SUSTAINABLE ENERGY IRELAND

A GUIDE TO

Connecting Renewable and CHP Electricity Generators to the Electricity Network

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Guide prepared for Sustainable Energy Ireland by:
Econnect Ireland

Disclaimer

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This Guide describes the connection process for renewable and CHP generators in place at the time of writing. However, the connection process is subject to change. The reader should be aware that in the event of any discrepancy between this Guide and the requirements of the CER or system operators, the requirements of the CER or system operators shall prevail. While this Guide has been produced with the guidance from ESB Networks, EirGrid and the CER it is not a definitive interpretation of the connection offer process.

Acknowledgements

This Guide has been produced with assistance from ESB Networks, EirGrid and the CER. The authors also wish to acknowledge that this Guide has been based on a UK document 'A Technical Guide for Connection of Embedded Generators to the Distribution Network' produced by Econnect and ILEX Associates, 1998 for Department for Business, Enterprise and Regulatory Reform (BERR).

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Table of Contents

Figures

Tables

1 Introduction

1.1 The Guide

1.1.1 The users of the Guide

This Guide provides information on connections to the Irish electricity grid for renewable and combined heat and power (CHP) generators of various scales. It is intended to explain the process involved in obtaining a grid connection for a generator installation. The types of people or organisations who may find this Guide of use include:

- Developers
- Consultants
- Public bodies and energy agencies
- Commercial and industrial demand customers considering on-site renewable or CHP generation
- Investors, and
- Electrical contractors

In this Guide, the person or organisation aiming to develop an electricity generation scheme is referred to as the *developer*. Getting a generation scheme connected to the electricity network involves considerable communication between the developer and the company responsible for the operation of the electricity network – the *system operator*.

This Guide deals only with generator connections where the generator will be operating in synchronisation with the grid. Generators that are installed to operate as a standby electricity supply (for example a standby diesel generator) or independent of the mains network are not covered in this Guide.

1.1.2 Scope of the Guide

The main aim of the Guide is to provide a 'route-map' for the process of getting a generation scheme connected to the network. The connection offer process involves agreements between the developer and the system operator. As such, the process is more likely to be successful if the parties can communicate effectively and understand each other's concerns. As a result, in addition to the primary aim of providing a route-map of the process, the Guide has the following subsidiary aims:

- To provide background information about the electricity industry
- To describe the main factors affecting connection costs and timescales
- To explain the technical issues that commonly crop up during the connection process, and
- To explain some of the jargon commonly used in the industry

Each generation scheme has a unique set of technical and commercial circumstances, so it is not possible to provide specific guidelines and solutions that apply for the design of connection arrangements. Instead, this Guide is intended to give the reader a general understanding of the issues which affect the connection of generators.

This Guide addresses the connection of renewable and CHP generator installations of all sizes except microgenerators. A separate Guide is available with information on connecting microgeneration to the grid, microgeneration being defined as generators that produce less than 11 kW (3 phase) or 6kW (single phase) of electrical power.

1.1.3 What is not covered in the Guide

In addition to getting a network connection, the developer of an electricity generation scheme has to address many other elements in order to get the scheme operational. These include:

- Obtaining planning permission for the project
- Planning the project
- Financing the project
- Buying and selling electricity

- Legal aspects of the project, and
- Health and safety

These issues are outside the scope of this Guide. However, further information can be obtained from the contacts listed in Appendix H.

1.1.4 Explanation of key terms and organisations

Table 1-1: Explanation of key terms and organisations

Renewable Energy	
Renewable energy means energy used in the production of electricity which uses as it primary source a sustainable fuel source such as wind, hydro, biomass, waste, biofuel, geothermal, fuel cells, tidal, solar and wave. This is similar to the definition given for renewable energy in the Electricity Regulation Act 1999 [2].	
Combined Heat and Power (CHP)	
Combined heat and power is the simultaneous production of heat and electricity. Although not always fuelled from renewable sources, CHP is considered as an efficient, low carbon source of energy as it uses both the heat and electricity produced onsite. The primary fuel used in CHP projects may include gas, oil, and biomass. CHP generators are available in a large range of sizes.	
System Operators	
The system operators are the utility companies responsible for the development, operation and maintenance of the electricity system. In Ireland the following two companies have this remit:	
ESB Networks	ESB Networks is the company that operates and develops the distribution system in the Ireland. The distribution network consists of systems operating at 230 V, 400 V, 10 kV, 20 kV, 38 kV and part of the 110 kV network. ESB Networks is known as the Distribution System Operator (DSO). ESB Networks also owns the transmission and distribution assets.
EirGrid	EirGrid is the company that is responsible for operating and developing the transmission system in Ireland. The transmission system operates at nominal voltages of 110 kV, 220 kV and 400 kV. EirGrid is also known as the Transmission System Operator (TSO).
Commission for Energy Regulation (CER)	
The CER is the regulator for the electricity and natural gas sectors in Ireland. It is a statutory public body that was set up in 1999 to oversee the liberalisation of Ireland's energy market. It monitors many areas of the energy industry including the generation, distribution and transmission of electricity. The provision of electricity distribution and transmission services is a natural monopoly and, in the absence of competitive market forces, the CER is responsible for regulating their prices and performance. They are also responsible for making determinations to resolve disputes between the system operators and various parties.	
Sustainable Energy Ireland (SEI)	
Sustainable Energy Ireland is the national agency responsible for the promotion and development of renewable and sustainable technologies.	
Maximum Export Capacity (MEC)	
Maximum export capacity is the maximum amount of electrical power which a customer is contracted to export to the grid in their connection agreement; it is typically measured in megawatts (MW).	

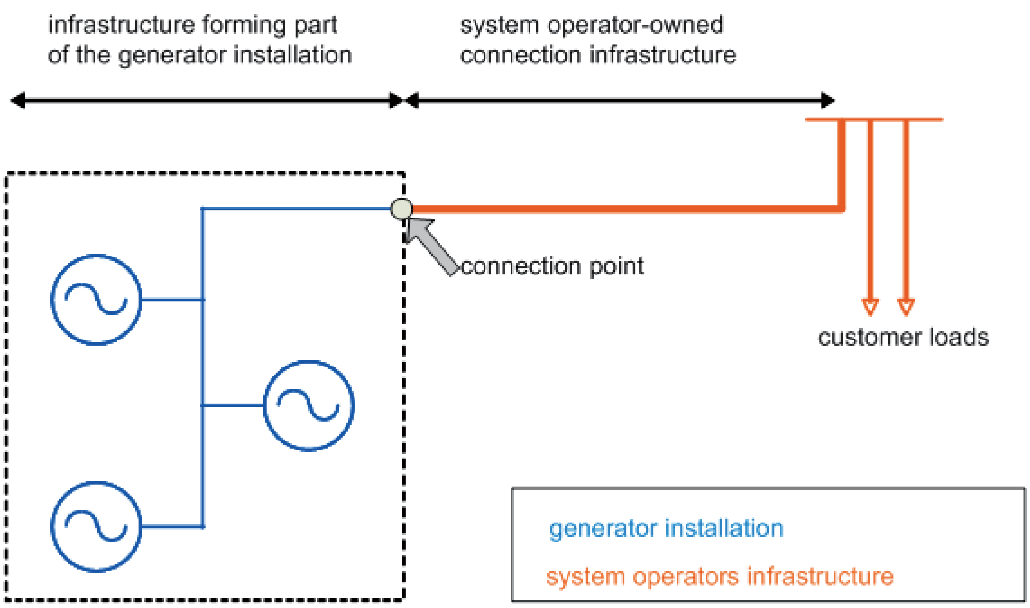
Maximum Import Capacity (MIC)
Maximum import capacity is the maximum amount of electrical power which a customer is contracted to import from the grid in their connection agreement; it is typically measured in kilovolt Amperes (kVA).
Connection agreement
The developer of a generation scheme must enter into a connection agreement with the relevant system operator or, if there is an existing connection agreement, the parties must modify this agreement to include conditions relating to the new generation scheme. The connection agreement sets out the terms and conditions under which the system operator will provide a connection to their system. More specifically, it specifies the rights and obligations of each party with respect to the installation, use and operation of the connection, and details the connection charges to be paid by the developer.

1.1.5 What is a connection?

Various physical and contractual arrangements must be in place before a generation scheme can be connected to the system operators' network. The physical arrangements consist of electrical infrastructure such as overhead lines, underground cables, switchgear and civil works, which constitute the electrical connection itself. The contractual arrangements consist of agreements between the developer and other parties covering matters such as connection arrangements, wayleaves and power purchase arrangements.

The physical infrastructure which connects a generator to an electricity network can be divided into two sections: that owned by the developer, and that owned by the system operator.
The interface between these two parts is known as the connection point as shown in Figure 1-1. The developer has sole responsibility for the design, installation and operation of the equipment on their side of this interface, although the system operator will want to assure themselves that this equipment does not pose a hazard to their network. The system operator will assume responsibility for the design, operation and maintenance of all infrastructure on their side of the interface. In this Guide, references to 'the connection', 'connection schemes', 'connection costs' and so on relate specifically to infrastructure owned by the system operator.

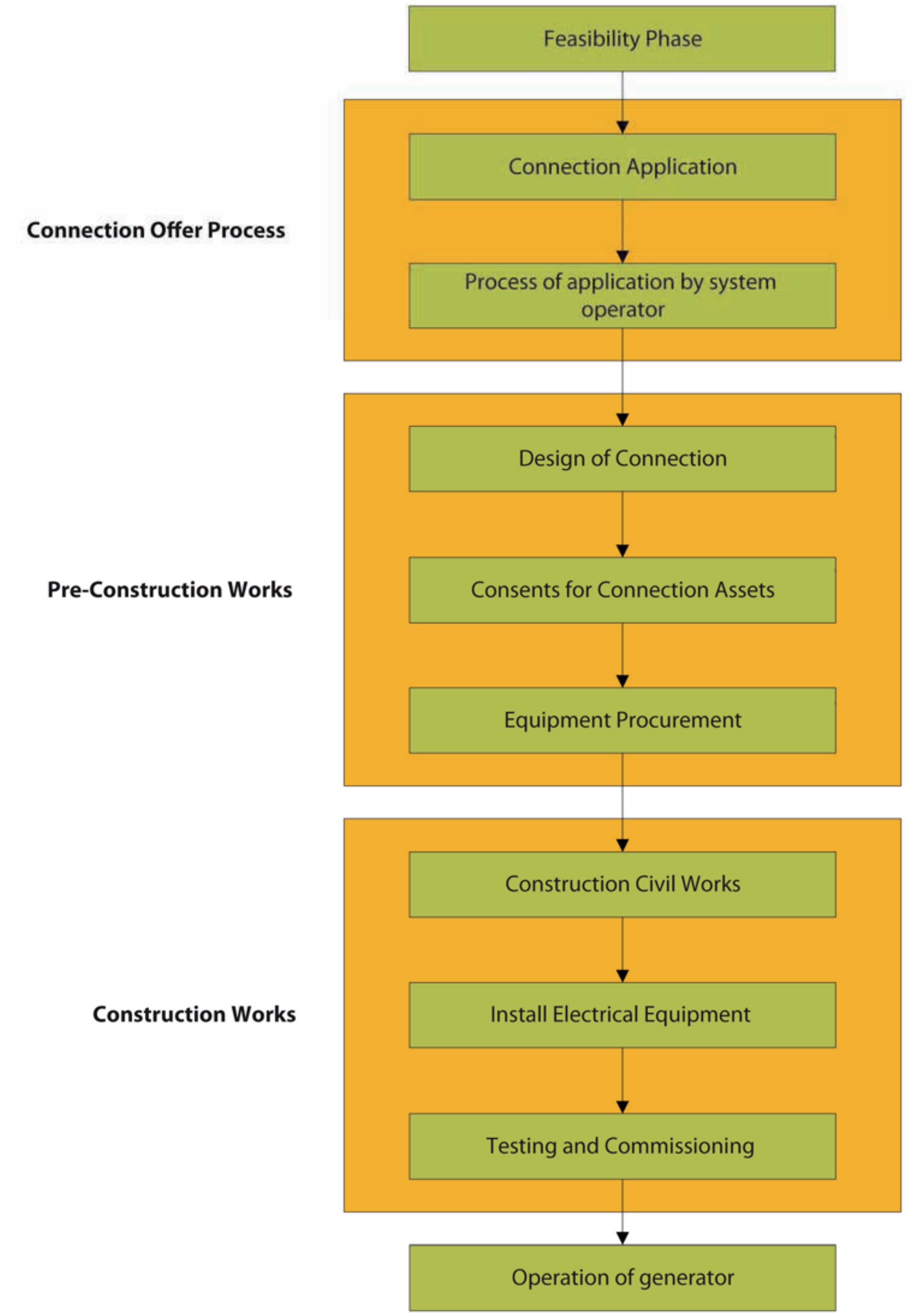
Figure 1-1: Connection point – interface between the developer's and system operator's assets



2 Summary – the quick guide

The aim of this chapter is to provide a high level overview of the process of connecting a generation scheme to the electricity network. The main tasks are briefly outlined and the reader is referred to the relevant chapter of the Guide, where appropriate, for a more detailed description. Figure 2-1 sets out the stages of development for the connection of a generator installation. The remainder of this section summarises the main features and issues associated with each of these stages.

Figure 2-1: Stages involved in the connection of a renewable/CHP generation scheme



2.1 Feasibility phase

Consideration of the electrical connection is one of the many factors that a developer will take into account during the feasibility phase of a generation scheme.

In considering the feasibility of the electrical connection, a developer will consider factors including:

- The Maximum Export Capacity (MEC) required. For CHP or on-site generation schemes there may be no requirement to export power from the site
- The likely connection voltage for the generation scheme, which in turn is likely to influence whether a connection application should be submitted to ESB Networks (distribution voltage) or EirGrid (transmission voltage)
- The proximity and characteristics of the local electricity network.
- Improvements planned for the local distribution and transmission system
- The presence of generation already connected or with signed connection offers in the vicinity of the proposed generation site or connecting to the same transmission node
- Other generation projects in the area that are in the queue for grid connection
- Generation projects that may join the queue – an unknown quantity
- The timeline for processing the connection application and receiving a connection offer
- The budget costs and timelines for constructing the connection
- Planning permission and consents for the electrical network to traverse landowners property
- Local authority and local population enthusiasm for project
- Other economic factors associated with network connections such as network loss factors and use of system charges

Generators can apply to ESB Networks and EirGrid to have a pre-feasibility study performed to provide information on the various connection options. In general the system operators do not complete feasibility studies for projects that will be processed under the group processing approach (see Section 0). The fee for an ESB Networks pre-feasibility study is €1,360 [45]. For further information of EirGrid's pre-feasibility studies contact their Customer Relations Team. See Appendix H for their contact details. It should be noted that the results of a pre-feasibility study can be overtaken by events, for example new generation applications within the same proposed transmission node post issue of the study.

2.2 Connection applications / connection offer process

A developer must apply to the relevant system operator (i.e. ESB Networks or EirGrid) to connect a generator scheme by submitting a completed connection application form. Once the relevant system operator has checked that the application and necessary support documentation has been provided in a satisfactory manner, the application is 'deemed complete'. The application is then 'queued', along with all other generator connection applications, until it is ready to be considered by the relevant system operators under the connection offer process. At the end of this process the developer will be issued a connection offer. If the terms of the offer are acceptable the developer can sign the offer. This is commonly referred to as 'execution' of an offer. Once the offer is executed it then becomes a connection agreement.

Currently there are two procedures that the system operators use to process the connection applications which are;

- Group processing
- Sequential processing

The procedure that the system operator will use to deal with an application depends on the size and type of generator.

Group processing generally applies to all renewable generator applications with a MEC greater than 500 kW (0.5MW). Essentially, this approach involves the collective processing of connection applications in batches known as gates. A set of defined criteria is used to decide on the applications that are eligible for each gate. The eligible applications are then broken into groups depending on their geographical location and level of interaction with other potential developments that have an application in the same gate. The generation projects in each group are then processed by the system operators and the resulting connection methods are designed by the system operators to efficiently connect all the generators in each group in accordance with the system planning criteria. The rules for inclusion and processing methodology are unique to each gate. These rules are defined by CER

Sequential processing applies to non-renewable generators. This process assesses each application independently of all other applications in the queue.

Renewable generators with an MEC of less than or equal to 500 kW may also be approved by the CER to be developed outside of group processing. In this case the CER must grant approval to proceed in the sequential process. In the CER approval process, consideration is given to issues such as negative interactions with applicants in the queue for connection and the wider public benefit of the generator in question. The interaction studies are carried out by both EirGrid and ESB Networks. The system operators pass the results of these interaction studies onto the CER who decides whether the application can be dealt with outside of group processing.

The CER will also consider handling renewable applications with a MEC greater than 500 kW in sequential processing if the developer can demonstrate that it would result in wider benefits in the public interest. To-date a number of non-wind renewable applications, such as landfill gas generation schemes, have been processed in the sequential process.

The lead times for issue of connection offers vary greatly between those applications managed in the sequential processing and those handled as part of group processing. Offers issued in the sequential process are typically issued in 90 working days from CER granting of approval to proceed. In group processing the lead time from joining the queue and issue of the offer is considerably longer.

Upon receiving a connection offer via the group processing approach the developer typically has 50 business days to accept the offer. Connection offers issued under sequential processing have, in the past, been held open for acceptance for 70 business days. This time period provides the opportunity for the developer to review the offer and query any of the conditions with the relevant system operator.

For further information on the sequential connection offer process and group processing see Section 4.

2.3 Getting new connection infrastructure built

After the developer has accepted the connection offer, the remainder of the process can be divided into three main phases associated with the construction of new connection infrastructure;

- the preconstruction phase
- the construction phase
- the testing and commissioning phase.

The system operator is generally responsible for the planning and construction of the ESB owned connection infrastructure. For transmission connections, the developer has the option to to take responsibility for the construction of the connection assets; this is known as contestability. Further information and guidelines on contestability are provided in Appendix E.

As part of the preconstruction stage the system operator will complete the following tasks:

- detailed design of the connection
- apply for planning permissions if required
- organise wayleaves with landowners
- procure materials

The developer will be responsible for obtaining the planning permission for the on-site substation. It should be noted that it is becoming increasing difficult for system operators to get agreement with landowners for the construction of overhead line infrastructure, particularly those associated with publicly opposed generation schemes.

2.3.1 Construction

The system operator will be responsible for the construction of the transmission and distribution off-site connection assets except in contestable transmission connections. It is advisable for the developer to meet regularly with the relevant system operator to discuss progress of all of the connection works.

In general, the developer is responsible for the construction works for the onsite connection assets, including the civil works for the generator substation. These responsibilities are specified in each connection agreement.

The proposed generation plant itself must comply with the various regulations and recommendations governing the connection of generators. Section 6 provides further information on the responsibilities of the developer during the construction phase.

2.3.2 Testing and commissioning

Before the connection is energised, tests must be carried out to ensure that the connection infrastructure is correctly installed, complies with either the Distribution Code [21] or the Grid Code [34], and that the protection systems operate as required. The system operator may ask to witness some of these tests, and will require to be notified of the results. For distribution connections these tests are known as G10 tests. Section 6 provides information about testing and commissioning.

2.4 Connection costs and timelines

Connection costs can make up a significant proportion of project costs and may therefore have a major impact on the financial viability of a generation scheme. These costs are project specific and will be driven by the characteristics of the generation scheme and the local distribution or transmission network into which the project would be looking to connect. Specifically, factors such as the location of the scheme, connection voltage, the rated capacity of the existing network, the existing demand for electricity in the area and export capacity will all be likely to have an impact on the connection cost. Generators should also be aware of the operation & maintenance and network charges that will be levied by the relevant system operator when the generator is operational. Section 5 contains more information about connection costs and network charges.

The timeline to build a connection will vary depending on the type and extent of the new connection infrastructure that is required. Exact timescales vary depending on project specific factors, however, broadly speaking, high and medium voltage connections tend to take longer to complete than connections to low voltage connections.

Table 2-1 shows typical construction timelines based on the connection voltage.

Table 2-1: Guidelines to construction timelines

Connection voltage	Construction timescale
LV (240/400 V)	4 months
MV (10/20kV)	6 - 24 months
38kV	12 - 36 months
110 kV	3-5 years

Factors that may influence the timescales include:

- Planning permission and appeals
- Wayleaves
- Disputes
- Development of existing ESB network
- Station upgrade
- New station build
- Multiple generators connecting to common node

2.5 Connection for CHP and on-site generation

Not all on-site generation schemes require the installation of new ESB connection infrastructure. Some schemes are installed at sites with existing ESB Networks or EirGrid connections, and in some cases the existing connection infrastructure can accommodate the new generation capacity. In other cases, the system operator assets may have to be reinforced in order to accommodate the new generation capacity. Whether new connection infrastructure is required or not, the developer must still apply to the system operator to connect a new generation scheme.

3 Overview of the Irish Electricity Industry

The aim of this chapter is to provide a general overview of the Irish electricity industry. This chapter is divided into two sections; the first section contains information relating to commercial relationships between industry participants and industry regulation; the second section contains information about the technical operation of the electricity transmission and distribution system.

3.1 Commercial and regulatory overview

3.1.1 Electricity legislation

Irish electricity legislation has seen continuous reform in response to European Directives aimed at the liberalisation of electricity markets. The CER was established in 1999 to regulate and oversee the liberalisation of the electricity sector. The retail electricity market has been fully opened to competition since 2005. As well as establishing competition in the generation and supply of electricity, EU and Irish legislation also provided reforms in the areas of security of supply and the promotion of renewables; for example, under the EU Renewable Energy Directive [1] Ireland committed to providing 13.2 % of gross electricity consumption from renewable sources by 2010.

The Electricity Regulation Act 1999 [2] provides the legal foundation for the electricity industry in Ireland. It defines the general duties of the CER as the industry regulator and provides the rules for access to the distribution and transmission system. The Electricity Regulation Act 1999 is a form of enabling legislation, which means that it provides a framework which can be amended through the use of secondary legislation. The secondary legislation that applies to the Electricity Regulations Act is encompassed within Statutory Instruments ('SI') (including specifically, SI 445 of 2000 [3] and SI 60 of 2005 [4]) that outline the roles of the transmission and the distribution system operators.

More recently, SI 406 of 2007 - Single Electricity Market [5], provides for the establishment of a single competitive wholesale electricity market, known as the Single Electricity Market (SEM), for the island of Ireland (i.e. covering Northern Ireland and Ireland).

