CCGT at the time of data freeze, both were assumed connected to the 220 kV busbar at Knockraha for the purposes of the TFS analyses only, as this is the main entry and exit point for power flowing into and out of the Cork area.

2.5 CONNECTION OF NEW INTERFACE STATIONS

For the period covered by this statement, Table 2-5 lists the planned new 110 kV stations connecting the distribution system or directly-connected customers to the grid. These stations 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 B.

Table 2-5 Planned 110 kV Stations

Station	Code	Nearest Main Town or Load Centre	County
Athy	ATY	Athy	Kildare
Ballyadam	BDM	Midleton	Cork
Ballycummin	BCM	Raheen	Limerick
Baltrasna	BAL	Ashbourne	Meath
Banoge	BOG	Gorey	Wexford
Baroda	BDA	Newbridge	Kildare
Bunbeg	BUN	Na Doirí Beaga	Dún na nGall
Camus	CAM	Camas Íochtar	Gaillimh
Charlesland	CLD	Greystones	Wicklow
Hartnett's Cross	HTS	Macroom	Cork
Kilmurry	KMY	Waterford Port	Kilkenny
Nenagh	NEN	Nenagh	Tipperary

2.6 DETAILED NETWORK INFORMATION

Figure A-1 in Appendix A presents a geographical map of the grid at the end of December 2006. 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.

- Tables B-2 to B-5 list the electrical characteristics of the existing overhead lines and underground cables at the different voltage levels. The ratings are shown in MVA for winter and for summer reference temperature conditions, 5°C and 25°C respectively.
- Tables B-6 to B-8 list data for each existing transmission transformer. The data includes impedance values, nameplate ratings and tap ranges. 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-9 lists details of the phase shifting transformer at Carrickmines 220 kV station.
- Table B-10 includes the Mvar capacity data for existing reactive compensation devices.

Figure A-2 in Appendix A presents a geographical map of the grid as forecast in 2013, including the planned developments. The schematic network diagrams in Appendix A show snapshots of the existing grid and planned developments at the end of 2007, 2008, 2010 and 2013. 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.

- Tables B-11 to B-16 contain data for new lines and cables and planned changes to existing line and cable data on an annual basis. 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 and headed by a project description which includes the Capital Project (CP) number.
- Tables B-17 to B-20 list the details of the planned network transformers.
- Table B-21 includes the Mvar capacity data for planned reactive compensation devices.

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.