Further information on legislation relating to the electricity industry is available on the CER and Department of Communications, Energy and Natural Resources websites.

3.1.2 Energy policy

Energy policy has gained particular significance in the political agenda in recent years due to concerns raised by increasing fossil fuel prices, security of supply and climate change. In March 2007, the Government published a white paper on energy policy entitled Delivering a Sustainable Energy Future for Ireland [6]. This paper set out an energy policy framework for the period 2007-2020, including actions and targets to ensure the Government meets its goals of ensuring safe and secure energy supplies, promoting a sustainable energy future, and supporting competitiveness. The principle actions and targets in the paper relating directly to renewables and CHP include:

- Target of 33% of electricity consumption to be produced from renewable sources by 2020 and an equivalent 15% target for 2010.
- Target to install at least 400 MW of CHP by 2010 and 800 MW of CHP by 2020.
- Target to install at least 500 MW of ocean energy technology by 2020.
- Investment of €150 million in energy research and innovation under the National Development Plan 2007-2013.

3.1.3 Commercial structure of the electricity industry

The electricity supply chain can be broken in four distinct areas; generation, transmission, distribution and supply, see Figure 3.1.

Generation: Electricity can be generated from either fossil fuels such as coal, oil, peat and gas or from renewable energy sources such as hydro, wind, biomass, wave and tidal. Although ESB owns and operates a significant proportion of the generation capacity in Ireland, the liberalisation of the Irish electricity sector has seen a substantial number of Independent Power Producers (IPP) entering the market and increasing competition in the generation sector.

Transmission and Distribution: Electricity is transported from power stations to customers using a network of electricity lines and substations. The electricity network is broken into the transmission and distribution system. The transmission system being the backbone of the Irish electricity system connects all the large generators and transports the electricity in bulk to all the large load centres. The transmission system delivers the electricity to transformer substations, where the voltage is transformed down and then delivered on the distribution system to domestic and commercial customers.

The transmission and distribution systems are owned and operated by regulated monopoly businesses: EirGrid is the Transmission System Operator (TSO), and ESB Networks is the Distribution System Operator (DSO). ESB Networks is also the asset owner of the both the transmission and distribution systems. These network businesses recover the costs of operating and maintaining these systems by levying use of system charges on all connected customers (i.e. generators and electricity consumers).

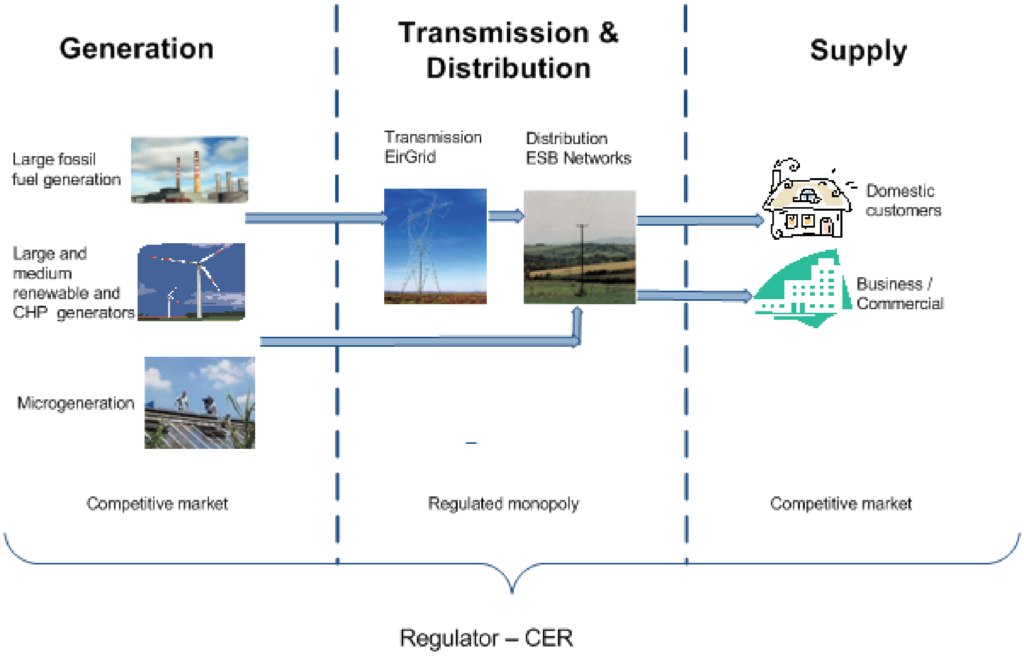
To ensure that the system operators do not abuse their monopoly position the system operator businesses are subject to regulation by the CER, ensuring there is a 'level playing field' for new and existing customers seeking to make use of the networks.

Supply: There is a competitive market in electricity retailing that enables industrial, commercial and domestic electricity users to contract with any one of a number of competing electricity suppliers. These suppliers are responsible for billing and other aspects of the customer relationship. A full list of electricity suppliers is available on the CER website.

3.1.4 The electricity market

In order for competition in generation and supply markets to be effective, it is necessary to have arrangements in place to facilitate the buying and selling of wholesale electricity between generators, suppliers and other trader bodies. The Single Electricity Market (SEM) is the wholesale electricity market that came into operation in November 2007 in Ireland and Northern Ireland. The market encompasses approximately 2.5 million electricity consumers, 1.8 million in Ireland and 0.7 million in Northern Ireland.

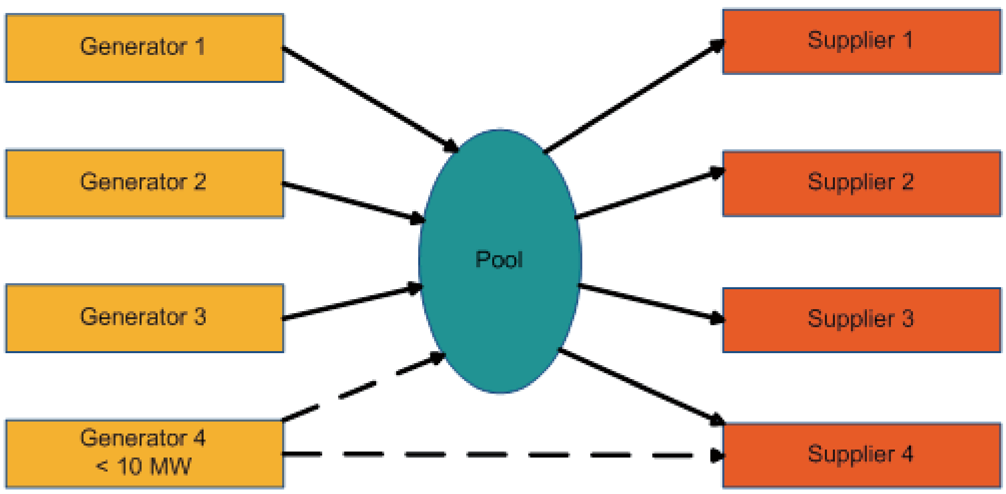
Figure 3-1: Irish electricity supply chain



The market operator is responsible for the administration and operation of the market. 'SEMO', a joint venture company owned by EirGrid and System Operator Northern Ireland (SONI), carry out the Single Electricity Market Operator function.

The rules of the market are set out in the Trading and Settlement Code (TSC) [7]. With the implementation of the SEM a market model known as a 'gross mandatory pool' was adopted, (see Figure 3-2). Generators sell their electricity directly into the pool and suppliers must purchase the electricity from the pool. This helps to promote transparency in the market in terms of wholesale prices.

Figure 3-2: SEM Pool trading arrangements



The TSC sets mandatory participation in the pool for generators with a MEC of 10 MW or greater. These generators selling into the pool can have bilateral financial arrangements with suppliers or through agents, known as Contracts for Differences (CFD), but these arrangements are separate from and not covered within the TSC.

Generators with a capacity less than the 10 MW threshold are not obliged to participate in the market and may decide to contract directly to a supplier through a bi-lateral agreement. This is illustrated in Figure 3-2.

The generator revenue from participation in the SEM includes:

- Energy Payments – Under the pool arrangement all generators receive the same energy price in each half hour trading period, known as the System Marginal Price (SMP). Many of the large generators bid-in prices for each half hour period and the highest bid price needed to meet the actual demand in each half hour becomes the SMP.
- Capacity payments – generators earn capacity payments based on their availability to generate.

More information on the market, including registering and becoming a party to the TSC, can be found on the SEMO website.

3.1.5 Renewable support mechanisms

Financial support mechanisms for renewables are a feature of all European electricity markets. The actual support mechanism employed varies between jurisdictions and may take the form of competitive tenders, fixed feed-in tariff or a renewable obligation certificate scheme. Ireland adopted a fixed feed-in tariff approach in 2006 – the Renewable Energy Feed in Tariff programme (REFIT).

A fixed feed-in tariff regime involves the setting of price support caps for specific technologies to have effect over a set period of time (often around 15 years). Feed-in tariffs are usually government guaranteed, therefore, the projects have guaranteed cash flows that result in enhanced borrowing capacity. Fixed feed-in tariffs have been successfully employed in many European countries including Denmark and Germany.

Under REFIT in Ireland, project developers are free to negotiate with any electricity suppliers in the liberalised electricity market, with the REFIT price acting as the minimum contracting price. Applicants for REFIT must already have planning permission and a grid connection offer for their generation scheme. Table 3-1 indicates the 2006 REFIT prices. Note that REFIT prices will increase annually with 100% indexation based on the consumer price index.

Table 3-1: 2006 REFIT prices

Renewable Technology	REFIT price (c/kWh)
Large Scale Wind	5.7
Small Scale Wind	5.9
Hydro	7.2
Biomass Landfill Gas	7.0
Other biomass	7.2

Further information on REFIT is available on the DCENR website.

3.1.6 Licences

The CER has the power under the Electricity Regulation Act 1999 [2] to issue licences for the generation, distribution, transmission and supply of electricity in Ireland. Developers wishing to construct a new generating station or reconstruct an existing generating station must have an authorisation to construct from the CER prior to commencing work. Generators must also be in possession of a licence to generate from the CER before commencing generation. Following the publication of CER decisions CER/07/128 [48] and CER/08/161[49], the application process by which a generator becomes authorised and licensed as well as associated obligations and requirements are determined by the maximum installed capacity of the generator. It should be noted that the definition of maximum installed capacity for the purposes of the licensing and authorisation process is based on the actual generating capacity (nameplate rating) of the generator and not the export capacity (MEC). The maximum installed capacity thresholds are:

- Less than or equal to 1 MW capacity: Such generators are authorised to construct and/or licensed to generate by Order, the relevant terms and conditions that pertain being set out in those Orders.
- Greater than 1 MW and less than 10 MW: Generators must apply to the CER by completing the relevant application form and providing the appropriate fee, see Table 3-2.
- Equal to or greater than 10 MW: Generators must apply to the CER by completing the relevant application form and provide the appropriate fee, see Table 3-2.

Generators authorised to construct and/or licensed to generate are subject to specific terms and conditions as set out in the relevant Orders, see CER/07/128 [48].
Supplementary information, in addition to that required in the application forms, may be requested by the CER where this is considered appropriate.
The arrangements in place are designed to minimize the administrative burden on applicants.

Table 3-2: CER application fees for licences (2008)

Installed Capacity	Authorisation to Construct (€)	Licence to Generate (€)
1MW to 5MW	35	35
5MW <15MW	270	55
15MW to < 50MW	995	200
50MW to < 100MW	1,995	400
100MW to < 200MW	6,635	1,330
200MW to < 500MW	16,590	3,320
500MW+	19,905	3,980

These fees are subject to review by the CER from time to time. The above fees are accurate at the time of writing this Guide. The CER will acknowledge the receipt of applications within 7 working days of receipt. There is no specified timeframe for the processing of applications but the CER will complete the process in a reasonable timeframe once all information has been provided by the generator. Further information on the licensing and authorisation process is available on the CER website, including the application forms and guidance notes.

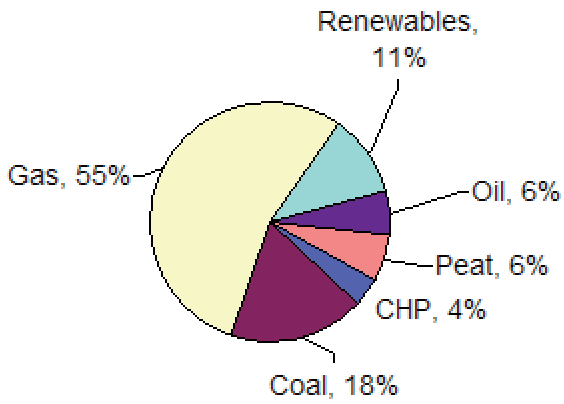
3.2 Technical overview

The aim of this section is to provide a technical overview of Ireland's electricity network particularly as it relates to the connection of renewable and CHP generation.

3.2.1 Generation

The majority of electricity consumed in Ireland is generated by large power stations running on natural gas, coal, oil and peat. Figure 3-3 shows the generation mix for 2006. Currently there is over 6,000 MW of generation capacity installed on the Irish electricity system with a maximum demand in excess of 5,000 MW. Renewable energy is making an increasing contribution to this mix with wind generation being the predominant renewable technology. More information on the generation connected to the system is available on EirGrid's website.

Figure 3-3: 2007 Generation Mix (percentage of energy generated)



3.2.2 Control of system frequency

In Ireland, the electricity system is operated at a nominal frequency of 50 Hz and within an acceptable tolerance of +/- 0.5Hz. Maintaining system frequency within these tolerances is necessary to ensure system stability is achieved by scheduling generation to match demand and by requiring specific actions by some generators. In the absence of these control actions, variations in the system demand could result in undesirable changes in system frequency.

3.2.3 Interconnected electricity networks

3.2.4 Physical infrastructure of electricity networks

The transmission and distribution networks are made up of several interconnected 'layers'. Each of these layers consists of a network of wires (i.e. overhead lines and underground cables) operating at a particular nominal voltage. Transformers act as the connections between layers, allowing power to be transferred between different nominal voltage levels. In general, power flows down through the layers, from higher voltage systems to lower voltage systems. Most electricity users are connected to low voltage systems operating at 400 V or 230 V, although some larger users are connected at higher voltages.

Figure **3-4** is a schematic layout of the Irish electricity system.

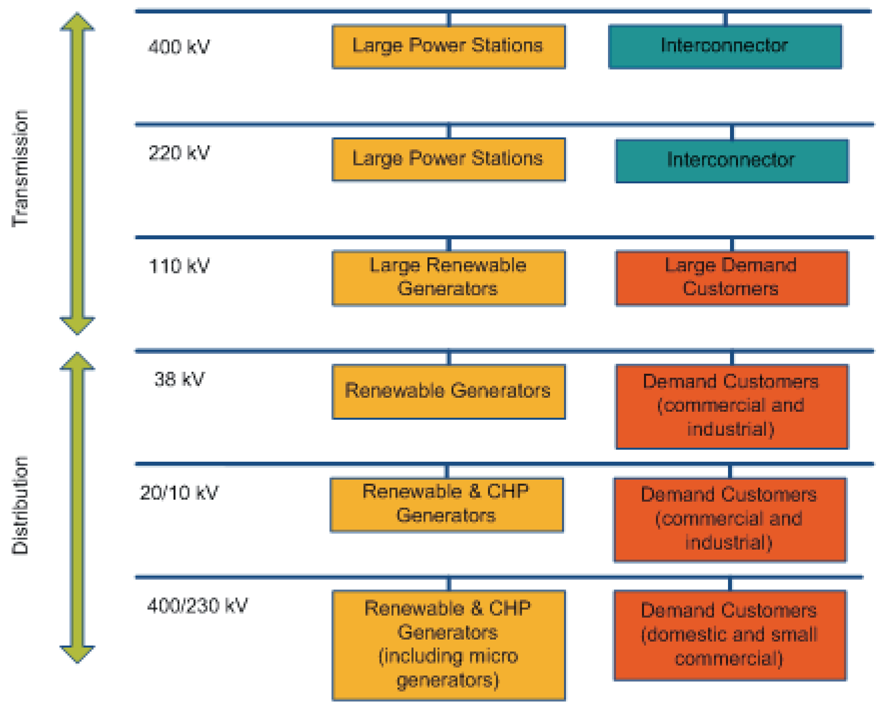
Table 3-3 provides the standard nominal voltage levels used for the transmission and distribution of electricity in Ireland. The transmission system operates at nominal voltages of 400 kV, 220 kV and 110 kV. Distribution networks include systems operating at 38 kV, 20 kV, 10 kV, 400 V and 230 V. In some instances the 110 kV networks may be part of the distribution system and operated by the DSO. For example, the 110 kV network in the Dublin area is operated by the DSO. The nominal voltage is typically used as a convenient term of reference for a particular layer of the network, for example, electrical engineers will often refer to the 'the 20 kV system' or 'the 110 kV system' in a particular area.

The terms HV (high voltage), MV (medium voltage) and LV (low voltage) are often used but can mean different things in different contexts. As per Power Quality standard EN 50160, LV is considered to cover anything below 1 kV, MV to cover voltages between 1 kV and 35 kV and HV to refer to voltages above 35 kV.

Table 3-3: Voltages that are in operation on the Irish electricity system (from ESB website)

System	Voltage	Length of network (km)	Category
Transmission	400 kV	435	High voltage (HV)
	220 kV	1,833	
	110 kV	4,555	
Distribution	38 kV	6,194	
	20 kV	18,455	Medium voltage (MV)
	10 kV	69,098	
	400 V	-	Low voltage (LV)
	230 V	-	

Figure 3-4: The Irish electricity system – schematic



3.2.5 Interconnectors

At present there is one main point of interconnection between Ireland and Northern Ireland - the double transmission circuit between Louth and Armagh. There are 2 smaller 110 kV interconnectors linking Donegal to Tyrone and Cavan to Fermanagh. The electricity system in Northern Ireland is interconnected with the Scottish electricity system through the Moyle interconnector.

There are plans for two further interconnectors by 2012:

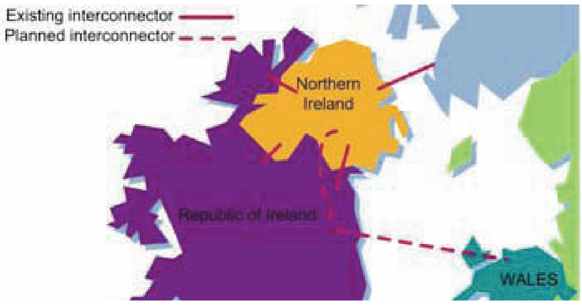
- North-South interconnector: a 400 kV line between Cavan and Tyrone.
- East-west interconnector: a high voltage direct current undersea cable linking Meath with North Wales.

There are also other interconnectors currently in the queue for connection.

Moving into an all-island electricity system the connections between Northern Ireland and Ireland will be known as transmission lines rather than interconnectors.

A higher level of interconnection will improve the flexibility of the Irish system and is likely to positively contribute towards the ability of the system to connect greater volumes of renewables.

Figure 3-5: Existing and planned electricity interconnectors



3.2.6 Control of system voltage

The control of voltage levels in networks is an important factor in maintaining the quality and security of supply to electricity users. EirGrid will endeavour to operate the system as close to nominal levels as possible, but the actual voltage will typically vary between different locations around the system and at different times of day in accordance with changes in load on the system. Voltages tend to fall at times of high demand and in locations towards the end of long distribution lines. Conversely, power in-feeds from generators connected directly into the distribution system tend to increase local voltage levels.

Distribution networks are designed to provide electricity to users within closely controlled voltage levels. Transmission networks are used to transport large amounts of electricity over long distances and this is one reason why it is subject to larger voltage variations.

Lower voltage layers of the distribution systems, such as 10 kV networks, are used to provide 400 V or 230 V supplies to customers via fixed tap transformers. To ensure that customers are supplied at a steady voltage, these systems must be isolated from the voltage changes on the higher-voltage systems. To achieve this isolation, the step-down transformers which transfer power from the higher voltage to the lower voltage systems are fitted with automatically controlled tap changers. These tap changers automatically alter the transformer ratio to compensate for voltage changes on the HV side of the transformer.

3.2.7 Network planning

Electricity networks must be extended, reinforced and modified in response to changing patterns of demand and generation of electricity. New housing developments, commercial and industrial sites and electricity generation schemes all require extensions to the electricity network. Use of existing network infrastructure is also monitored for appropriateness in light of growth in demand (which may necessitate upgrade to existing assets), age of assets (which may require asset replacement) and decrease in demand (which may provoke the need for decommissioning).

All of these aspects of network planning have to be co-ordinated to maintain standards of safety, reliability and operation. ESB Networks and EirGrid are responsible for the planning and the development of the distribution and transmission networks, respectively. Such planning and development activities are undertaken in accordance with the standards set out in their planning criteria and grid code documents. For this reason, system operators must be involved in the process of designing and specifying connection arrangements for new electricity users and generation schemes.

Operation of electricity networks
EirGrid operate the transmission system from the National Control Centre (NCC) in Dublin. In the NCC, EirGrid engineers schedule generators to run in order to ensure that generation capacity meets customer demand. As demand varies on a daily, weekly and seasonal basis this is a very complex task. Available generation must match demand on a real-time basis to ensure the system frequency is maintained within acceptable tolerances. The NCC also continuously monitors and controls the voltage on the transmission system and manages the daily outage requests for maintenance of the network.

The distribution system is operated by ESB Networks through their two regional control centres located in Dublin and Cork. With the vast nature of the distribution system, the engineers in the control centres are continuously managing faults, maintenance and new connections on the network.

Most networks can be operated in a variety of configurations. This is a useful feature as it can be used to manage any disruption caused by network faults and routine maintenance work. In the event of a fault, for example, the system operators can reconfigure the network, selecting the configuration which maintains supplies to the greatest number of customers while the fault is being rectified.

4 Connection offer process

4.1 Introduction

This chapter sets out the process through which a generation scheme would receive an offer of terms for connection to the transmission or distribution system. The system operators are obliged under their licence conditions to provide connection offers to applicants in a non-discriminatory manner. This chapter includes guidance on completing the appropriate connection application form and information on the different connection offer processes used by the system operators.

There are four processes that system operators apply to manage the connection of generation:

- Microgeneration process
- Process for on-site generators that require no export capacity
- Group processing approach
- Sequential processing approach

The criteria used to determine the appropriate process for an applicant takes account of the size and type of the generator in question.
Figure 4-1 illustrates the decision points for routing applications to an assigned connection offer process. The CER will ultimately decide on the connection offer process to be applied to a particular application.

Microgeneration is managed under a separate process and more information can be found in the 'Your Guide to Connecting Microgeneration to the Electricity Network'. ESB Networks define microgeneration as 'a source of electrical energy with a rating of equipment less than 25 A - single phase - this is equivalent to a maximum output of 6 kW , or less than 16A - 3 phase - this is equivalent to a maximum output of 11 kW' in Conditions Governing Connection and Operation of Micro Generation [10].

Applications for on-site generators that require no export capacity are usually managed by amending the existing connection agreement for the site. Developers are still required to complete an application form if operating in parallel with the ESB system and to submit it to the system operator for processing. This is a relatively simple process with a reduced level of technical analysis required by the system operators. For a site without an existing connection, the generator application form can be submitted along with the application for a demand connection.

For generators that require export capacity, the connection application can be handled either through sequential processing or group processing. The decision as to which process should be followed will ultimately be made by the CER.

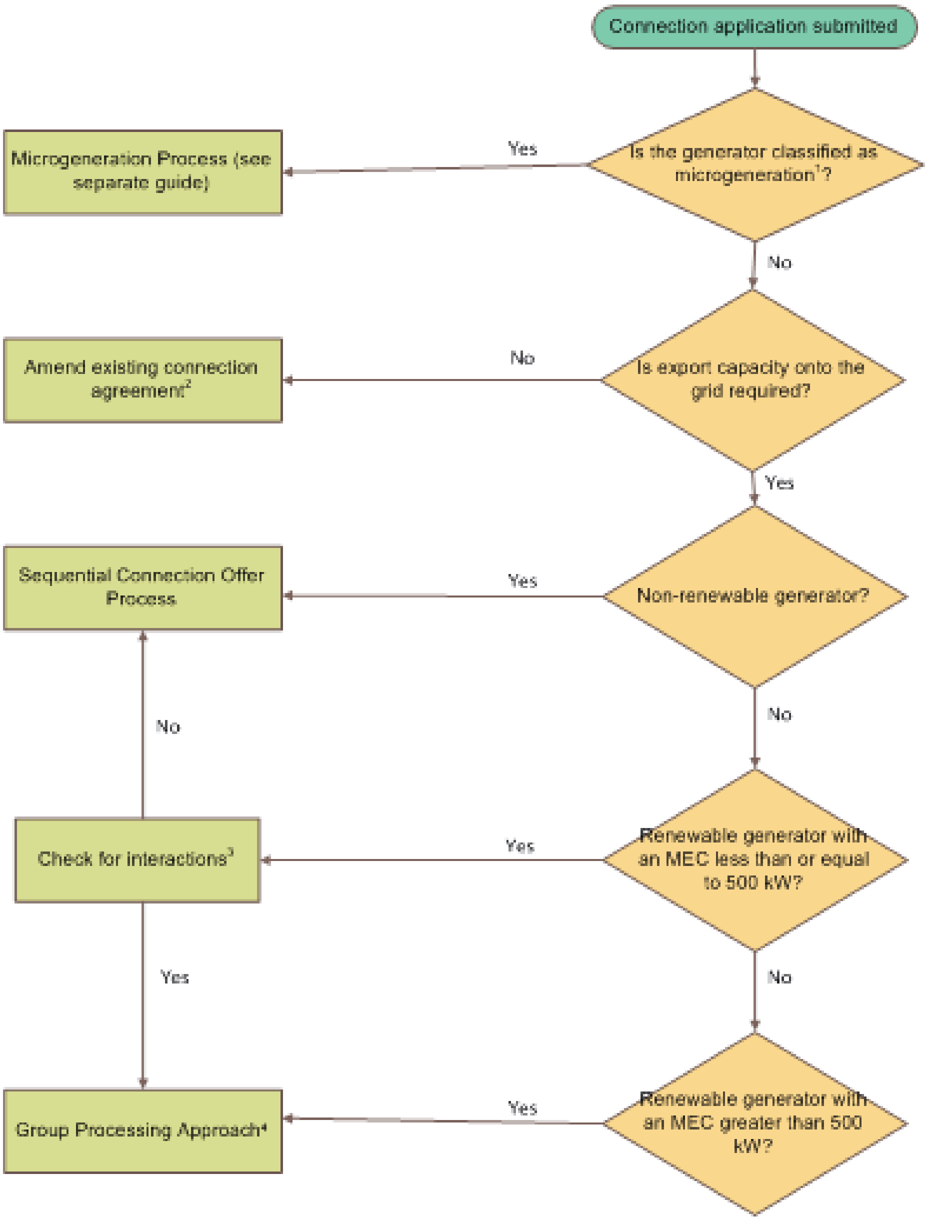
In simple terms, non-renewable generators are handled through sequential processing. Non-renewables are not dealt with under the group processing approach, although if they interact with projects in group processing they may be delayed by it. Also, renewable generator applications with a MEC less than or equal to 500 kW will typically be handled through sequential processing. In this case approval to proceed through sequential processing is partly dependent on interactions between the applicant and generators within the queue (i.e. interaction occurs when two projects compete for capacity on the same part of the network) and on whether connection of the generator in question is in the wider public interest. The sequential connection offer process is considered in more detail in section 4.6.

For renewable generators with a MEC greater than 500 kW (and in the absence of decision from the CER to the contrary) the applicant will be queued for a connection under the group processing approach [43]. The group processing approach is considered in more detail in section 4.5.

A full list of applications currently awaiting connection offers can be found in the Connection Offers Disclosure of Applicants list published on the EirGrid website. Due to the large number of applications in the queue for connection under group processing the timeline to receive a connection offer can be in years rather than months.

As noted earlier in this section, there have been instances where the CER have approved applications for connection of renewable generators with a MEC greater than 500 kW to be handled under the sequential offer process. Such connection applications are considered in greater detail in the next chapter.

Figure 4-1: Connection offer process decision tree



1. ESB define microgeneration as 'a source of electrical energy with a rating of equipment less than 25 A - single phase - this is equivalent to a maximum output of 6 kW , or less than 16A - 3 phase - this is equivalent to a maximum output of 11 kW'.
2. In the case where there is no existing connection agreement the generation application will be processed alongside the normal demand connection process.
3. The CER decides on how applications with a MEC of less than or equal to 500 kW will be treated on a case by case basis.
4. Applicants can make a request to the CER to be processed under the sequential offer process on grounds of 'public interest' (generally non-wind applicants).

4.2 The connection application form

In order to apply for connection of a generation scheme, a developer must complete and submit a connection application form. This includes generators that do not wish to export to but operate in parallel with the grid. The amount of information to be provided depends on the type and size of the generator installation.

For connection to the distribution network, ESB Networks has a standard application form for all types of generation (except microgeneration). This form (Form NC5) can be downloaded from the ESB Networks website or by requesting from CallSave 1850 372 757. The information requested in the form can be broken down into the following broad areas:

- Applicant, site and general details
- Maps and diagrams
- Technical details of the generator
- Transformer data, if applicable
- Information on wind turbines, if applicable
- Signature of land owner and applicant

Generator manufacturers or suppliers may be able to assist developers with the completion of the application form. If such assistance is not available, developers may require the support of an electrical engineer. Guidance notes on completing the ESB Network's application form are provided in Appendix G.

Generation schemes with a MEC greater than 20 MW may wish to consider a connection to the transmission system and apply to EirGrid for a connection. It is important to note that the system operators will consult with each other to ensure that the developer receives the least cost technically acceptable connection offer regardless of whether the original application was originally submitted to ESB Networks or to EirGrid. This may result in an application being transferred from one system operator to the other.

EirGrid have two different application forms:

- Wind Generation Facility Application Form
- Generation Facility Application Form

These forms can be downloaded from EirGrid's website. Guidance notes on completing the EirGrid application forms are provided in Appendix G of this Guide.

If a developer wishes to avoid group processing and believes that grid connection of the generation scheme is in the public interest then the developer should request the application be referred to the CER for consideration under sequential processing. Arguments to support this assertion should be included in the cover letter accompanying the application. It is typical for arguments to focus on the progression of the three pillars of energy policy; security of supply, competitiveness and the environment.

All applications, once checked by the system operators and deemed complete, will be included in the '*Connection Offers Disclosure of Applicants*' list published on the EirGrid website. The published information from the application form includes:

- Project name
- Company name
- Contact name
- Contact telephone number
- Contact email address
- Location and co-ordinates
- MEC

4.3 Application fees

Developers are charged an application fee that covers the cost of processing a connection offer. The fee is dependent upon the size (MEC) of the applicant's development and whether shallow connection works are involved in order to accommodate the capacity required. See Section 5.1.1 for a description of shallow assets.

4.3.1 ESB Networks application fees

All generators are liable to pay an application fee prior to processing either as part of the group processing or as part of sequential processing. Generators in the sequential process will be invoiced for the fee once they have been approved by the CER for processing. For generators being processed within group processing, practice to date has been that they have been invoiced for fees once they have been deemed to be eligible for inclusion within a gate, or as otherwise directed by the CER. This new approach overrides the statement on the NC5 form online since 2007. The application fees shown in Table 4-1 are for 2008. These costs are updated yearly by the Consumer Price Index (CPI).

Table 4-1: ESB Networks connection application charges for generators connecting to the distribution network (2008)

MEC	Application Fee (excluding VAT)	
	(Shallow works required)	(No shallow works required)
No export	no fee	no fee
0 ≤ 11 kVA (microgeneration)	€0	€0
> 11 ≤ 50 kVA	€789	€789
> 50 kVA ≤ 500 kVA	€1,611	€1,642
> 500kVA ≤ 4 MW	€9,145	€8,805
> 4 ≤ 10 MW	€28,211	€23,642
> 10 ≤ 30 MW	€54,642	€33,758
> 30 ≤ 50 MW	€63,676	€37,846
> 50 ≤ 100 MW	€76,367	€40,807
> 100 MW	€89,389	€44,348

4.3.2 EirGrid application fees

The 2008 application fees for transmission connections are detailed in Table 4-2. A first instalment of €7,000 (including VAT) must accompany the application form. The remainder will be invoiced prior to work starting on processing the application.

Table 4-2: EirGrid connection application charges for generators connecting to the transmission system (2008)

MEC	Application Fee (excluding VAT)	
	Shallow works required	No shallow works required
≤ 4 MW	€31,265	€13,171
> 4 ≤ 20 MW	€62,413	€30,543
> 20 ≤ 100 MW	€80,437	€43,869
>100 MW	€88,533	€46,986

4.3.3 Modification and reassignment fees

Developers may request a modification of the connection offer after the initial connection offer has been accepted. For modifications of a minor nature the system operator's fee will be calculated on an individual basis.

For more substantial modifications that essentially require the complete reprocessing of a new connection offer, the standard application fee will apply.

The system operators will also charge a fee for the re-assignment of a connection agreement to a different legal entity, change in company name or share take over as shown in Table 4-3 . Further details of this fee can be found on the CER Decision Paper on LCTA, Rebates and Fees [45] and Proposals on Distribution Connection Policy and Charges [46].

Table 4-3: Fees to modify an ESB Networks connection offer

Re-assignment to different legal entity	€ 1,000 excl vat
Change of company name or share take over	€ 200 excl vat

The developer is not permitted to reduce the MEC once processing of the application has commenced. However after the connection offer has been accepted and initial payment received a request to reduce MEC may be made. Depending on circumstances the developer may be liable for the original costs in the connection offer despite the request for a reduced MEC.

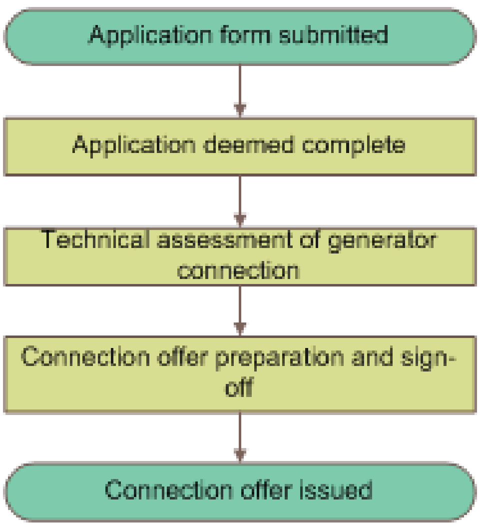
4.4 Connection process for on-site generators that require no export capacity

This section describes the connection offer process for applicants requesting the direct connection of an on-site generator to the network with no requirement for export capacity. Under most circumstances, this type of connection will not require any new ESB Network assets. However it is still imperative that developers apply to the relevant system operator as any generator connecting to the network can have implications for the safe and secure operation of the system.

Demand sites with an existing connection seeking to install on-site generation should only require a modification to their connection agreement; however a completed connection application form should be submitted to the system operator. If the site does not have an existing connection, the generator connection application can be made along with an application for a demand connection.

Following the connection application being deemed complete, ESB Networks will issue a new connection agreement within 30 business days (assuming no additional ESB Network assets are required). EirGrid will typically take 70 business days to issue a new connection agreement.

Figure 4-2: Connection process for on-site generators that require no export capacity



4.4.1 Applications deemed complete

After the system operator receives the application form it typically takes 10 business days for the form to be checked and acknowledged as complete in writing. If the form is incomplete or there is a discrepancy in the information provided, the system operator will request further information. Once the system operator is satisfied that all the necessary information has been provided, the application is 'deemed complete' and is assigned a reference number. Providing clarification or additional information to the relevant system operator can involve a number of cycles of correspondence between the developer and the system operator, which can, in turn, result in a delay in the application being deemed complete.

4.4.2 Technical assessment of generator connection

As noted earlier in this section, on-site generators with no requirement for export still have the potential to affect the safe operation of an electricity network, particularly during fault conditions. For connection to the distribution network, ESB Networks require mandatory interface protection requirements (known as G10 interface requirements) with which the installation must comply. Operation of this protection must be witnessed by ESB networks or EirGrid as appropriate.

4.4.3 Offer validity

A connection offer for both transmission and distribution connections in respect of generators that do not require export capacity will typically be valid for 70 business days from the date of issue. The full list of conditions to be satisfied in order to execute the connection agreement will be set out in the connection offer letter. It is recommended that these should be carefully checked upon receipt. See Section 4.7 for guidance on reviewing the connection offer.

4.5 Connection offer process for generators within the group processing approach

To manage the large number of connection applications from renewable generators, the CER introduced the group processing approach in December 2004. The group processing approach effectively replaces the sequential connection offer process for renewable generators with a MEC greater than 500 kW (subject to a few exceptions as discussed in the introduction to this chapter). The group processing approach is aimed at bringing about efficient connection solutions for a large number of applications and to ensure optimum network development, minimising network costs in the long run and, where ever possible, avoidance of bottlenecks on the network.

Figure 4-3: terms commonly used in the group processing approach

Gate: Renewable generator applications deemed complete and meeting the pre-defined criteria will be included in a particular gate and will be considered in the group study.

Transmission Group: Generators in a given geographical area that share or drive common transmission deep reinforcements

Transmission Sub-group: Generators who ultimately connect to the same 110kV node

Distribution Group: Generators who share or drive common distribution deep reinforcements

Distribution Sub-group: Generators who share common distribution shallow works

Generally, shallow works can be though of as works associated with connecting the generator to the existing network. Deep works can be considered as the reinforcement of the existing distribution or transmission infrastructure or new network assets to accommodate the generator.

Group processing involves connection applications being processed simultaneously in batches know as gates. A set of criteria is used to decide on the applications that are eligible for each gate. Generally the eligible applications are then broken into groups depending on their geographical location and level of interaction. The groups are then further broken into subgroups based upon the connections that share the same connection assets. The generation projects in each group are then processed by the system operators in unison. The connection method is designed by the system operators to efficiently connect all the generators in the group and subgroups in accordance with the system planning criteria. The connection charge is based on the Least Cost Technically Acceptable (LCTA) principle for the sub-group and not necessarily each individual project. The CER has issued a Proposed Direction for Criteria for Gate 3 Renewable Generation Connection Offers [42] that contains further information on how group processing is likely to be implemented for Gate 3.

The basic steps involved in the connection offer process for generators within group processing are illustrated in Figure 4-4.

The overall group processing concept is outlined in the Joint TSO/DSO paper Group Processing Approach for Renewable Generators [42]

1. All renewable generator applications which satisfy criteria specified by CER are processed in one batch, know as a gate.

2. Based on their level of interaction and geographic location, the applications within the gate are divided into specific groups by the TSO and DSO for processing purposes.

3. Within each group there can be subgroups of applications.

4. The system operators will study the groups from a load-flow impact and short circuit impact perspective and the appropriate network reinforcements for each group will be determined based on these studies.

5. The system operators will identify the shallow (i.e. direct) connection method and associated deep reinforcements for each individual application within the group/subgroup. The system operators will determine the most appropriate shallow connection method, irrespective of whether the original application form was submitted to TSO or DSO. This may result in TSO applications becoming DSO connection offers and vice versa.

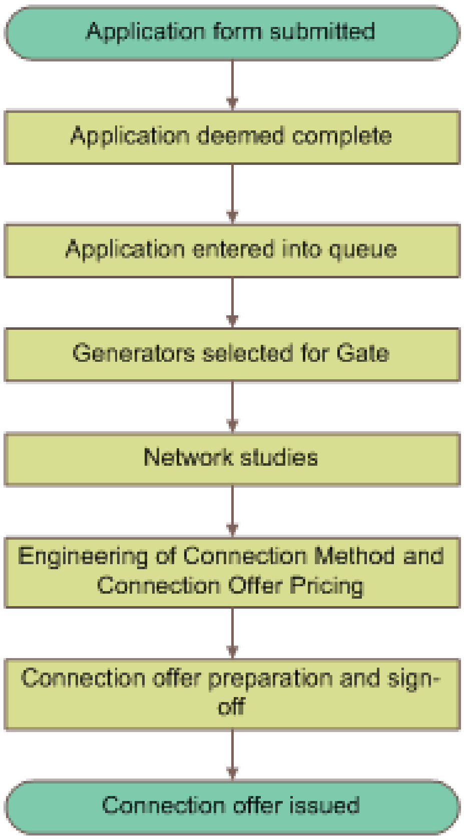
6. The relevant system operator will issue the connection offers to the individual applicants within the group/subgroup.

7. Offers will remain valid for a fixed, specified period of time irrespective of whether other applicants in the same group/subgroup accept their connection offers or not.

8. The connection charge will be largely independent of offer uptake. However, in the event of a major change in shared connection design (for example as a result of inability to obtain planning permission or extremely low offer acceptance, applicants request for reduced MEC etc.) the connection method and shared connection charge may vary from the initial offer.

The time period between initial application and receiving a connection offer under the group processing approach cannot be clearly defined. Once the connection application is deemed complete it is entered into the connection queue. It waits in the connection queue until it is chosen to be included in a gate. Each gate has its own CER approved selection and processing rules. Due to the large number of applications in the queue for connection under the group processing the timeline to receive a connection offer can be in years rather than months.

Figure 4-4: Group processing approach



4.5.1 Application deemed complete

After the system operator receives the application form it typically takes 10 business days for the form to be checked and acknowledged as complete in writing. If the form is incomplete or there is a discrepancy in the information provided, the system operator will request further information. Once the system operator is satisfied that all the necessary information has been provided, the application is 'deemed complete' and is assigned a reference number. Providing clarification or additional information to the relevant system operator can involve a number of cycles of correspondence between the developer and the system operator, which can, in turn, result in a delay in the application being deemed complete. An applicant cannot progress onto the queue until the application is deemed complete.

4.5.2 Generators selected for inclusion in a gate

Generation schemes are selected for inclusion in the next gate from the applications in the connection queue. The CER may specify a drop-dead date after which applications will not be considered for inclusion in the gate. The CER will consult on the criteria that will be used for the selection of applications. Based on the agreed criteria the system operators may have to perform some technical studies to determine the list of applicants to be included in the gate.

To-date, the system operators have processed two gates details of which are set out in

Table 4-4. For Gate 1, the sole criterion was the chronological sequence of submission of the connection application. Gate 2 was based on a complex set of criteria including date of application, extensions, and system optimisation. Gate 3 is likely to be selected on the basis of chronological sequence of the connection applications. The CER has issued a Proposed Direction for Criteria for Gate 3 Renewable Generation Connection Offers [42] that contains further information on Gate 3.

Table 4-4: Gate 1, 2 and 3

Gate	Size of Gate	Criteria set	All connection offers issued by
Gate 1	373 MW (34 applications)	2004	2005
Gate 2	1,321 MW (121 applicants)	2006	2008
Gate 3	3,000 (151 applicants) MW (proposed)	2008	2010 (proposed)

As part of the selection process, the system operators allocate each successful applicant to a group based on geographical location and the level of electrical interaction with the other members of the group. The CER will publish a schedule of the applicants that are in each group and an indicative timeframe for the issuing of the connection offers. At this stage, applicants will also be allocated into a subgroup if they share a connection method or connection assets with other applicants. It should be noted that the actual members of each subgroup and the connection methods are only finalised during the detailed network study phase, which occurs later in the process.

4.5.3 Network studies

Once the list of generators has been selected for the relevant gate and the groups allocated, the first task for the system operators is to complete network studies to determine the connection method for each generator. Generators that are part of a subgroup are studied together to determine the optimum connection method for the entire subgroup. The studies analyse how the networks will behave under different loading conditions or in the event of particular faults. Due to the complexity of the networks and the amount of data involved, system studies are invariably carried out using specialised computer software packages known as 'load flow software'. Specific criteria examined include voltage rise/dip, conductor capacity, transformer capacity, conductor losses and loss of feeders. Fault level and dynamic studies are also carried out as part of the technical analysis.

Based on these studies the system operator will arrive at a connection method which complies with the relevant standards most notably the system planning criteria [20] and [39]. The system operator may arrive at several feasible connection methods but will only make a connection offer based on one of these methods.

EirGrid completes wider system studies to identify the transmission reinforcement that are required to accommodate all the generators that are in each group onto the system. The level of transmission reinforcements will mainly depend on the size of the group and the amount of available capacity in both the local and wider transmission system. Further information on the approach to network studies for Gate 3 can be found on the CER website.

EirGrid will also complete a constraint study to analyse the potential level of constraints until the identified transmission reinforcements are complete. The constraint report will be issued around the same time as the connection offer. See Appendix B for more information on constraints.

4.5.4 Engineering of connection

After the network studies have been completed and the appropriate connection method determined, the feasibility of constructing the connection assets is examined. This may involve a site visit to consider issues such as potential line routes and the ability to connect lines into existing substations. This will often take into account practical requirements such as a cable rather than overhead connection in an urban setting or the need for additional works in an existing substation. For example a substation may require to be physically extended with purchase of addition land to accommodate a busbar extension. The outcome of this review may result in an alternative connection method becoming the LCTA.

At this stage, developers that are connecting to the transmission system are invited to a connection method meeting. As well as providing indicative information on the connection method, the connection method meeting is used to consider the option of a connection offer based on the developer constructing all or part of the connection on their own. This is known as 'contestability' and is considered further in Appendix E. The contestable option is currently not available for distribution connections.

4.5.5 Connection offer pricing

The connection method is priced according to the CER approved connection pricing policy. The pricing policy for Gate 2 was published in the CER Joint TSO/ DSO Group Processing Approach Pricing Principles Guidelines [43] . For a description of the generic pricing methodology see Section 5.

4.5.6 Connection offer preparation and sign-off

The final step in the connection offer process is to formulate all the technical and commercial information into the connection offer letter. This is signed-off by the system operator for issuance to the generator developer.

4.5.7 Offer validity

The connection offers under the group processing approach are generally valid for 50 business days from the date of issue. Acceptance of the connection offer requires:

- Signature of Connection Agreement
- Initial payment of approximately 10%
- Capacity bond of €10,000 per MW
- Power quality report where requested
- Firm or non firm acceptance (if requested)
- Declaration of independence (if requested)

If a constraint report is issued later than the connection offer, the expiry date of that connection offer may be extended. It should be noted that, under the group processing, developers have 25 business days from the date of issuance of the connection offer and the constraint report, whichever is later, to dispute the connection offer to the CER. Before submitting a dispute to the CER the developer must engage with ESB to clarify and if possible resolve the issue.

See Section 4.7 for guidance on reviewing the connection offer.

4.6 Sequential connection offer process

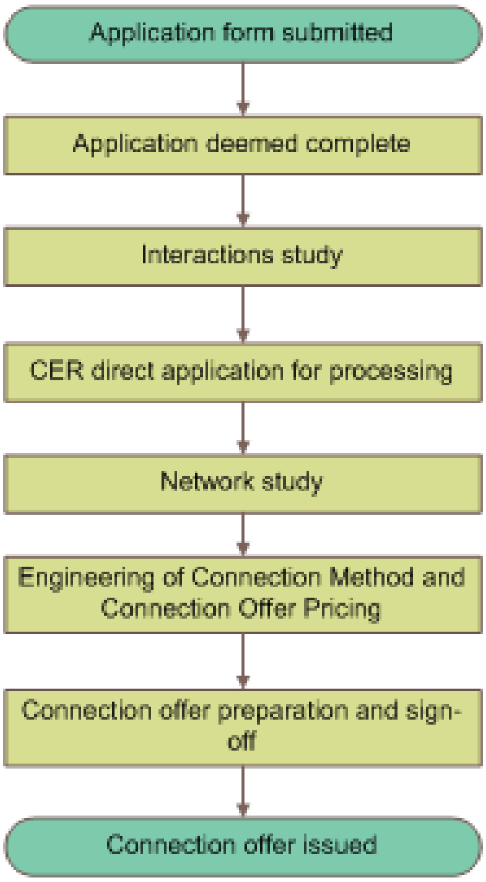
The sequential connection offer process describes the approach for processing applications on a sequential basis, that is to say that the connection method will be designed for the individual generator scheme covered by the application in question.

As noted in the introduction to this section, the following types of generator are eligible to be handled under the sequential connection offer process:

- Non-renewable generators of all sizes
- All renewable generators that have a MEC of less than or equal to 500 kW that the CER approve to be in the sequential process. In determining this CER are likely to consider factors such as the level of interaction that the generator has with other projects and the public good benefit of the generator
- Generators greater than or equal to 500 kW that the CER have deemed to be outside of the group processing for reasons of public interest

The basic steps in the normal connection offer process are illustrated in Figure 4-5. Both ESB Networks and EirGrid follow the same basic steps. Any variances between the processes used by the system operators are highlighted below.

Figure 4-5: Sequential connection offer process



It takes approximately 90 business days for the system operators to process the applications after the CER has given approval to proceed. It is advisable for the developer to discuss the timescales for the connection offer process with the system operator at the application stage. In circumstances that the system operators deem the connection as 'complex' the timescale for processing the application can take longer than 90 business days.

This sub-section provides an outline of the typical process that the system operators follow for issuing connection offers under the sequential connection offer process. However, this process can vary from application to application depending upon factors such as the MEC, generator technology, the area of the network and the level of interaction with other applications. The concept of interaction is considered in Section 4.6.2 below.

4.6.1 Applications deemed complete

After the system operator receives the application form it typically takes 10 business days for the form to be checked and acknowledged as complete in writing. If the form is incomplete or there is a discrepancy in the information provided, the system operator will request further information. Once the system operator is satisfied that all the necessary information has been provided, the application is 'deemed complete' and is assigned a reference number. Providing clarification or additional information to the relevant system operator can involve a number of cycles of correspondence between the developer and the system operator, which can, in turn, result in a delay in the application being deemed complete.

4.6.2 CER approve application for processing

Applications that are eligible for processing outside of group processing are considered on a case-by-case basis with all applications being referred to the CER for a ruling. In making a decision, the CER will take into consideration the information provided by the system operators on the impact of the generator scheme on other generators in the queue for connection. This is known as 'interaction', which, as a result of the increasing scarcity of available grid capacity and the deluge of renewable generation connection applications, has become a critical factor in the allocation of network capacity to individual projects.

The level of interaction between applications depends on many factors including:

- the number and size of generator applications in the area
- generation already connected in the area
- the available capacity in the local distribution and transmission network for more generation

The CER may also consider other factors such as the public good of the generator in making their decision as to what process it should be handled in.

It should be noted that there is no defined timeframe for the CER to issue an instruction to the system operators to proceed with processing the application using the sequential connection offer process.

4.6.3 Network study

Once the CER has authorised the application to be processed under the sequential approach, the first task for the system operators is to complete network studies to determine the connection method. The studies analyse how the network will behave under different loading conditions or in the event of particular foreseeable faults. Due to the complexity of the network and the amount of data involved, system studies are invariably carried out using specialised computer software packages collectively known as 'load flow software'. Specific criteria examined include voltage rise, conductor capacity, transformer capacity, conductor losses and loss of feeder. Fault level and dynamic studies are also carried out as part of this technical analysis.

Based on these studies, the system operator will determine a connection method which complies with the relevant standards most notably the distribution [20] and transmission [39] planning criteria. The system operator may arrive at several feasible connection methods but will only make a connection offer based on one of these methods. The connection charge will always be made on the basis of the 'Least Cost Technically Acceptable' (LCTA) shallow connection method, even where the system operator will connect the customer using a different connection method. For example, the LCTA connection method for a new generator may be a tail-fed station; however the system operator may choose, for overall system cost reasons, to loop-in the station. In this instance, the connection charge would still be based on the tail-fed method.

The transmission system operator also completes wider system studies to identify the transmission reinforcement that are required to accommodate the generator scheme. These studies are completed for all transmission applicants and for larger distribution applicants as deemed appropriate by the system operators.

See Appendix A for more information on the effect of generators on networks.

4.6.4 Engineering of connection method

After the network studies have been completed and the appropriate connection method determined, the feasibility of constructing the connection assets is examined. This usually involves a site visit to consider issues such as potential line routes and the ability to connect lines into existing substations. This will often take into account practical requirements such as a cable rather than overhead connection in an urban setting or the need for additional works in an existing substation.

At this stage, developers that are connecting to the transmission system are invited to a connection method meeting. As well as providing indicative information on the connection method, the connection method meeting is used to consider the option of an offer based on the developer constructing all or part of the connection on their own. This is known as 'contestability' and is considered further in Appendix E.

4.6.5 Connection offer pricing

The connection method is priced according to the CER approved connection pricing policy. Both system operators use standard pricing models where the prices for connection elements have been calculated based on recent experience from constructing network assets. The CER publish the standard prices [46] for distribution connections on their website.

At this stage the distribution loss adjustment factors (see Section 5.2) and the operational and maintenance charges are also calculated.

See Section 5 for further information on connection pricing policy and charges.

4.6.6 Connection offer preparation validity

The final step in the connection offer process is to formulate all the technical and commercial information into the connection offer letter. This is then signed-off by the system operator for issue to the generator developer.

4.6.7 Offer validity

Connection offers issued in the sequential process will typically be valid for 70 business days from the date of issue or from the issue of a constraint report if applicable. The connection offer will contain details of the precise validity period.

Acceptance of a connection offer requires:

- the connection agreement to be signed
- Initial payment of approximately 10% (there may be a single payment if the offer charge is small)
- Capacity bond of €10,000 per MW if requested
- Power quality report where requested
- Firm or non firm acceptance (if requested)
- Declaration of independence (if requested)

The full list of conditions to be satisfied in order to execute the connection agreement will be set out in the connection offer letter; it is recommended that these should be carefully checked upon receipt. Design and construction will not proceed until all the developer has demonstrated compliance with all requested conditions.

4.7 Reviewing the connection offer

At the end of the connection offer process the system operators will issue a connection offer letter, a connection agreement and a general conditions document. If there is an existing connection agreement in place for the project in question, the previous offer is rescinded and replaced by a new offer.

The connection agreement and the general conditions set out the terms and conditions under which the system operator will provide a connection to their system. More specifically, it specifies the rights and obligations of each party relating to the installation, use and operation of the connection. The connection offer letter will include specific details of the connection including the connection method, costs and timescales.

ESB Network's general conditions are available on their website under the title General Conditions for Connection of Industrial and Commercial Customers and Generators to the Distribution System [12]. The standard transmission connection agreement [29] and general conditions [30] are also available on EirGrid's website.

It is very important for the developer to carefully review all the connection offer documents before executing the agreement. The following key issues should be considered when reviewing the connection offer:

- the MEC and MIC levels
- requirements to execute the agreement including the initial connection charge and capacity bond
- connection method
- scheduled timelines
- connection charges
- pass through costs including wayleaves and civil costs
- list of assumptions
- use of system charges including operational and maintenance charges
- technical requirements such as soft start and power factor
- list of transmission deep reinforcement and constraints if applicable

If the developer is unclear on any of these areas then a query should initially be sent, in writing or via email, to the system operator requesting clarification. If necessary the developer should also seek technical and/or legal advice on the connection agreement documents.

The developer also has the right to dispute the connection offer under the Electricity Regulations Act, 1999. Disputes may relate to the terms of a connection offer, the charges proposed or other matters relating to the connection. All disputes should be referred to the CER in writing for resolution. A dispute letter should clearly demonstrate that there is a material matter in dispute and that reasonable efforts have been made to engage with the system operator on these disputed issues. Further information on the dispute process is available on the CER website.

4.8 Further information

Further information on the connection processing for connecting a generator to the distribution system can be found on ESB Networks website under 'Generation Connections'.

Information on the connection process for the transmission system can be found on EirGrid's website under 'Customer/Connection Offer Process'.

Appendix I provides a list of useful documents on the connection offer process including the CER's directions relating to the Group Processing Approach.

5 Connection and operational costs

When a developer submits a connection application, ESB Networks or EirGrid are obliged to offer terms for providing a connection for the proposed generation scheme. These terms will include charges to the developer, to cover the system operators' costs in providing the connection. The aim of this chapter is to describe the main components of these costs and the basis on which these costs are charged to the generator. Some of the ongoing charges which the generator may have to pay after the connection to the system operator's network is completed are also outlined.

5.1 Connection costs

5.1.1 Connection method and charging principles

The following paragraphs set out the principles that system operators follow in developing methods of connection for generation projects.

Least cost technically acceptable principle

When considering the method of connection for a generator, or a group of generators, the system operators will often consider more than one connection option. To determine the most appropriate connection method the system operators apply the Least Cost Technically Acceptable (LCTA) principle. LCTA evaluates a connection option in light of the technical standards against which the system is planned and operated and then, assuming those standards are met, considers the capital cost of the equipment required to facilitate the connection of the generator or a group of generators. In the case of a sub-group of generators being processed at the same time, the LCTA principle applies to the entire sub-group of generators, not an individual applicant.

The system operator may specify a connection method which deviates from a strict application of the LCTA principle; however, this can be justified in light of the system operator's broader duty to ensure wider long-term system development and future capacity for connections. In the event of the system operator pursuing such a 'non-LCTA' connection method, the applicant would only be liable for a charge based on the LCTA cost.

If a generator decides to request a connection method that deviates from the LCTA solution, but would still be technically acceptable and consistent with the long term development of the system, the generator must also pay for the difference between the LCTA and the as-built cost. For example, if the LCTA for the connection is an overhead line and the applicant decides to use an underground cable then the applicant pays for the incremental cost associated with the cable.

The extent to which an applicant is liable for the cost of assets required to bring about a connection for its generation projects may be influenced by whether

- the system operator considers those assets to be shallow or deep reinforcement assets
- the required assets can be shared with one or more other generation projects.

Shallow and deep reinforcement assets

A generation project's connection provides an electrical path into the existing network. The connection assets start at the point of connection with the generator's installation and ends at the system operator's network. The work required to provide this path can be broken down into two categories.

Firstly, new infrastructure must be installed in order to provide an extension from the existing network to the generator's site. This infrastructure is known as the **shallow connection assets**. The extent to which an applicant is liable for the cost of shallow connection assets will be influenced by the number of other projects that are to make use of them.

Secondly, if reinforcement of the existing distribution or transmission infrastructure or new network assets are necessary in order to accommodate the planned generation capacity, then this infrastructure is known as **deep reinforcement assets**. The extent to which an applicant bears the cost of deep reinforcement assets will vary depending upon, in part, whether the connection will be to the distribution system or the transmission system, see Table 5-1.

Dedicated connection asset: When a connection asset is required for a single generator, it is referred to as a dedicated connection asset and the generator will pay 100% of the associated cost.

Shared connection asset: When a connection asset is required that will be shared with one or more other generators, each generator will pay a connection charge based on a pro-rata share of the associated cost on a € per MW basis. For example, if three connecting parties with Maximum Export Capacities (MEC) of 4 MW, 4 MW and 2 MW are sharing connection assets they will pay for 40%, 40% and 20% of the cost of the assets, respectively.

Further details on pricing principle guidelines can be found in the Joint TSO/DSO Group Processing Approach, Pricing Principles Guidelines [43] document available on the CER's website, however the key guiding principles are set out in Table 5-1 below.

Table 5-1: System operators charging policy for shallow and deep assets

Costs	Distribution System Charging Policy	Transmission System Charging Policy
Shallow connection asset	100%	100%
Deep reinforcements	100%	0%

The principles of connection charging are considered in more detail in the following sub-sections.

5.1.2 Connection to the distribution system

Generators connecting to the distribution system are charged 100% for both the shallow connection assets and any associated distribution deep reinforcement. If any of the shallow connection assets or deep reinforcement assets are shared with other generators then the cost is shared on a per MW basis.

Ordinarily, the connection of a generation project to the distribution system would not impact upon the transmission system; however, there has, in recent years, been a proliferation of distribution connected generation. In certain circumstances, the extent of this generation has been sufficient to exceed connected demand in the area resulting in the reversal of the flow of power at the point of connection between the distribution system and the transmission system. In this scenario, it is possible for distribution connected generation to provoke the need for reinforcement of the transmission system. As well as changing power flows the impact of new generation on voltage, short circuit and dynamic stability on the transmission system can trigger deep reinforcements. Similar to transmission connected generators, distribution generators are not charged for any transmission deep reinforcements that are triggered by the connection.

ESB Networks publish standard costs for the common connection assets required to connect a generator. These costs [46] are approved by the CER and are regularly updated and published on CER's website.

When connecting a generator to the distribution system the generator should consider the following costs:

- **Shallow connection cost:** The shallow connection assets depend on the connection method determined by ESB Networks during the connection offer process. It could include items such as upgrades of existing assets and new assets in an existing substation, a length of overhead line or cable and onsite metering. For large generators or groups of generators processed a new 110 kV or 38 kV substation may be required.
- **Distribution deep reinforcements:** These can be identified only after ESB Networks has completed its detailed studies during the connection offer process. Deep reinforcements could include overhead line upgrades, new overhead lines or the installation of devices such as voltage regulators.
- **Pass through costs:** The generator connection offer will afford ESB Networks the right to pass though certain additional costs. These include but are not limited to:
  - Costs associated with the serving and enforcement of consents such as wayleave or easement
  - Cost for civil works at ESB substations and civil works and road opening licences for cables
  - Forestry compensation

  The potential for pass through costs to arise should be considered when reviewing a connection offer as they can substantially increase costs.

- **Internal network requirements:** Consideration should also be given to the costs associated with electrical infrastructure on the generator's side of the point of supply.
- **Distribution Code compliance costs:** Consideration should be given to the cost of any additional electrical or communication equipment that may be required to ensure the generator complies with the ESB Network's Distribution Code [21].

A worked example of distribution connection charges is set out in Figure 5-1 below.

Figure 5-1: Example of distribution connection costs

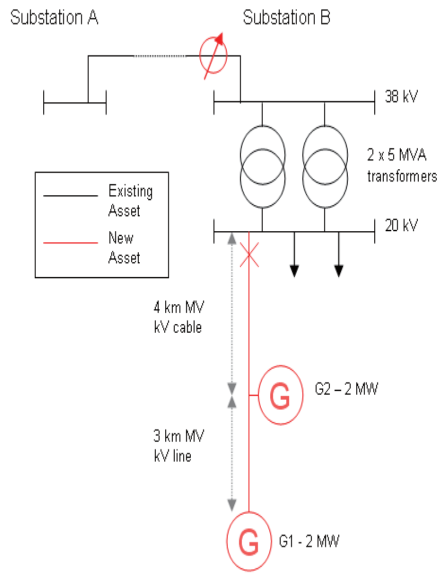
Example: Generator connecting to the Distribution System

Two Generators, G1 and G2 are going to connect into an existing 38/20 kV substation, substation B.

The shallow connection includes a new shared MV cubicle in substation B, 4 km of MV cable shared between both generators and 3 km of dedicated MV kV overhead line to G1. MV metering and ESB Networks communication equipment are also required for both generators.

Connection studies have shown that a voltage regulator is required as a deep reinforcement between substation B and A.

The connection cost for G1 is shown in the Table 5-2. For the shared assets, G1's contribution is calculated based on:



$$\frac{G1}{G1 + G2}\% = \frac{2\ MW}{2\ MW + 2\ MW}\% = 50\%$$

Table 5-2: Connection Cost for Example Generator

Connection Asset	Cost	G1 % Share	G1 Cost
Voltage Regulator	€190,000	50%	€95,000
MV Cubicle in 38 kV Substation B	€55,400[1]	50%	€27,700
4 km of MV cable	€221,600[1]	50%	€110,800
3 km of MV overhead line	€149,580[1]	100%	€149,580
MV Meter <10 MW	€27,700[1]	100%	€27,700
ESB Communication Equipment including recloser	€16,417[1]	100%	€16,417
Total			€427,197

1 - Cost from ESB Network 'Standard Prices for Generator 2008'

For this connection the generator would also have to consider the following pass through and additional costs such as:

- Wayleaves and easement for the overhead line and cable
- Civil works for the cable. These are normally carried out by the developer

5.1.3 Connection to the transmission system

The charging policy for connection to the transmission system is commonly referred to as 'shallow' charging. This is because generators pay for 100% of the dedicated 'shallow' connection assets but pay 0% towards any 'deep' transmission reinforcements that may be required as a result of the connection. In instances where a generator is sharing a shallow connection asset with other generators then the cost of the associated assets will be shared on a per MW basis.

Where a generator connects into an existing transmission substation, they will be charged, in addition to the cost of the dedicated connection assets, for a proportion of the substation common costs. This cost is a contribution towards what is referred to as 'common equipment', which includes; busbars, couplers, control building and site and civil costs.

Generators connecting to the transmission system have the right to construct, or arrange to have constructed, the shallow connection to the transmission system rather than contract with EirGrid to construct these assets. This is referred to as contestability. The rules associated with contestability are described in Appendix E.

EirGrid currently do not publish standard costs for transmission connection. Therefore it is recommended that for information on the cost of transmission connections, EirGrid's Customer Relations Team should be contacted.

When connecting a generator to the transmission system the generator should consider the following costs:

- **Shallow connection cost:** The amount and type of shallow connection assets required will depend on the connection method determined by EirGrid during the connection offer process. It could include items such as new assets in an existing substation, a new substation, a length of overhead line or underground cable and a terminal substation on the customer's premises.
- **Pass through costs:** The connection offer will afford EirGrid the right to pass though certain additional costs. These include:
  - Costs associated with the serving and enforcement of consents such as wayleave or easement
  - Cost for civil works at an ESB substation and civil works for cables
  - Forestry compensation

  The potential for pass through costs to arise should be considered when reviewing a connection offer.
- **Internal network requirements**: Consideration should also be given to the costs associated with electrical infrastructure on the generator's side of the point of supply. For a transmission connection the cost of equipment, such as a grid step up transformer (e.g. a 110/20 kV transformer), can be substantial.
- **Grid code compliance costs:** Consideration should be given to the cost of any additional electrical or communication equipment that may be required to ensure the generator complies with the Grid Code. The issue of grid code compliance is considered in further detail in Appendix A.

Further information on the charging policy for transmission connections, including connection cost allocation examples, is outlined in the Asset Cost: Guiding Principles [41] document on EirGrid's website.

5.1.4 Schedule of payments

Each offer of terms for connection will include a schedule of payments to be made to the relevant system operator. Each payment is scheduled to ensure that the system operator is kept cash positive throughout the construction programme. Payment of the full connection charge is usually a condition of the system operator before allowing the connection to be energised.

The typical payment schedule for a distribution connection is described in Table 5-3 below.

Table 5-3: Distribution connections payment schedule

Payment due	Portion
On offer acceptance	10% of connection charges
Prior to ESB construction/at the Consents Issue Date	55% of connection charges and any known pass-through costs
1 calendar month before operational date	35% of connection charges and any additional pass-through costs

The 10% initial payment at offer acceptance is non-refundable except in the case where the ESB or developer fails to obtain planning permission. In this instance a refund will be made less the expenses incurred by the system operator.

It should be noted that the costs at the second payment stage can be substantially different from the connection offer due to issues such as planning complications, wayleaves or client requested changes.

5.1.5 Connection bonds

Generators are required to provide financial security to the relevant system operator in the form of bonds as part of the generator connection agreement. ESB and EirGrid have a standard format of bond agreement and it is general practice that the bank is not entitled to modify this format. For a copy of the standard format of the bond contact dsogenerators@esb.ie or info@eirgrid.com. In light of the limited validity period during which an offer is open for acceptance, it is advisable for developer to consult with their bank on the format of the bonds promptly after the connection offer is issued.

Table 5-4 shows the bonds that are required for distribution and transmission connections.

Table 5-4: Bonds for transmission and distribution connections

Type of Bond	Distribution connection	Transmission connection
Capacity Bond	✓	✓
Decommissioning and Reinstatement Bond	x	✓
Connection Charges Bond	x	✓

Capacity bond

The capacity bond is intended to reflect the future value of network capacity and to also provide a disincentive to the hoarding of network capacity by generation project developers. Capacity bonds are calculated on the basis of €10,000 per MW based on the MEC, specified in MW, in the connection agreement.

The full bond amount is released back to the developer on the condition that the maximum capacity of the connected generation plant reaches 90% of the agreed MEC within 1 year of energisation. The capacity bond will be drawn down on a pro-rata basis if the 90% threshold is not reached.

For example, if a generator has a MEC of 10 MW then a capacity bond of €100,000 is required when accepting the connection agreement. If a year after the energisation of the connection, the developer has only installed 7 MW of generation plant then €30,000 of the bond will be drawn down. If the developer after accepting an offer requests and is granted a reduced MEC the capacity bond remains in place based on the original MEC. Hence an element of the capacity bond will be liable to be drawn down despite the developer achieving 90% export of the new MEC.

It should be noted that the capacity bond is non-refundable if the generator project does not receive planning permission.

Capacity bonds are not requested where there is no additional materials or construction work required. This can arise in the case of an extension to an existing project

Connection charges bond (transmission connections only)
Generators will pay approximately 10% of the connection cost as part of accepting the connection offer and approximately a further 60% at the consents issue date. The connection charges bond is required as financial security for the remaining 30% of the connection charge. EirGrid will draw down from the connection charges bond in the event that the generation project can not proceed to connect and EirGrid have incurred costs during construction which are not covered by the connection charge payments made by the generator.

Decommissioning and reinstatement bond (transmission connections only)
At the end of the lifetime of the connection there is a cost to the relevant system operator associated with removing their connection assets and restoring the site to its former condition. The decommissioning and reinstatement bond is intended to ensure that the disconnecting generator covers the cost of these works. This bond is held by the relevant system operator for the lifetime of the connection agreement, which is typically 20 years. Unlike the capacity bond and connection charges bond, the decommissioning and reinstatement bond is not required at the execution of the connection offer; rather it must be paid prior to energisation of connection.

5.1.6 Rebates

Generators will receive a rebate if another party connects to the network using assets that had been previously paid for as shared or dedicated connection assets within ten years of the energisation date of the original connection. The principal of rebate is based on a per MW share similar to the shared costs at connection offer stage.

Further information on the rebate policy can be found in the Joint TSO/DSO Group Processing Approach, Pricing Principles Guidelines [43].

5.2 Operational costs

In addition to the initial capital cost for the connection, there are a number of network related ongoing charges levied by the relevant system operator to be considered.

Generators are also liable for an element of the costs associated with electrical losses from the network. All of these charges are covered in this section.

5.2.1 Ongoing charges

The following are network related ongoing costs that developers should be aware of:

- Operation and Maintenance (O&M) Charges
- Transmission Use of System (TUoS) Capacity Charges
- Demand charges

Table 5-5 sets out a summary of these charges and their respective drivers.

Table 5-5: Table of ongoing charges

Charge	Charged for:	Dependent on:	Distribution Connections	Transmission Connections
Operation and Maintenance Charge/Ongoing Service Charge	Operation and maintenance charges for shallow assets	Shallow connection assets	All	All
TUoS capacity payments	Operation and maintenance of the transmission system	MEC and location of generator	Generators with an MEC greater or equal to 10MW	Generators with an MEC greater or equal to 10MW
Demand charges	Electricity imported	Connection voltage and imported energy consumption	Embedded generators not liable for DUoS standing charges or capacity charge	All

Operation and maintenance charges

All generators connected to the distribution system are required to pay annual **operation and maintenance (O&M) charges** for the shallow connection assets. For transmission connections, the charge is known as the **on-going service charges**. These charges incorporate the cost of maintenance, rates, operation and indirect overheads attributed to maintaining the shallow connection assets.

The amount charged is dependent on the quantity of shallow connection assets associated with the generator (e.g. the length of line/cable installed and the extent of substation assets associated with the connection). In the case of shared connection assets, the O&M charges will be pro-rata shared on the basis of the respective MECs, specified in MW, in the relevant connection agreements.

The O&M charge for distribution connections is re-calculated annually based on charges published by ESB Networks. The Schedule of Operation and Maintenance Charges [22] document lists common types of distribution assets and the associated O&M charges.

The on-going service charge for transmission connections is calculated at the connection offer stage. This charge is recalculated annually in accordance with the Consumer Prices Index (CPI). It is also invoiced on an annual basis.

Transmission capacity charges

EirGrid publish an annual TUoS tariff to be paid by users of the transmission system. The TUoS tariff allows EirGrid to recover monies to cover the cost of operation, planning and development of the transmission system infrastructure. The TUoS tariff is calculated to recover 25% of the network related costs from generators, with the remaining 75% being recovered from demand customers. The specific TUoS tariff to be paid by generators is referred to as the **generator capacity charge**.

Generators with a connection agreement which includes a MEC that is greater than or equal to 10 MW are liable for Generator Capacity Charges. This charge is calculated individually for each generator based on the location of its connection to the system, using an analysis known as the 'Reverse MW mile' methodology. The aim of this charging methodology is provide a locational pricing signal to generators, which should in turn assist with the efficient use and development of the transmission system. A detailed explanation of this methodology can be found in EirGrid's Explanatory Paper for 2007 Statement of Charges [37].

A list of the latest capacity charges for each generator can be found in Schedule 1 of EirGrid's Statement of Charges 1st November to 30th of December 2008 [38].

For generators with non-firm access (see Appendix B on non-firm access) the capacity payment is charged based on a € per MWh basis rather than a € per MW of MEC charge. This alternative charging method is intended to ensure that generators receive a cost benefit for accepting interruptible access to the system.

Demand charges

There can be times when generators are not exporting electricity but are actually importing electricity to supply load onsite, such as, ancillary equipment. Similar to all demand customers, generators need to have a supply agreement for the imported electricity.

The CER has approved that ESB Networks establish a Distribution Use of System (DUoS) charging category specific to embedded generators connected to the distribution system. This also applies to exporting autoproducers, which is generally defined as a generator that produces electricity for use on-site. In practice, this will result in embedded generators not being liable for DUoS standing charges or capacity charges.

Generators should contact suppliers for up-to-date tariffs. A full list of electricity suppliers is available on the CER website.

Treatment of autoproducers and CHP

The EirGrid TUoS tariffs include a separate category for the charging of autoproducers, including all CHP generators. If autoproducers or CHP sites export electricity then their connection agreements would include provision for Maximum Import Capacity (MIC) and a MEC. To ensure that such users are not overcharged for using the transmission system, the CER issued a direction in 2002 [CER/02/07] [51] which ruled that autoproducers and CHP generators should pay network capacity charges as either a demand user or as a generator user, but not both. In practice, the generator is only charged for the higher of the MIC or MEC.

5.2.2 Treatment of losses

Electrical losses occur in the transportation of electricity along networks from generators to demand loads. The location of a generator on a network will heavily influence the extent to which it would have a positive or negative impact on system losses. To provide a financial signal to generators to connect in areas of the system that minimise losses, the metered output of the generator will be adjusted by a locational loss factor. The losses factor applied to the metered output associated with generation connected to the transmission system is known as the Transmission Loss Adjustment Factor (TLAF) and for generation connected to the distribution system it is known as the Distribution Loss Adjustment Factor (DLAF). The output of generators connected to the distribution system is adjusted by both a TLAF and DLAF. Table 5-6 summarises the characteristics of TLAF's and DLAF's.

Figure 5-2: Tradable energy

$$\text{Tradable Energy} = \text{Metered Energy} \times \text{DLAF} \times \text{TLAF}$$

Table 5-6: Table of losses factors

Factor	Accounting for:	Dependent on:	Distribution	Transmission
TLAF	Losses in the transmission system	Location of generator on the transmission system	All	All
DLAF	Losses in the distribution system	Voltage level that the generator is connected at and the extent of installed shallow connection assets	All	N/A

<u>Transmission loss adjustment factors (TLAF)</u>

Since the commencement in November 2007 of the single all-island market for electricity in Ireland and Northern Ireland, TLAFs have been calculated on an all-island basis. EirGrid and SONI jointly calculate site specific TLAFs for all transmission substations on the system. Each distribution connected generator will be allocated to the transmission substation that they are connected to under normal operating conditions. The loss factors are calculated annually by EirGrid and SONI and are approved by the CER and NIAUR. The TLAFs are calculated on load flow software by simulating the marginal impact of additional generation at each substation on the transmission system.

The average TLAF value across the whole transmission system is less than 1. However, the TLAFs at certain substations are greater than 1 because the output of the generator has the effect of reducing overall transmission losses. Generators should be aware that, when considering TLAFs for long term financial analysis, TLAFs are sensitive to changes to the installed system, connected demand and connected generation in any given area and are therefore potentially subject to year on year change.

Further information and the current list of TLAFs can be found on EirGrid's website.

<u>Distribution loss adjustment factors (DLAF)</u>

DLAFs are calculated on a site specific basis and are defined in the relevant connection agreement. Generators embedded in the distribution system will generally have a positive impact on overall system losses and will typically be subject to a DLAF greater than 1. A generator's specific DLAF value is dependent on the connection voltage and the extent of the installed shallow connection assets.

Figure 5-3: Distribution loss adjustment factors

Generator DLAF = Connection Voltage − Shallow Connection losses

The connection voltage DLAF is the starting point for calculation of a generator's DLAF. Table 5-7 below displays the current connection voltage values for 38kV, MV and LV. The Connection DLAF values are updated annually, but typically only change by small amounts year on year.

To calculate the generator specific DLAF, the losses factor value associated with the shallow connection is subtracted from the Connection Voltage DLAF. The shallow connection loss factor is calculated as part of the preparation of the connection offer. This value is mainly influenced by the MEC requested and the number and length of shallow connection assets, such as overhead lines, cables and transformers. Generation voltage DLAF values are normally greater than 1, which reflects the benefit of generation being located in close proximity to demand.
However in the case of a connection into a non-load substation, which is typically a new dedicated 110kV station, the Connection Voltage DLAF is 1 both for day and night. This will result in a Generation DLAF of less than 1.

DLAFs are generally less volatile than TLAFs. However a new generator sharing a shallow asset or contributing to an increase in MEC is likely to have a negative impact on the DLAF

Further information on DLAFs can be found on ESB Network's website [22]

Table 5-7: Distribution loss adjustment factors for 2008

Connection Voltage Level	Time Period	
	Day	Night
38 kV	1.019	1.016
MV (20/10 kV)	1.047	1.040
LV (400/230V)	1.096	1.082

6 Constructing the connection

The aim of this chapter is to provide a comprehensive list of the activities which are involved in connecting a generation project once the connection agreement is in place.

Construction of an electrical connection to the grid can be structured in the following three phases:

- Pre-construction
- Construction
- Commissioning

The activities described in this chapter apply to a new connection involving an extension to the distribution or transmission network and the provision of a new point of supply. Many of these activities may not be required if the generating scheme is to be connected to the network via an existing point of supply or in circumstances where a project is sufficiently small such that significant connection construction activities are not justified.

6.1 Pre-construction

The pre-construction phase involves defining, at the outset of the project, the engineering requirements in terms of design for both civil and electrical works. At this stage, it is important to consider any particular conditions that may affect the project in terms of obtaining access to the network and also consents or wayleaving. To facilitate this process, it is important to liaise with ESB Networks or EirGrid to identify the likely form of the connection between the generator and the grid and to clarify any likely features of note at an early stage. Figure 6-1 shows the appearance of typical MV, 38 kV and 110 kV overhead lines. The operational voltage of the network connecting the generator site and ESB network is only confirmed at offer issue stage following the connection studies. Finalisation of equipment requirement at the generator site can only be progressed at this stage.

6.1.1 Planning and wayleaving activities

Developers should be aware of the planning implications of the grid connection when they are advancing the planning applications for their generation project. In addition to planning permission for the generation plant itself, permission may also be required for overhead lines and new or upgraded substations which may be off-site. Planning permission is only required for overhead lines at voltage levels of 38 kV and greater. The system operator will also be required to obtain planning permission for construction or upgrade of MV, 38kV and 110kV substations.

For all overhead lines, permission is required from land owners for overhead lines to pass across their land. These agreements are known as wayleaves. Negotiating wayleaves for connection infrastructure can be a delicate matter, and it is often difficult to forecast how long it will take. For this reason, if new wayleaves are required, it is advised that the developer ensures that discussions with landowners get under way as early in the project's development as is possible. It is normal practice for the system operator to obtain the necessary wayleaves for non-contestable connections (see Appendix E). The system operators will usually aim to obtain these wayleaves at standard rates. Negotiations between the system operators and the landowners can take a long time. If progress is slow there may be the opportunity for the developer to work with the system operator to expedite the process by securing a deal with the landowner in question.

Planning permission is not required for underground cables. Underground connection reduces the visual impact and may, in certain cases, be economic in comparison with overhead lines, for example, when the use of cable results in a shorter connection route length, for instance in steep terrain. The cost of an underground cable installation can be significantly higher on a Euros per km basis than its equivalent overhead line and they must also be installed to ESB Network's or EirGrid's specification. Cables are generally laid in the verges of, or under, roads and permission must be obtained from the authority responsible for the land on which the cable is to be installed. This permission is known as cable easements. An easement must be obtained from the Local Authority or the National Roads Authority if the cable is installed along a public road. If the cable is installed along a private road, permission must be obtained from the landowner.

The developer should also consult the system operator on their requirements for on-site substations. It is normally the responsibility of the developer to obtain planning permission for on-site substations. The outcome of planning and wayleaves can impact on the connection costs and these are applied at second payment stage (see Section 5.1.4). A typical example is an increase in line length due to avoidance of objecting landowner's fields resulting in increased charges.

Figure 6-1: MV, 38 kV and 110 kV electricity lines using wood poles

6.2 The Construction

6.2.1 Project management

The developer is responsible for the project management of the generation scheme and, therefore, must consider the overall programme, communication and co-ordination of activities between all contractors involved. The developer must also ensure that the project is compliant with relevant regulations and legislation.

6.2.2 Regulations

The developer is responsible for ensuring that their installation complies with relevant safety legislation. The most significant piece of safety legislation is the Safety Health and Welfare at Work Act 2005 [8], including all the regulations and orders made under this Act.

6.2.3 Civil works

It is normal practice for all civil works on site to be carried out by the developer or their contractors. Civil works typically includes the provision of foundations for new substations and other equipment to be provided by the system operators. The system operators will usually provide the technical specifications for the civil works. The system operator will also provide civil works where required at an existing substation. It should be noted that the design of foundations for outdoor substation compounds can involve a considerable amount of work. For MV substations, further information can be found in ESB Specification 13320, Specification of MV Substation Buildings [19]. The system operator may choose to inspect the civil works at completion, or at several stages throughout construction in the case of large foundations.

6.2.4 Customer works and equipment

The developer is responsible for the supply and installation of the generation plant, control and protection equipment, access roads, accommodation, operational facilities and any other installation that may be required. This includes all electrical infrastructure up to the connection point. The system interface should be designed during the pre-construction phase; it should not be assumed that the generation plant purchased from a generator supplier will interface directly with the system operator assets without the need for any other equipment.

6.2.5 Earthing

Responsibility for provision of earth electrodes, bonding and main earth terminals is agreed with the relevant network operator during the detailed design phase. For further information on earthing see Appendix C.

6.2.6 Telecommunications

Telecommunication links will be required at the site of the generation scheme for purposes of metering, remote control and protection communication to the TSO and DSO control centres. Getting these lines installed is normally the developer's responsibility. This process can take a long time, especially if the site is in a remote location.

6.2.7 Metering

The metering requirements are specific for each connection and will depend on the type, size and nature of the installation. These requirements will be specified in the connection agreement. Information on this subject can be found in ESB Networks, Conditions Governing Connection to the Distribution System (for embedded generators connecting at LV, MV and 38 kV) [10] and The Meter Code [49].

6.3 Documentation

Documentation relating to the generation scheme should be compiled as the project progresses. Some documents are needed to record agreements between the developer and the system operator on issues such as the protection relays settings. Other documents are needed to provide useful information such as nomenclature and site contact details. On project completion, the project owner should be provided with a copy of the 'Operation and Maintenance' manuals. These would normally include all site and plant drawings, health and safety documentation, test documents for all civil and electrical works and technical specifications and maintenance documentation for all plant and equipment

6.3.1 Nomenclature

The naming and numbering of all equipment should be agreed between the developer and the system operator at an early stage in the project. This ensures that references to items of equipment in correspondence, drawings and safety documentation are unambiguous and clear. This nomenclature should also be used for labelling of equipment at site.

6.3.2 Health and safety file

The Health and Safety File should contain all the relevant design information to enable the safe operation, development and decommissioning of the project. On completion of the project, the file should be passed to the project owner as part of the O&M manuals.

6.3.3 Contact details

A schedule of contact details should be posted at the point of supply. This should include contacts for both the system operator and the operator of the generation scheme. Both parties should appoint one or more competent persons who will attend the site in an emergency.

6.3.4 Protection settings

Settings for the protection relays should be agreed between the developer and the system operator to ensure relay protection coordination between the electrical network and the generator. A record of these agreed settings should be kept by both parties.

6.3.5 Site safety rules and safe working procedures

The developer is responsible for ensuring that there are written site safety rules and safe working procedures to cover all operations and eventualities on site following energisation. These rules are supplementary to site safety rules applicable during the construction phase, which should be made available to all contractors working on the site.

6.3.6 Completion Certificates

When an electrical contractor completes a section of their works, they should issue the developer with a Completion Certificate. The purpose of this Certificate is to certify fitness for testing or energisation and pass ownership, control and operation to the developer. All new electrical installations and alterations to existing installations require a Completion Certificate. For LV connections further information on the Completion Certificate can be found in ESB Networks National Code of Practice for Customer Interface [18]. For connections at MV and higher this certification is known as a Declaration of Fitness (DOF) Certificate.

6.4 Testing and commissioning phase

6.4.1 Safe working areas, procedures and warning notices

Before energisation, a thorough inspection must be completed and equipment locked off, cordoned off and labelled as live. Permit to work procedures must be initiated at this stage even if the equipment is not yet energised. It is the developer's responsibility to set up and manage the permit to work procedures covering their assets.

6.4.2 Pre-commissioning tests

The system operator and the developer are responsible for commissioning and testing their own assets. The system operators may ask to witness certain tests of developer's assets or to see the test results. These tests may include static and dynamic G10 tests, earth electrode resistance measurements, tests on protection relays, pressure tests on cables and switchgear and tests on the integrity of connections.

6.4.3 Energisation

The connection will be energised by the system operator using their safety rules. A switching plan will be prepared by the system operator.

6.4.4 Commissioning

Following energisation, the developer is in a position to commission his plant. If the generation scheme uses synchronous machines, the system operator may wish to witness the first synchronisation of these machines. The system operator may want to perform some protection tests, including dynamic G10 tests for generating plants connected to the distribution system seeking to operate at varying power levels.

6.4.5 Grid code tests

Once the generating plant has been commissioned, a grid code compliance test must be arranged with the system operator. The different exercises that have to be carried out during grid code compliance tests will normally be adapted according to the type of connection and specific features of the generator.

6.5 Operation

6.5.1 Provision of personnel

In the case of un-manned sites, the system operator will require the developer to nominate a competent person know as the 'Responsible Operator' to be available to attend site. This person may be required to attend site within two hours notice.

6.5.2 Future modifications

The developer should inform the system operator if they are planning to modify the installation. Any changes should be discussed and agreed with the system operator. If changes are made, these changes should be documented in the relevant O&M files. Such changes would include changes to the generation plant, protection settings, electrical system characteristics or controls.

7 Appendix A - Generation and the Effects on the Network

The aim of this appendix is to provide an overview of the key technical characteristics of electricity generating plant, and the effects generators have on electricity networks. It also includes an overview of the features of the distribution and transmission network codes likely to be of most interest to developers of generation projects.

7.1 Characteristics of generating plant

The electrical characteristics of a generator will have a significant influence on the design of a connection scheme. In particular, electrical generating capacity of the scheme, the characteristics of the electricity generation technology to be deployed and the amount of power to be exported on to the network will be of significance. These key factors are considered in greater detail below.

7.1.1 Size and rating

The 'size' of a generation scheme is normally expressed in terms of its electrical power output. This is usually expressed in kilowatts (kW) or megawatts (MW) and normally refers to the maximum continuous output which can be sustained by the generation scheme. Some generators operate at or near their maximum output for most of the time, but others – notably wind, wave, tidal and solar installations – will generate at their maximum output only occasionally.

As well as generating electrical power, generation schemes often generate or consume reactive power (see Appendix D). This must be taken into account in the design of the connection scheme as transfers of reactive power will have an effect on the network.

7.1.2 Export level

Many generation schemes supply some on-site demand, with the result that the maximum power exported into the network is less that the rated power output of the generator. In such cases, it is the maximum export level rather than the rated output of the generator which determines the required connection capacity. This export level is known as the Maximum Export Capacity (MEC).

In some cases, the normal on-site demand is greater than the rated output of the generation scheme, so no power is exported to the network under normal operating conditions. Even if this is the case, operation of the generation scheme can have consequences for the safe operation of the network in relation to technical parameters such as fault levels, harmonic systems, system resonance and danger of isolated operation. For this reason, all generators that are connected to the network and operating in parallel with it are required to apply to the system operators for permission to connect, regardless of whether they export power or not.

7.1.3 Characteristics of generation technologies

Various technologies are used for generating electricity from other forms of energy. These generating technologies can be grouped as follows:

- Rotating machines coupled to synchronous AC generators
    - steam turbines
    - gas turbines
    - diesel engines
    - spark ignition engines
    - large water turbines
- Rotating machines coupled to induction or asynchronous generators
    - Small water turbines
    - Fixed speed wind turbines
    - Variable speed wind turbines

- DC current sources coupled to electronic inverter system
  - Fuel cells
  - Photo-voltaic (PV) cells
  - Some wind turbines
  - Variable speed inverter coupled wind turbines

The electrical characteristics of synchronous generators, induction generators and electronic inverters are quite different, particularly with respect to fault contribution (see Section 7.2.6 and harmonics (see Section 7.2.8). Table 7-1 indicates the relative effect of these devices.

Table 7-1: Network effects of generation technologies

	Synchronous generators	Induction Generators	Electronic inverters
Fault Contribution	High	Low	Very low
Harmonic Contribution	Very low	Very low	Significant

7.2 Effects of generators on networks

As noted above, the connection of a generation scheme to an electricity network will effect the operation and performance of that network. The system operators will require the network to operate within safe limits and will also want to ensure that the operation of the scheme does not cause problems for other electricity users. Through careful design of the connection arrangement, the developer and system operator can ensure that the scheme does not cause problems. Indeed, there are some scenarios where generators can enhance the performance of the network.

This section provides an overview of the main technical issues relating to the connection of generators to electricity networks. An appreciation of these issues will help the developer to understand some of the system operator's concerns about the design of the connection scheme.

7.2.1 Systems or network studies

All system operators maintain detailed databases describing the electrical characteristics of their networks. This data can be used to analyse how the networks will behave under different loading conditions, network configurations, during maintenance, or in the event of particular faults. These case studies are usually referred to as system or network studies. Due to the complexity of the networks and the amount of data involved, system studies are invariably carried out using specialised computer software packages.

The connection of a generator to the system will inevitably result in some changes to the characteristics of the network. To evaluate the possible consequences of these changes, the system operators will carry out some network studies with the generator included in the network model. In carrying out these studies, the system operator's engineers will be particularly interested in whether the connection of the proposed generator would result in any of the network planning criteria being exceeded, including:

- Thermal ratings of equipment
- Unacceptable voltage rise
- Fault level limits of existing switchgear
- Losses limits
- Voltage stability/dynamic studies

As well as studying the network under normal operating conditions (that is, with all items of installed network plant being available), the system operator's engineers will also study the network under a number of contingency cases. An example of a transmission contingency case is a single contingency (N-1), which covers the loss of any single item of network equipment or generation at any time. A full list of the technical planning criteria and the contingency requirements is available in the transmission [39] and distribution [20] planning criteria documents.

The system operator will carry out these studies and the cost of the studies is charged to the developer as part of the cost of processing the connection application.

Generation developers or their consultants can also carry out their own network studies. System data for modelling the transmission system is published annually in EirGrid's Transmission Forecast Statement [24].There is currently no published data for the distribution system but developers can request the information from ESB Networks.

7.2.2 Thermal rating

Most elements of the existing network infrastructure – lines, cables transformers and so on – have a limited current carrying capacity. If they are loaded above the limit for an extended period of time, they will overheat. For this reason, the current carrying capacity of an item of network infrastructure is referred to as its thermal rating. Loading a device beyond its thermal rating may lead to permanent damage, or even a dangerous event such as a fire or explosion.

7.2.3 Voltage control issues

7.2.4 Steady-state voltage rise

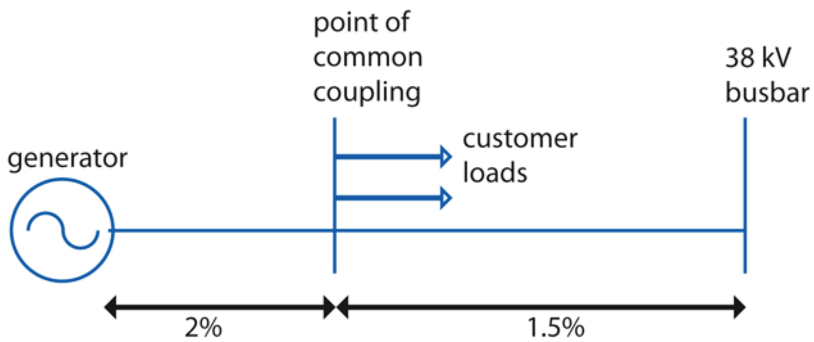
The operation of a generator will tend to push up local voltage levels on the network to which it is connected. This can conflict with the system operator's obligation to ensure that electricity consumers are supplied at the standard voltage, particularly in the circumstances where a generator is connected to a circuit shared with demand customers. Circuits supplying demand customers can only accommodate relatively small amounts of exporting generation. ESB Networks permit a broader tolerance in relation to voltage rise on MV and 38 kV circuits that are dedicated to the connection of generation. Generators connected to the transmission system are less likely to be constrained by voltage control issues.

Table 7-2 indicates the permitted voltage rise on the distribution network for shared and dedicated circuits. In this table reference is made to the 'point of common coupling'. ESB Networks define this as 'the point on the distribution system which is electrically nearest to the connection point and from which other customers' loads are, or may be, connected'.

Table 7-2: Voltage rise limits for the distribution system

Voltage Level	Limit for shared circuit	Limit for a dedicated circuit
MV (10/20 kV)	1% at point of common coupling of load share, with an additional 2% at generation site	Total of 3% rise at generation site
38 kV	1.5% at point of common coupling of load share, with an additional 2% at generation site	Total of 3.5% rise at generation site

Figure 7-1: Illustration of typical voltage rise limits permitted on 38kV shared circuits



7.2.5 Step voltage rise and drop

The process of starting a generator can sometimes cause step changes in voltage levels on the network. These step changes are caused by inrush currents, which may occur when transformers or induction generators are energised from the network. Synchronous generators do not give rise to inrush currents themselves, but their generator transformers may do so if they are energised from the network. Step voltage change will also occur whenever a generator is suddenly disconnected from the network due to faults or other occurrences. ESB Networks standard is the step change cannot be greater than 10% at all distribution voltage levels.

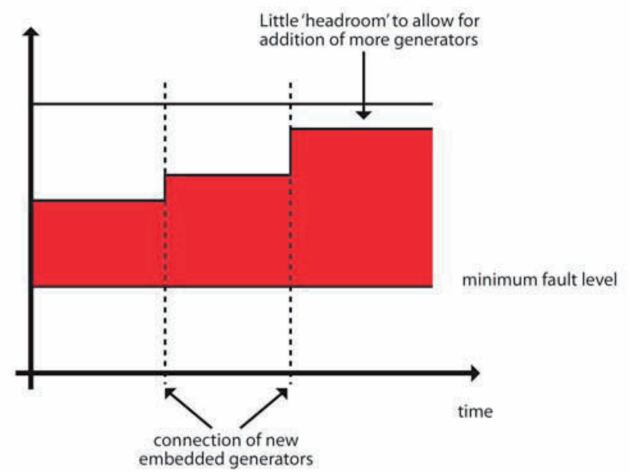
Where induction generators are used, such as in wind turbines, they are normally fitted with 'soft starters'. These devices limit inrush currents to roughly the same level as the normal rated current, which in turn reduces the magnitude of the step changes in voltage which occurs on start up.

7.2.6 Fault Level Contribution

Connecting a generator to a network has the effect of increasing the fault levels in the network close to the point of connection. The extent of the fault current that can be safely accommodated by an electricity network is usually determined by the rating of existing switchgear in the vicinity of the point of connection. This upper limit is sometimes referred to as the design fault level in that part of the network. Design fault levels in networks can sometimes be a limiting factor in the connection of new generators or loads.

Generally speaking, generators would not be permitted to push maximum fault levels beyond the network design fault levels and/or equipment fault levels. In some cases they may be required to contribute to the cost of new equipment, mainly switchgear to accommodate the increase in fault level associated with the connection of new generation.

Figure 7-2: Fault levels



7.2.7 Voltage Flicker

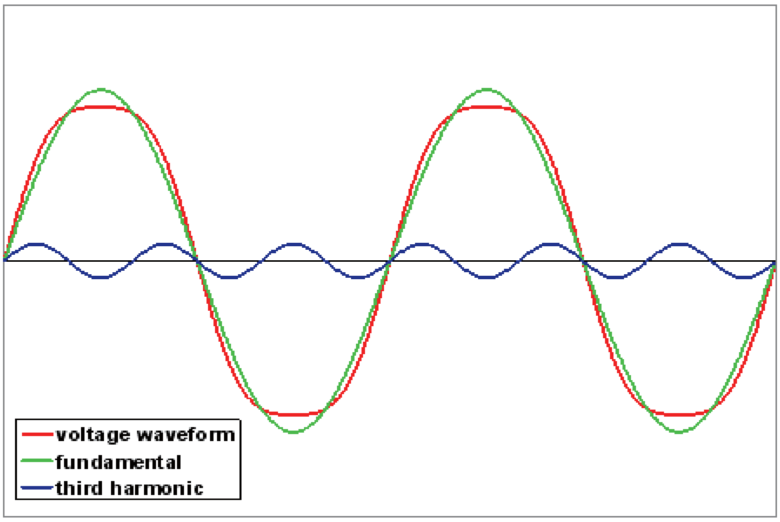
Voltage flicker refers to rapid fluctuations in the voltage level on an electricity system. These fluctuations can interfere with the quality of supply to customers, resulting in, for example, light bulb 'flicker' instead of producing a steady light. Limits of voltage flicker are specified in the Distribution Code [21] and Grid Code [34] (see Section 7.3).

7.2.8 Harmonics

Ideally, the voltage at any point in a network should have a perfectly sinusoidal, 50 Hz waveform. However, this is rarely the case in practice. Rectified power supplies, compact fluorescent lights, variable speed motor drives and other switched loads introduce harmonic components, which distort the waveform. Harmonics can also be introduced by inverter-coupled generator schemes using technologies such as inverter coupled wind turbines, fuel cells and PV cells.

Limits on the level of harmonic current that generators and loads are permitted to inject into networks are specified in Distribution Code [21] and Grid Code [34].

Figure 7-3: Example of the Impact of Harmonics



7.3 Network codes

Both system operators have Codes, which provide a set of technical rules with which all users connecting to the electrical network must comply. Its purpose is to facilitate the safe, secure and reliable operation of the network for all users. There are 2 network codes presently in operation:

- The Distribution Code c applies to all users connected to the distribution system. It is available on the ESB Networks website
- The Grid Code [34] applies to all users connected to the transmission system. It is available on the EirGrid website.

These two documents are collectively referred to in this Guide as the network codes. All generators connecting to the grid must comply with the relevant network code.

The network codes are key documents for generators wishing to connect to the network as it will place conditions on the connection and operation of the generator which in turn may have implications for the design of the connection. A condition of acceptance of the connection offer is that the generator installation must comply with the relevant network code. For this reason, all generator developers should be familiar with the relevant network code and ensure that the design of the generation scheme complies with its requirements. Developers should also consider during the procurement process the ability of different types of generators to meet the relevant network code requirements.

If a user is unable to comply with the relevant network code they must notify the system operator without delay. They can then either remedy the non-compliance or seek derogation from the relevant network code from the CER.

Both the EirGrid Grid and Distribution Codes have a similar structure. They contain the following sections.

- The General Conditions (GC) sets out the general principles guiding the operation of the network code and covers items such as the legal basis of the network code, development and revision of the network code and derogations.
- The Planning Code (PC) contains details of the design and technical criteria used in the planning and development of the electricity system.
- The Connection Conditions (CC) defines the minimum technical, design and operational standards required of users connecting to the system. In the Distribution Code Section DCC10 contains the rules applying to all distribution connected generators and Section DCC11 sets out the provisions with which wind generation must abide.
- The Operating Code (OC) deals with the various operational matters affecting users such as providing forecasts, planning of outages, reporting of operational changes and events, safety matters and procedures for dealing with emergency situations.
- The Data Registration Code details the information that the system operators request to know about each user in order for them to operate and plan the system. In the EirGrid Grid Code the equivalent Section is known as the Planning Code Appendix.
- Scheduling and Dispatch Code (SDC) -EirGrid Grid Code only: This details the information required by the systems operators to enable them to have sufficient generation capacity to meet demand.
- Controllable Wind Farm Power Stations (CWFPS) - EirGrid Grid Code only: This Section details the special requirements that apply to wind generation. It is analogous to Section DCC11 in the Distribution Grid Code.

As discussed above, the distribution and transmission network codes have specific sections for wind farms. The network code requirements of wind farm installations vary depending on the connection method and the MEC. For example, a 2 MW distribution connected generator connected into a local ESB Networks 38 kV substation would have substantially different requirements in terms of grid code compliance compared with a 35 MW wind farm connecting into the transmission system at 110 kV. The network code requirements for wind farms can be broken down into the following general areas:

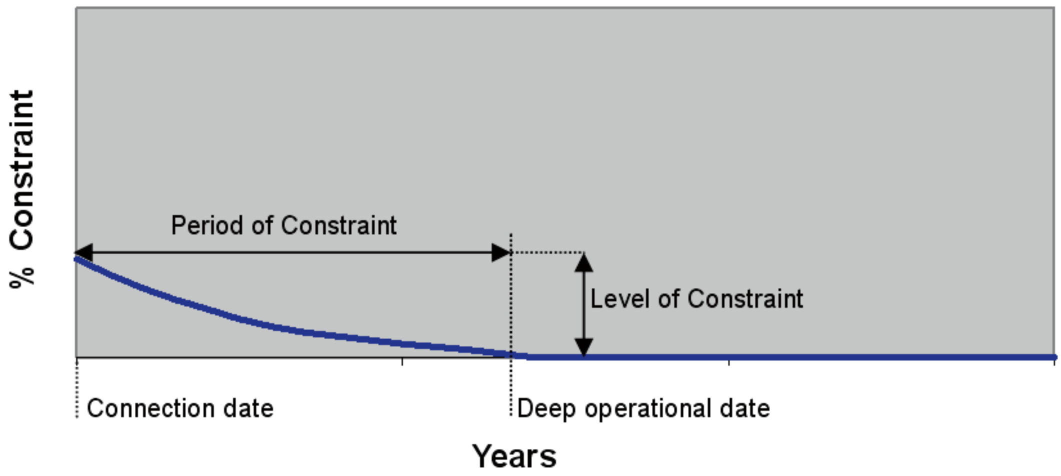
- Fault ride through
- Frequency Control
- Voltage Control
- Reactive Power
- Signals for Communications and Control
- Dynamic Modelling

8 Appendix B - Non-Firm Transmission Access and Constraints

As part of the connection offer process, EirGrid may identify transmission deep reinforcements that are necessary to accommodate the new generation capacity. In some circumstances the transmission deep reinforcements may take longer to the construct than the shallow connection assets. However, under existing connection rules, it is possible for generators to connect onto the system once the shallow connection is constructed but before the transmission deep reinforcements are complete[1]. However, until all of the associated deep reinforcements are complete the generator will only have non-firm access to the transmission system. The concept of firm and non-firm access is explained in the following paragraphs.

In order to ensure the safe and secure operation of the system, the system operator may under certain grid conditions, require a generator to reduce its output. Generators with non-firm access are not financially compensated for this reduction in their output. This reduction in the generator output under non-firm access conditions is known as constraint.

Figure 8-1: Impact of constraint on generator output



The duration of the constraint period depends on the time it takes for EirGrid to design, consent and construct the transmission assets. For assets such as over head lines, that require planning permission and wayleaving, it can be difficult to quantify the constraint period. As the deep operational date is only a scheduled date in the generators connection offer, the risk of delays in constructing deep reinforcements presently rests with the generator developer.

The level of constraint depends on many factors including:

- The number and nature of the associated deep reinforcements
- The capacity and operating regime of existing and the new generation
- The system demand in the region

Constraints can pose a risk to the commercial viability of a generation project. To assist wind farm developers to understand the likely level of constraint associated with their connection, EirGrid provide constraint reports as part of the connection offer process. The constraint report is based on the modelling of complex factors such as those listed above. The report provides estimates of the total energy reduction that may be experienced by generator during the non-firm period.

1 Distribution connected generators can avail of non-firm access to the transmission system but only after any associated distribution deep reinforcements are complete. Transmission deep reinforcements relating to fault levels must generally be complete before a generator can connect to the network.

9 Appendix C – Protection and Earthing

The aim of this chapter is to describe the typical arrangements for protection and earthing of generators that are connected to the electricity system. The system operator has a responsibility to ensure that a generator installation will not adversely affect the network or other customers connected to the network before they allow that generator installation to connect. For this reason, the system operator has a legitimate interest in the design of the protection and earthing systems for the installation. It is therefore essential for the developer to obtain agreement with the system operator on these arrangements before placing contracts for the supply and installation of the necessary equipment.

The following documents provide information on ESB Networks and EirGrid requirements for protection and earthing:

- ESB Networks, Conditions Governing Connection to the Distribution System [13]
- Grid Code [34], the Distribution Code [21]
- ESB Networks, National Code of Practice for Customer Interface [18]
- ESB Networks, ESB Specification 13320, Specification of MV Substation Buildings [19]
- The Electrotechnical Council of Ireland (ETCI) National Rules for Electrical Installations available from the ETCI

9.1 Protection

9.1.1 Protection Systems

Although electrical networks are reliable systems, electrical faults will occur from time to time. These faults may be caused by events such as an overhead line breaking, or a short circuit in the windings of a generator. When these abnormal conditions occur, very high currents can develop at the fault point in the network. If they are not quickly detected and stopped, these fault currents are a risk to life and can cause extensive damage to cables, transformers, generators and other equipment, as well as adversely affecting the supply of electricity to consumers.

To protect personnel, members of the public, generating plant and network infrastructure from the effects of faults, fuses and circuit breakers, together with protection relays, are fitted at strategic points on the network. Relays are devices which can trip the circuit breakers on detection of unusually high currents or other abnormal conditions. Circuit breakers, relays and measuring apparatus are the main components of a protection system.

9.1.2 Switchgear/ Breaking Devices

The developer must install a protection scheme to detect and isolate faults in the generator installation. One or more breaking or isolating devices are normally installed at the point of supply to the generator installation in order to support the necessary switching operations and provide isolation of the generator from the distribution or transmission network. Examples of breaking devices include circuit breakers, disconnectors and fuses. Generally, at least two breaking or isolating points are installed.

- A breaking or isolating device is installed on the system operator's side of the point of supply, to allow the system operators to switch off or isolate the generation plant from the electricity network. A second breaking or isolating device provides a back-up to the system operator's breaker. This allows the developer to provide their own isolation point, if required, in order to carry out maintenance of the generator installation in a safe manner.

- The generator installation may include circuit breakers, isolators or other switchgear in addition to the incomer circuit breaker, to allow isolation of individual machines or transformers. ESB Networks requirements for this type of equipment are set out in their published document, Conditions Governing Connection to the Distribution System [13]. It should be noted that the MV / 38kV short circuit rating is higher in certain designated areas.

9.1.3 Relays / G10 protection

All generators connecting to the grid at voltages of 38 kV and below must comply with ESB Networks Conditions Governing Connection to the Distribution System [13]. This document describes ESB Network's requirements for protection systems (also known as G10 requirements). It also sets out the synchronisation and change-over requirements for generators.

G10 protection includes systems for the detection of the following conditions at the generator installation:

- over and under voltage
- over and under frequency
- loss of mains
- directional overcurrent
- earth fault

A set of relays must be installed at the point of supply to detect these conditions. Indicative settings for these relays are specified in the Conditions Governing Connection to the Distribution System [13] document. However, this document is a recommendation rather than a standard, as such, it may be appropriate to apply different settings to suit the specific circumstances as requested by the system operators.

Loss of mains protection: In addition to detecting faults that emanate from the generator, the G10 protection is required to detect loss of mains. The relay will disconnect the generator from the ESB network if a fault in the ESB mains is detected which could result in a loss of supply to the area from the wider network; in this manner 'islanding' is prevented. Islanding occurs when a section of network with both generation and load demand, becomes separated from the rest of the wider network, allowing the separated network to continue to supply itself independent of the wider network. It is critical that islanding is detected and prevented as the continued operation of the generating plant, even for a short period of time following the loss of the network supply, may cause the generator to suffer severe damage when the mains supply is restored as the generator will be out of synchronisation with the network.

In addition to the G10 requirements, the system operator may require additional protection for their network. This protection may be implemented in different ways depending on the voltage level and the size of the generator. Such protection schemes include:

Impedance (distance) protection: This operates by monitoring the impedance along a line. If there is a fault the impedance will change and the relay is able to determine the location of the fault; the faulted line will then trip. Impedance protection is commonly installed on long runs of 110 kV and 38 kV lines.

Differential protection: This operates by determining the difference in current between the two or more ends of a feeder. It is installed on 110kV busbars, power transformers and on HV feeders when the impedance of the feeder is too low for impedance protection to be effective. These circumstances typically arise in cable networks and very short overhead lines.

Earth fault protection: This is implemented in different ways depending on the way the system neutral is treated. It is commonly installed on 110 kV, 38 kV and MV systems.

For transmission connected generators, EirGrid provide a functional specification for the protection requirements to be applied at the generation site.

9.2 Site earthing

The developer is normally required to provide a site earthing system. This earthing system is typically used for the earth bonding of the assets on the generation site belonging to both the developer and the system operator.

The function of the earthing system is:

- To ensure that a person in the vicinity of the equipment is not exposed to unsafe potentials by providing alternative means to carry electric current into the earth under normal and fault conditions; and
- To provide sufficiently low impedance to facilitate satisfactory protection operation under fault conditions

The earthing system typically consists of one or more earth electrodes connected together to form an integrated earthing grid.

9.2.1 Design of the earthing system

The design of the earthing system must be agreed with the system operator during the detailed design of the connection. There are a number of factors to be considered in designing the earthing system, including:

- The system operators' requirements for the treatment of the neutral conductor. This depends on the voltage and the location at which the generator is connected. The system operators will advise on how they require the neutral to be earthed at individual generating sites.
- Earthing requirements differ depending on the voltage level at which the generator is connected. For LV connections, the earthing system must comply with the ETCI National Rules for Electrical Installations. For 38 kV and MV connections, information on the earthing requirements can be found in ESB Networks' Conditions Governing Connection to the Distribution System [13]
- For transmission connected generators, EirGrid will provide a functional specification and / or guidelines for the earthing requirements.
- The soil type present on the site of the substation will influence the design of the earthing system. For example, typically a substation built upon granite rock would require a more extensive earthing system than a substation built on clay as the electrical resistivity of granite is higher than that of clay.
- The type of earth electrodes used. The most commonly used electrode is a copper mesh installed in the floor of the substation.
- For sites with both MV and LV systems, a common earthing system for both the MV and LV earthing may be used provided that the combined resistance is sufficiently low.
- The available fault current at the site for which an earth system is to be implemented. A high or low fault current at a particular point will influence the extent of the earth electrode system required in order to achieve safe conditions. The system operator will provide the fault current from the network at the point of connection.

10 Appendix D - power factor and reactive power

The aim of this appendix is to provide a brief introduction to the concepts of power factor and reactive power. These concepts are important in the design and operation of electricity systems based on alternating current (AC). The two concepts are also closely related to the concepts of active power and apparent power. The notation is used in this appendix is shown in Table 10-1.

Table 10-1: Notation used in Appendix D

Symbol	Meaning	Units
P	Active power	Watts
Q	Reactive power	Volt-amperes reactive
VA	Apparent power	Volt-amperes
Pf or CosΦ	Power factor	Unit less
Φ	Phase angle	Unit less
V	Voltage (rms- root mean square)	Volts
I	Current (rms- root mean square)	Amps

10.1 Active power

Active power is a measure of the rate of energy transfer in AC circuits. It has units of watts (W, kW or MW). Active power is generated in some circuit components, notably generators, and is consumed in other components including lines, transformers and loads. Taking a circuit as a whole, the total generation and the total consumption of active power is always equal. When the voltage and current waveforms are sinusoidal the active power can be calculated as follows:

$P = V * I * Cos\phi$ for single phase circuits

$P = \sqrt{3} * V * I * Cos\phi$ for balanced three phase circuits

10.2 Apparent power

Apparent power is the product of the voltage and current. It has units of volt-amperes (VA, kVA or MVA). It can be calculated as follows:

$VA = V * I$ for single phase circuits

$VA = \sqrt{3} * V * I$ for balanced three phase circuits

Apparent power is often used as the basis for the rating of electrical equipment. It is a measure of the electrical stress placed on circuit components such as transformers and transmission lines.

10.3 Power factor

Power factor is a measure of the effectiveness of energy transfer in AC circuits. It is a dimensionless parameter, equal to the ratio of active power to apparent power at a particular point in a circuit:

$$PF = \frac{P}{VA}$$

At any point in an AC circuit, the magnitude of the active power transferred is always less than or equal to the apparent power at that point. For this reason, the power factor always lies between -1 and +1. The power factor ranges that generators are required to be able to operate within are contained in the Distribution Code [21] and Grid Code [34]. The power factor required depends on the type of connection and also on the type of generator technology.

It can be shown that the power factor is equal to the cosine of the phase angle between the voltage and current waveforms:

$$pf = P / VA = \cos\phi$$

10.4 Reactive power

Reactive power is analogous to active power in many ways. It is generated in some circuit components, and consumed in others. The generation and consumption of reactive power in a circuit must balance, in the same way as the generation and consumption of active power. Also, reactive power is transferred from one part of a circuit to another, in the same way as active power.

The mathematical expression for reactive power is similar to that for active power. However, whereas active power is proportional to the cosine of the phase angle between the voltage and current waveforms, reactive power is proportional to the sine of the phase angle:

$$Q = V * I * Sin\phi$$ for single phase circuits

$$Q = \sqrt{3} * V * I * Sin\phi$$ for balanced three phase circuits

10.5 Leading and lagging power factors

The words 'leading' and 'lagging' are often used to describe if a generator is importing or exporting reactive power to or from the grid. The Distribution Code [21] defines a generator with a leading power factor to be exporting reactive power onto the grid and likewise a generator with a lagging power factor to be importing reactive power from the grid.

11 Appendix E - Contestable Connections

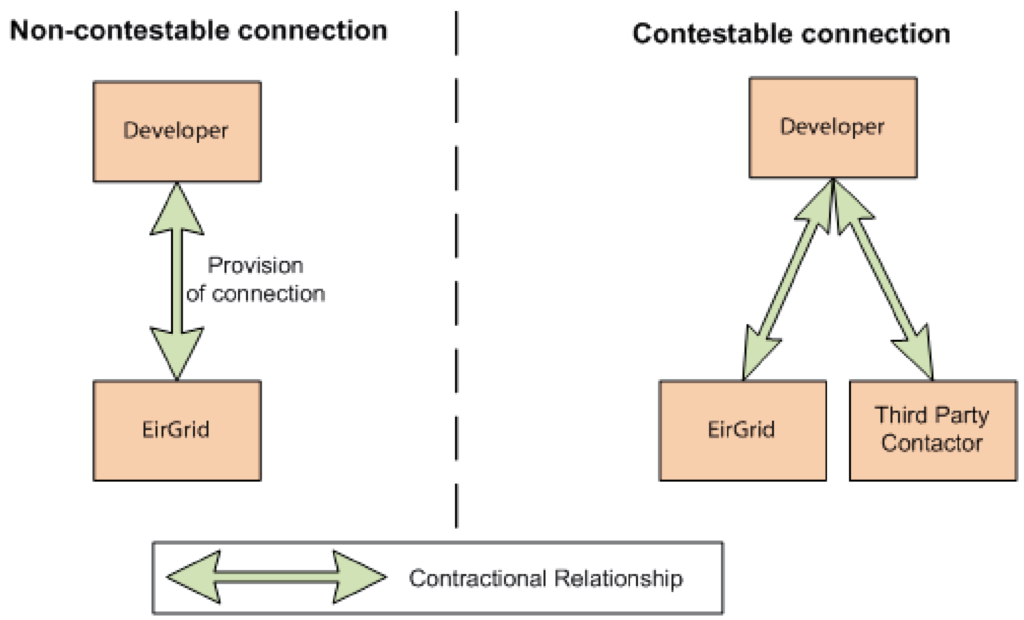
Developers connecting generators to the transmission system have the right to construct the shallow connection assets. This right is known as contestability. During the connection offer process generators are given two options for the construction of the shallow assets.

Non-contestable connection: The developer engages EirGrid to undertake all the necessary works to provide the shallow connection infrastructure. The cost of these works will be charged to the developer. In practice, EirGrid will undertake the design and consenting of the shallow connection infrastructure with the construction works being undertaken by the transmission assets owner, ESB Networks.

Contestable connection: The generator opts to construct, or arrange to have constructed, some or all of the contestable shallow connection assets to a pre-agreed boundary. The generator would be responsible for the detailed design, route and site selection, consents, equipment procurement and construction. EirGrid's responsibilities will include specifying the connection method, providing a functional specification, design approval, inspection during construction and commissioning the assets.

These options both involve a contractual relationship between the developer and EirGrid, as shown in Figure 11-1. However, the contestable connection option will also typically require the developer to enter into an additional relationship with a third party contractor. By choosing the contestable connection option the developer gains more control over the cost and timeline for the connection. However, this benefit must be weighed against the time, cost and effort involved in undertaking this work, managing the additional relationship with the third party contractor and ensuring that the necessary co-ordination with EirGrid occurs. There is also additional cost risk associated with failure on the part of the generator to deliver contestable works in accordance with the construction programme agreed with EirGrid.

Figure 11-1: Contractual relationships in non-contestable and contestable connections



All contestable works must be completed to EirGrid's transmission standards as a consequence of the transmission asset owner (ESB Networks) having the right to acquire the ownership of the contestable works for a nominal amount (if they deem that the assets should form part of the transmission system). This scenario is most likely in circumstance where EirGrid consider that the contestable assets could facilitate the future connection of other parties, or could form part of the wider development of the transmission system.

Approximately mid way through the connection offer process, EirGrid hold a connection method meeting with the developer to formally discuss contestability.

Currently, generators connecting to the distribution system **do not** have the right to contestably build the shallow connection assets. The issue of contestability for distribution assets is currently being progressed by the industry.

11.1 Contestable work and non-contestable work

Not all aspects of shallow connection works may be undertaken on a contestable basis. If assets are deemed by EirGrid to be in 'close proximity' to the existing 'live' system then they will be deemed 'non-contestable'. For example, if the shallow assets connect into an existing live substation then all works in the substation will be non-contestable. Figure 11-2 provides an example of a shallow connection looping into an existing transmission line. The assets in close proximity to the existing transmission line are deemed non-contestable. The costs incurred by EirGrid in carrying out the non-contestable works are charged to the developer.

Figure 11-2: Example of the boundary between contestable and non-contestable assets

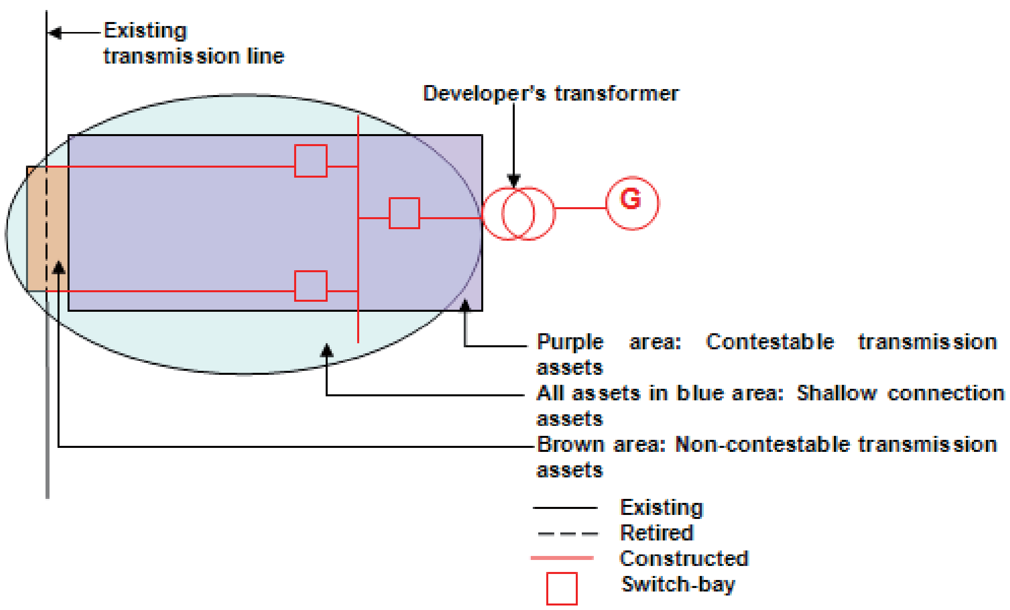


Table 11-1 shows the activities that are typically contestable and non-contestable.

Table 11-1: Contestable and non-contestable activities

Contestable works	Non-contestable works
Route and site selection	Connection method
Planning consents	Outline design and functional specification
Wayleaves procurement	Assets that, due to their location, can not be safely segregated from existing 'live' transmission systems
Detailed design	Detailed design approval
Equipment procurement	System protection and communication works
Construction	Inspection during construction
	Commissioning contestability assets

11.2 Contestability and group processing

One of the features of group processing is that EirGrid may decide to connect a number of generators as part of a subgroup sharing the same shallow transmission assets. If there is a generator in the sub-group seeking connection directly into the transmission system then the shallow connection assets can be built contestably. Figure 11-3 below details the set of rules for contestability under Group Processing as set out in the Group Processing Approach Pricing Principles Guidelines [43].

Figure 11-3: Rules for contestability of transmission connection under group processing

Rules for Contestability of Transmission Connections under Group Processing

a) The identity of applicants within subgroups involving a shared transmission connection asset shall be disclosed to all applicants within that subgroup prior to issuing the connection offers.

b) Only the transmission connecting parties shall be allowed to construct or arrange to have constructed the shared transmission connection asset.

c) All applicants – transmission and distribution - sharing the transmission asset within a subgroup must come to a unanimous agreement amongst themselves that they wish to make the shared transmission connection asset contestable.

d) This agreement must be notified in writing to the TSO three weeks following the connection method update meeting, with evidence that unanimous agreement has been reached. The applicants shall nominate one transmission applicant who will liaise with the TSO during the process of constructing the contestable shared transmission connection asset.

e) Should the parties not be able to able to agree on the shared transmission connection assets being contestable, or the nominated transmission applicant not accepting its connection offer (where there is no other transmission applicant in the subgroup) the shared transmission connection asset will be deemed to be non-contestable. This is important to ensure that the parties within the subgroup, and subsequent Gates, are not unduly delayed. However, the remaining accepted offers may have to be reworked as the connection costs discussed in (f) below may have to be reviewed with a view to cost recovery on behalf of the final customer.

f) The arrangements for payment of connection costs for the shared transmission connection asset shall be a matter for the parties within the subgroup if the contestable option is chosen. The CER has no remit to protect any party, other than the final TUoS and DUoS customer, from potential financial risk of unrecovered connection costs.

g) If the TSO considers it necessary for system security and stability reasons to make the shared transmission connection asset of a subgroup non-contestable it shall notify the CER as soon as practicable. The CER shall decide on such cases on an individual basis. Such a situation will be an exception and the burden of proof will rest with the TSO.

As the connection offer process only affords the parties within a subgroup a limited time period to make the unanimous decision on contestability, it is advisable for developers in a subgroup to start discussions on the contestable contractual arrangements as soon as possible. If developers cannot come to an agreement on contestability during the connection offer process there is usually also the option to accept an offer on a non-contestable basis and to then request a modification of the agreement to a contestable connection. If developers have further queries on contestability they should contact EirGrid's Customer Relationship Team (see Appendix H).

11.3 Practicalities of contestable works

If the developer wishes to get third party quotations for connection work, they must first establish;

- the scope of the work that is contestable
- the relevant standards for the specification of work, materials and equipment
- details of approved contractors

The scope of the contestable work is agreed between EirGrid and the developer. Formal notification of the scope of the contestable work is normally provided in the EirGrid connection offer letter and a detailed functional specification is provided shortly after the connection offer is accepted. The developer can then invite the contractors to bid for these activities.

If the developer decides to contract with a third party contractor for contestable works, it is the developer's responsibility to ensure that the contractor's work is acceptable to EirGrid under the terms of the connection agreement. The developer should ensure that a contractor's bid covers all the necessary items of work and provides for materials and equipment which comply with EirGrid's standards before placing a contract with a third party.

Schedule 10 [31] of the connection agreement sets out EirGrid's contractual requirements for the construction and commissioning of a contestable connection. EirGrid has also published a guideline document, Contestability of Connection Assets [40] that covers contestable terminology and definitions, key principles.

12 Appendix F - Direct Lines /Private Wire Networks

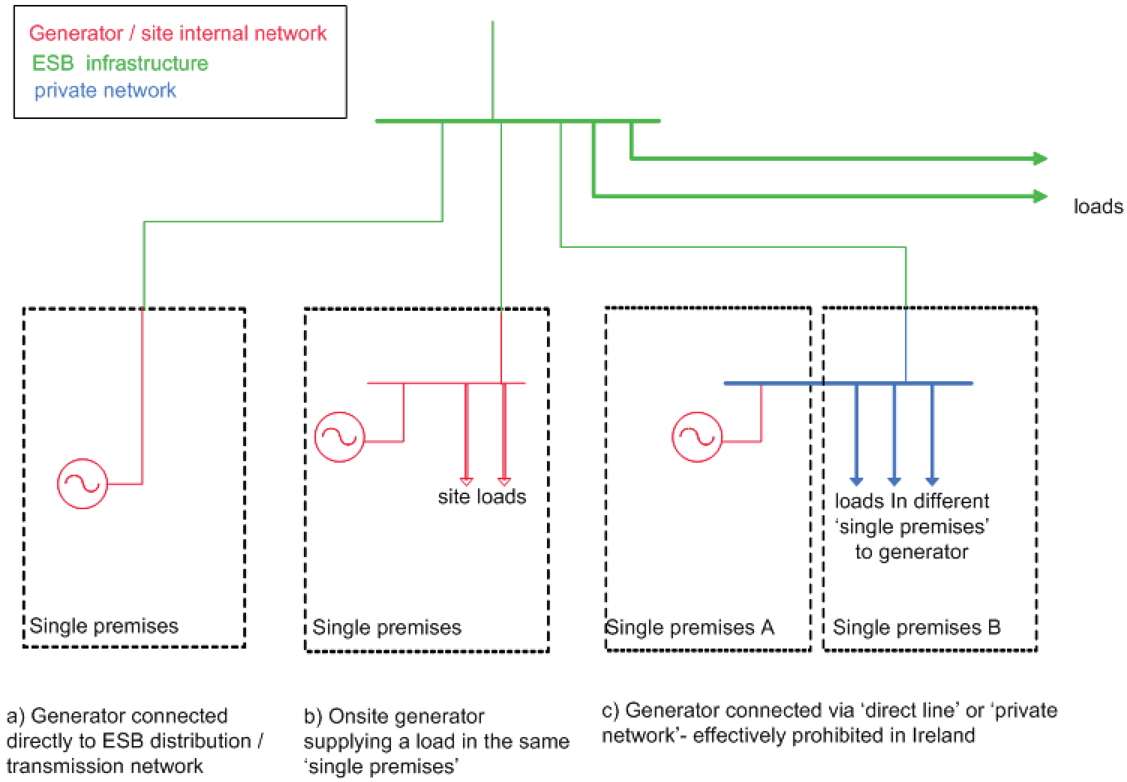
Some developers of CHP and renewable installations have considered the possibility of installing a direct line (also known as a private wire network).

A direct line can be thought of as a piece of electrical infrastructure that is independent of the ESB system and whose purpose is to supply electricity directly to another party located on the same site (e.g. an industrial estate) as the generator. Direct line installations are not uncommon in other jurisdictions however they are, effectively, prohibited under Irish legislation, as described below.

Figure 12-1 illustrates how a generator connected via a 'direct line' would differ from a generator connected directly to the ESB network or an onsite generator.

Figure 12-1 provides representations of;
a) The standard way a generator is connected to the ESB system. The generator feeds loads via the ESB system
b) Onsite generation: the generator feeds loads that are on the same 'single premise' (see definition below) and also may export electricity to the ESB system
c) Private wire network or direct line: the generator supplies loads that are on a different 'single premise'. These loads are supplied without using the ESB system. This type of configuration is prohibited in Ireland.

Figure 12-1: Direct line / private wire network



An important piece of legislation that deals with direct lines is Section 10 of S.I 60 2005 [4] (this amends Section 14 of the Electricity Regulation Act 1999 [2]).

The Electricity Regulation Act 1999 [2] provides the following definitions:

Distribution
in relation to electricity, means the transport of electricity by means of a distribution system, that is to say, a system which consists of electric lines, electric plant, transformers and switchgear and which is used for conveying electricity to final customers;
Transmission
in relation to electricity, means the transport of electricity by means of a transmission system, that is to say, a system which consists, wholly or mainly, of high voltage lines and electric plant and which is used for conveying electricity from a generating station to a substation, from one generating station to another, from one substation to another or to or from any interconnector or to final customers but shall not include any such lines which the Board may, from time to time, with the approval of the Commission, specify as being part of the distribution system but shall include any interconnector owned by the Board.
Single premises
means one or more buildings or structures, occupied and used by a person, where each building or structure is adjacent to, or contiguous with, the other building or structure;
Final customer
means a person being supplied with electricity at a single premises for consumption on those premises

S.I 60 2005 [4] states that 'the Commission may grant or refuse to grant to any person a licence…to discharge the functions of the distribution / transmission system operator…[that licence] shall only be granted to the Board or a subsidiary of the Board'. In this case the 'Board' refers to ESB.

This essentially means that a licence to operate a distribution / transmission system can only be granted to ESB (or a subsidiary) and therefore only ESB Networks / EirGrid can operate a distribution / transmission system (i.e. only ESB Networks / EirGrid are permitted to transport electricity by means of a distribution / transmission system to final customers). The effect of the definitions of 'final customer' and 'single premises' means that the transport of electricity from one single premise to another requires the use of a 'distribution/transmission system'. Unless this distribution / transmission system is to be operated by ESB Networks / EirGrid then this would be in contravention of the legislation.

However it should be noted that, Section 30 of S.I 60 2005 [4] amends Section 37 of the Electricity Regulation Act 1999 [2]. This legislation prohibits the use of direct lines unless ESB has first refused permission for a connection to the network and the CER has given its approval. This piece of legislation is intended to transcribe Article 22 of EU Directive 2003/54/EC [9].This regulation provides a theoretical opportunity for the development of direct lines, although, to-date, there has been no occurrence of direct lines in Ireland as ESB have never refused permission for connection or the CER has never given permission for a direct line.

13 Appendix G – Guidance notes for completing connection applications

The information provided in the connection application form is used by the system operators to plan the connection method for the generator and to prepare a connection offer. The application form requires the submission of both technical and non-technical data. To assist with the completion of the connection application forms, developers will often seek assistance from an electrical engineer. Generator manufacturers and suppliers can also assist with the completion of certain section of the forms.

13.1 ESB Networks Microgeneration Application (≤11 kW) [11]

Guidance on completing the micro generation application can be found in the 'Your Guide to Connecting Microgeneration to the Electricity Network'.

13.2 ESB Networks Distribution Connection Application (>11 kW) [16]

Wind farm applicants with a predicted Maximum Export Capacity (MEC) of less than or equal to 5 MW: complete parts 1, 2, 3 and 5.

Wind farm applicants with a predicted MEC of greater than 5 MW: complete parts 1, 2, 4 and 5.

Non-wind applicants: complete parts 1 and 5.

Guidance for completion of the various parts of the connection application is given in Table 13-1; a checklist for a Distribution Connection Application is given in Table 13-2.

It is important that applicants check that they are using latest version of application form at all times. Use of an out of date form can render the application incomplete.

Table 13-1: Guidance notes for completing a Distribution Connection Application Form.

Section	Question	Description	
Part 1 – To be completed by all applicants			
Applicant details	1-6	Insert the contact details for the applicant. ESB Networks will use these contact details for future correspondence. This is normally the name of the developer rather than the consultant.	
Site details	7-11	Planning permission	The status of the request for planning permission; for example, pending or granted, at the time of submission of the application should be entered. Any planning reference number from the County Council or An Bord Pleanála should be provided. Planning permission is not a pre-requisite for the submission of an application for a grid connection.
		Site substation co-ordinates	Provide map grid reference co-ordinates of the proposed location of the generator substation. See Section 13.4 below for an explanation of how to derive grid co-ordinates from an Ordnance Survey map. In selecting the location of the substation, consideration should be given to the proximity to the generator(s), site access, planning permission constraints and the direction of the likely connection route to the ESB infrastructure. The precise location of the substation may be permitted to change later in the connection development process following discussions with ESB Networks.

General details	12-15	Projected start-up date	The date that construction is expected to begin on the site.
		Target connection date	The date when the generator will be ready to connect to the grid.
		Maximum Export Capacity (MEC) Required	The maximum power, expressed in MW, to be exported onto the grid at any given time. This is a critical parameter in the connection application form and should be considered carefully prior to submission. After the connection application is deemed complete it is not possible to increase the MEC requested. A separate application is required to increase the MEC. If the application is an extension to an existing generator or connection application it is the additional export capacity required that is entered here.
		Is this project an extension?	If the project is an extension to an existing generator or connection application, it should be stated as such here.
Generator application fees		Generator application fees	For generators that are likely to be processed under group processing, application fees are only requested once the project is accepted into a gate. For applications that are outside of group processing, the appropriate fee will be requested once they have been approved to be handled outside group processing.

Maps and diagrams	17-19	The application must be accompanied by 2 Ordnance Survey maps, a site plan and an electrical single line diagram.	
		Site Plan	This must show the proposed connection point/substation, generators, transformers, site buildings.
		Electrical Single Line Diagram	This drawing should include the details (e.g. voltage level) of all significant electrical plant, including transformers, relays, interlocking, earthing, synchronising arrangements, CT and VT ratios, power factor correction etc. ESB are unable to confirm connection method and operating voltage at application stage hence the SLD may be a proposal rather than final. For extensions, to assist with designing the metering arrangements it is important to indicate the existing customer network.
Site load data	20-22	Maximum Import Capacity (MIC)	This is the peak power, expressed in kVA, the connection will import at any given time.
		House load	The maximum amount of power, expressed in kW, the site will need when running continuously during normal conditions.
		For example, a project may have a house load of 6 kW but an MIC of 20 kW during start-up.	
Technical details	23-40	Insert technical details of the generator, which would allow ESB Networks to form a detailed assessment of the impact of the generator's output upon its system. Much of the necessary data can usually be obtained from the generator manufacturer / supplier. A response to question 40 within the application form will require the completion of a calculation sheet demonstrating the predicted fault current from the proposed generator facility. If the generator manufacturer or supplier cannot assist you with the necessary calculations, you should consult an electrical engineer. Q40 calculations are site specific; it is unacceptable to respond with a reference to manufactures specification sheets. The calculations take into account the sum of generators, site conductors and transformers. For avoidance of doubt calculations relate only to the fault level from the generators	

Network connection transformer	41-50	Insert details of the proposed network connection transformer. The network connection transformer converts the voltage at the point of supply to the internal site voltage, for example a 38/20 kV transformer where the generator connects to the ESB 38 kV system and the internal voltage on the generation site is 20 kV. Data for the network connection transformer should be obtained from a transformer manufacturer / supplier. It should be noted that in some cases a network connection transformer may not be required, for example a wind farm that has an internal voltage of 20 kV and a connection at 20 kV. ESB cannot confirm the connection method and operating voltage at application stage hence the details may be a proposal rather than final. In particular this indicates the preferred connection method on behalf of the developer.
Generator transformer data	51-58	Each generator may have its own transformer to step-up the voltage from the generator voltage to the internal network voltage. For example, in a wind farm it is typical for each turbine to generate at low voltage (e.g. 690 V); each turbine would be connected to a generator transformer to step-up the voltage to that used in the internal wind farm network (e.g. 20 kV).
Power quality	59	Information on power quality is not required to be submitted with the application but voltage flicker and harmonic contribution data will be required upon acceptance of the connection offer. Generator manufacturers / suppliers can usually assist with providing this information.
Mains excited asynchronous generators	60-65	This section applies to mains excited asynchronous generators only. The information on the generator can be obtained from the generator manufacturer / supplier. If the generator manufacturer / supplier cannot assist with supplying these figures, then an electrical engineer should be consulted. An electrical engineer may also have to be consulted for the calculations on the reactive power compensation to be installed and the cable charging current.
Question 66 to 81 apply to non-wind applicants only		
Generator data for fault studies	66-73	These parameters can be obtained from the generator manufacturer / supplier.

Generator data for dynamic studies	74-81	These parameters can be obtained from the generator manufacturer / supplier.
Part 2 – To be completed by all wind farm applicants		
Independence of contiguous wind farms	82	If the developer has a commercial / legal relationship with a neighbouring wind farm it should be declared in this section.
Generator data for fault studies (short circuit);	83	These parameters can be obtained from the generator manufacturer / supplier.
Part 3 – To be completed by all wind farms with a MEC less than or equal to 5 MW		
Wind turbine generators	84-85	These parameters can be obtained from the generator manufacturer / supplier.
Dynamic simulation data	86-112	EirGrid publishes a list of the Wind Turbine Generators (WTG) that have approved dynamic models. A dynamic model is a representation of the behaviour of a wind turbine generator in power system simulation software. This list can be viewed on the EirGrid website. If EirGrid list an approved dynamic model for the WTG, only questions 86 to 90 need be completed. If the proposed WTG is not on the list then questions 91 to 112 must be completed. Information on dynamic models can be requested from the WTG manufacturer / supplier. Where a supplier is developing a new model ESB Networks may deem the application complete subject to information being provided prior to applicant been qualified within a gate.

Part 4 – To be completed by all wind farms with a MEC greater than 5 MW		
Wind turbine generators	113-114	These parameters can be obtained from the generator manufacturer / supplier.
Internal wind farm network structure and corresponding data	115-132	Insert details of the proposed internal network of the wind farm. Completion of this section will require an outline design of the proposed wind farm, which in turn is likely to require the assistance of an electrical engineer to derive indicative specifications of major items of plant such as cables, transformers and reactive power compensation equipment.
Dynamic simulation data	133-139	EirGrid publishes a list of WTG that have approved dynamic models. This list can be viewed on the EirGrid website. If EirGrid have an approved dynamic model for the WTG only questions 134 to 139 need be completed. If the proposed WTG is not on this list then questions 133 and 139 must be completed. Information on dynamic models can be requested from the WTG manufacturer / supplier. Where a supplier is developing a new model ESB Networks may deem the application complete subject to information being provided prior to applicant been qualified within a gate.

Part 5 - To be completed by all applicants		
Signature of the landowner		The signature is required for all landowners on whose land the substation / generators are located.
Signature of the applicants		This is the signature of the person wishing to develop the generator facility.

Table 13-2: Checklist for Distribution Connection Applications.

Item	Distribution Application Checklist	Applicable to	√ / X
1	Covering letter	All generators	
2	Connection application	All generators	
3	Application fee	See Section 4.3.1. For generators that are likely to be processed under group processing, application fees are only requested once the project is accepted into a gate. For applications that are outside of group processing the appropriate fee will be requested once they have been approved to be processed outside the group processing.	
4	2 Ordnance Survey 'Discovery Series' maps	All generators	
5	Site plan	All generators	
6	Single line diagram	All generators	
7	Functional block diagram	Thermal generators only	
8	Short circuit fault current calculation sheet	All generators	
9	Wind turbine generator power curve	Wind generators only	
10	Information on internal network	Wind farms with a MEC greater than 5 MW only	
11	Reactive power capability curve for wind farm site	Wind farms with a MEC greater than 5 MW only	
12	Dynamic model from manufacturer	All wind farms – only if it has not previously been submitted by the manufacturer.	
13	Signature of the landowner	All generators	
14	Signature of the applicant	All generators	

13.3 EirGrid Transmission connection application

EirGrid has to two different generator connection application forms:

Application form for the connection of Wind Generation Facilities
Application form for the connection of Generation Facilities

It is important that applicants check that they are using latest version of application form at all times. Use of an out of date form can render the application incomplete.

13.3.1 Wind generation facilities [28]

The information required for this application form is given in Table 13-3; a checklist for Transmission Connection Application for Wind Generation Facilities is given in Table 13-4.

Table 13-3: Guidance notes for completing a transmission connection application form for wind generation facilities.

<table>
<tr><th colspan="4">Wind Generation Facilities</th></tr>
<tr><th>Section</th><th>Question</th><th colspan="2">Description</th></tr>
<tr><td>Details of applicant</td><td>1-8</td><td colspan="2">Insert the contact details for the applicant of the wind farm. All EirGrid correspondence in relation to the site will be sent to these details.</td></tr>
<tr><td>General details</td><td>9-11</td><td colspan="2">If the applicant has not signed a confidentiality agreement, 2 copies must accompany the application. Confidentiality agreement templates can be found on the EirGrid website [C2].</td></tr>
<tr><td rowspan="4">Maps and diagrams</td><td rowspan="4">12-14</td><td colspan="2">The application must be accompanied by 1 Ordnance Survey map, a site plan and an electrical single line diagram.</td></tr>
<tr><td>Site substation co-ordinates</td><td>Insert map grid reference co-ordinates of the proposed location of the generator substation. See Section 13.4 below for an explanation of how to derive grid co-ordinates from an Ordnance Survey map. In selecting the location of the substation, consideration should be given to the proximity to the generator(s), site access, planning permission constraints and the direction of the likely connection route to the EirGrid's system.

The location of the substation may be changed later in the connection development process following discussions with ESB Networks.</td></tr>
<tr><td>Site Plan</td><td>This must show the proposed connection point / substation, generators, transformers, site buildings, meteorological masts etc.</td></tr>
<tr><td>Electrical Single Line Diagram</td><td>The Single Line Diagram shall include the details (e.g. voltage levels) of all significant electrical plant including transformers, relays, interlocking, earthing, synchronising arrangements, CT and VT ratios, power factor correction, etc.</td></tr>
</table>

Technical Details Required	15-19	Target connection date	This is the date when the energisation of the connection is required.
		Projected period from target connection date to operational date	This is the time period between the energisation of the connection and operational date for the generator to start exporting power.
		Maximum Export Capacity (MEC) Required	This is the maximum power, expressed in MW, to be exported onto the grid at any given time. This is a critical parameter in the connection application form and should be considered carefully prior to submission. After the connection application is deemed complete it is not possible to increase the MEC requested. A separate application is required to increase the MEC.
		Number of connecting circuits	It is typical for generators to only request one connecting circuit but more may be requested for security of supply reasons.
Wind turbine data	20-29	These details can be obtained from the generator manufacturer / supplier.	
Wind turbine generator transformer	30-37	Each generator may have its own transformer to step-up the voltage from the generator voltage to the internal network voltage. For example, in a wind farm it is typical for each turbine to generate at low voltage and to have a generator transformer to step-up to a higher voltage such as 20 kV.	
Wind farm site	38-45	The information required about the power factor of the generators, details of start-up regime and test results for the fault ride through can be requested from the generator manufacturer / supplier. Information required to respond to Questions 40-42 will require the indicative specification of reactive power compensation devices necessary for the wind farm to achieve compliance with the Grid Code. Assistance from an electrical engineer may be required.	
Internal wind farm network and corresponding data	46-55	Insert details of the proposed internal network of the wind farm. Completion of this section will require an outline design of the proposed wind farm, which in turn is likely to require the assistance of an electrical engineer to derive indicative specifications of major items of plant such as cables, transformers and reactive power compensation equipment. See Section 10 for an explanation note on reactive power.	

Grid connected transformer data	56-65	This section requests information on the network connected transformer which steps the internal network voltage up the to the transmission network voltage. Data for the network connection transformer can be obtained from a transformer manufacturer / supplier.	
Station data	66-68	Maximum Import Capacity (MIC)	This is the peak power, expressed in kVA, the connection will import at any given time.
		House load	The maximum amount of power, expressed in kW, the site will need when running continuously during normal conditions.
Generation data for fault studies	69-70	These details can be obtained from the generator manufacturer / supplier.	
Dynamic simulation data	71-81	EirGrid publishes a list of Wind Turbine Generators (WTG) that are the subject of approved dynamic models. A dynamic model is a representation of the behaviour of a wind turbine generator in power system simulation software. This list can be viewed on the EirGrid website. If EirGrid list an approved dynamic model for the WTG only questions 71 to 77 need be completed. If the proposed WTG is not on this EirGrid list then questions 78 and 79 must be completed. Information on dynamic models can be requested from the WTG manufacturer / supplier.	

Table 13-4: Checklist for transmission connection application for wind generation facilities.

Transmission Wind Generation Application Checklist		Applicable to	√ / X
1	Covering letter	All generators	
2	Connection application	All generators	
3	Application fee - €7,000	All generators	
4	2 signed copies of the Confidentiality Agreement (if not already signed)	All generators	
5	1 Ordnance Survey 'Discovery Series' map	All generators	
6	Site plan	All generators	
7	Single line diagram	All generators	
8	Wind turbine generator power curve	All generators	
9	Power quality test report	All generators	
10	Reactive power capability curve for wind farm site	All generators	
11	Fault ride through capability test results	All generators	
12	Information on internal network	All generators	
13	Station data details	Only if a separate transmission connection is required to feed house load	
14	Short circuit decrement curve	All generators	
15	Dynamic model from manufacturer	Only if it has not previously been submitted by the manufacturer.	
16	Grid Code Acknowledgement/Compliance Declaration	All generators	

13.3.2 Generation facilities (other than wind)

The information required for this application form is given in Table 13-5; a checklist for transmission connection application for all generators apart from wind energy is given in Table 13-6.

Table 13-5: Guidance notes for completing a transmission connection application form (all generators other than wind).

Generation facilities (other than wind)			
Section	**Question**	**Description**	
Details of applicant	1-8	Insert applicant contact details. All EirGrid correspondence in relation to the site will be sent to these details.	
General details	9-12	If the applicant has not signed a confidentiality agreement, 2 copies must accompany the application. Confidentiality agreement templates can be found on the EirGrid website.	
Maps and Diagrams	13-16	The application must be accompanied by 1 Ordnance Survey maps, a site plan and an electrical single line diagram.	
		Site substation co-ordinate	Insert map grid reference co-ordinates of the proposed location of the generator substation. See Section 13.4 below an explanation of how to derive grid co-ordinates from an Ordnance Survey map. In selecting the location of the substation, consideration should be given to the proximity to the generator(s), site access, planning permission constraints and the direction of the likely connection route to the EirGrid's system. The location of the substation may be changed later in the connection development process following discussions with ESB Networks.
		Site Plan	This must show the proposed connection point / substation, generators, transformers, site buildings, etc.
		Electrical Single Line Diagram	The Single Line Diagram shall include the details (e.g. voltage levels) of all significant electrical plant including, transformers, relays, interlocking, earthing, synchronising arrangements, CT and VT ratios, power factor correction equipment, etc.

General data	17-22	Target connection date	This is the date when the energisation of the connection is required.
		Projected period from target connection date to operational date	This is the time period between the energisation of the connection and operational date for the generator to start exporting power.
		Maximum Export Capacity (MEC) Required	This is the maximum power (expressed in MW) exported onto the grid at any given time. This is a critical parameter in the connection application form and should be considered carefully. After the connection application is deemed complete it is not possible to increase the MEC requested. A separate application is required to increase the MEC.
		Number of connecting circuits	It is typical for generators to only request one connecting circuit but more may be requested for security of supply reasons.
Plant capability data	23-42	This requests general information on the generator such as its fuel type, range of generation capacity and power factor range. These details can be obtained from the generator manufacturer / supplier.	
Grid connected transformer data	43-77	This section requests information on the network connected transformer which steps the internal network voltage up to transmission voltage. Data for the network connection transformer can be obtained from a transformer manufacturer / suppliers.	
Station data	78-80	Maximum import capacity	This is the peak power, expressed in kVA, the connection will import at any given time.
		House load	The maximum amount of power, expressed in kW, the site will need when running continuously during normal conditions.
Generation data for fault studies	81-86	These details can be obtained from the generator manufacturer / supplier.	
Dynamic	87-101	Generator Data	These details can be obtained from the generator manufacturer / supplier.

Simulation Data		Excitation system	This control model of the generator excitation system must be submitted. The generator manufacturer / supplier should be able to provide this information. See Appendix C of the application for a list of standard models.
		Power system stabiliser	The generator manufacturer / supplier should be able to provide this information when required.
		Governor system	The control model of the generator governor system must be submitted. The generator manufacturer / supplier should be able to provide this information. See Appendix E of the application form for a list of standard models.

Table 13-6: Checklist for transmission connection applications (other than wind)

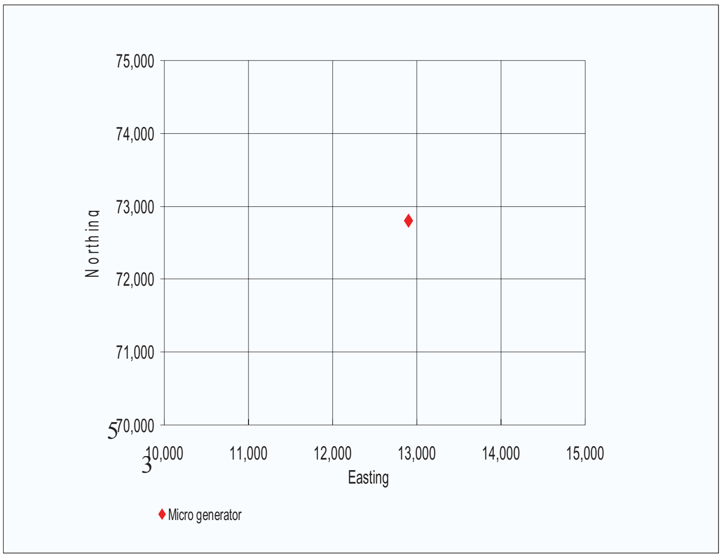
Transmission Generation Facilities (other than wind) Application Checklist		Applicable to	√ / X
1	Covering letter	All generators	
2	Connection application	All generators	
3	Application fee - €7,000	All generators	
4	2 signed copies of the Confidentiality Agreement (it not already signed)	All generators	
5	1 Ordnance Survey 'Discovery Series' maps	All generators	
6	Site plan	All generators	
7	Single line diagram	All generators	
8	Functional block diagram	All generators	
9	MW output vs. ambient temperature chart	If applicable	
10	Peaking capacity graph	If applicable	
11	Reactive power capability curve	All generators	
12	Station data details	Only if separate transmission connection is required to feed house load	
13	Open-circuit magnetic saturation curve	If applicable	
14	Generator excitation control block diagram	If applicable	
15	Governor control block diagram	All generators	
16	Grid Code Acknowledgement/Compliance Declaration	All generators	

13.4 OS co-ordinates

For the connection application forms the site co-ordinates requested are the Easting and the Northing co-ordinates of the proposed substation. These can be found from a 1:50,000 Discovery Series Ordnance Survey (OS) map. Easting co-ordinates are the numbers on the horizontal axis. Northing co-ordinates are the numbers on the vertical axis.

OS co-ordinates are usually presented in the following fashion - QYY,ZZZ, where;
Q = the first number (in a subscript) at the bottom left hand corner of the map.
YY = the numbers on the horizontal axis directly below the site to the left (i.e. 12).
ZZZ = the actual position in the grid expressed from 0 to 999 (e.g. if halfway horizontally within the grid square, the Easting number is approximately 500).The Northing co-ordinates are similarly identified, except that the numbers refer to the vertical axis.
In the following example the microgenerator is located at Easting 312,900 and Northing 572,800.

Figure 13-1: Grid reference for microgeneration notification form



14 Appendix H - Contact Details of Key Organisations

Sustainable Energy Ireland Glasnevin Dublin 9 Tel: +353 (0)1 836 9080 Fax: +353 (0)1 837 2848 Email: info@sei.ie Web: http://www.sei.ie/	**ESB Networks** Generator Connections PO Box 29 Garrycastle Athlone Co. Westmeath Tel: 1850 372 757 Fax: 0906479329 Email: dsogenerators@esb.ie Web: http://www.esb.ie/esbnetworks
EirGrid Plc 160 Shelbourne Road Ballsbridge Dublin 4 Tel: +353 (0)1 677 1700 (Reception) +353 (0)1 702 6642 (Customer Relations Team) Fax: +353 (0)1 661 5375 Email: info@eirgrid.com Web: http://www.eirgrid.com/	**Commission for Energy Regulation** The Exchange Belgard Square North Tallaght Dublin 24 Tel: +353 (0)1 4000 800 Fax: +353 (0)1 4000 850 Email: info@cer.ie Web: http://www.cer.ie/
Department of Communications, Energy and Natural Resources 29-31 Adelaide Road Dublin 2 Tel: +353 (0)1 678 2000 Fax: +353 (0)1 678 2449 Email: firstname.lastname@dcenr.gov.ie Web: http://www.dcmnr.gov.ie/	**SEMO Customer Service** 160 Shelbourne Road Ballsbridge Dublin 4 Tel: 1 800 778 111 Email:markethelpdesk@allislandmarket.com Web: http://allislandmarket.com/ Or **SEMO Customer Service** Castlereagh House 12 Manse Road Belfast BT6 9RT Northern Ireland Tel: **0 8000 778 111** Email:markethelpdesk@allislandmarket.com Web: http://allislandmarket.com/

Irish Wind Energy Association Killowen House Southernlink Business Park Jigginstown Naas Co. Kildare Tel: +353 (0)45 899341 Email: office@iwea.com	**CHP Ireland** c/o Conor Gouldsbury IBEC Confederation House 84-86 Lower Baggot Street Dublin 2 Tel: +353 (0)1 605 1557 Fax: +353 (0)1 638 1557 Email: conor.gouldsbury@ibec.ie
IBEC Renewables Group c/o Erik O'Donovan IBEC Confederation House 84-86 Lower Baggot Street Dublin 2 Tel: +353 (0)1 605 1672 Email: erik.odonovan@ibec.ie	**Solar Energy Society of Ireland** C/O Focas Institute, Dublin Institute of Technology, Kevin Street Dublin E-mail: sesireland@gmail.com http://www.irishsolar.com/
The National Offshore Wind Energy Association of Ireland (NOW Ireland) Marine Court Blackrock Co. Louth Ireland Tel: +353 (0) 42 9322994 Email: info@nowireland.ie Web: http://www.nowireland.ie	**Irish Bioenergy Association** Email: contact@irbea.org Web: http://www.irbea.org
Irish Ocean Energy Industry Forum c/o Marine Institute Rinville, Oranmore, Co.Galway. Phone: +353 91 387 200 Fax +353 91 387 201 Email: marinetech@marine.ie Web:http://www.marine.ie/home/services/rnd/oceanenergymarinetechnology/OceanEnergyIndustryForum.htm	**Irish Hydro Power Association** c/o Neil Stewart Joseph Stewart and Company, Corn Mills Boyle Co. Roscommon Tel: 071 967 0100 Email: info@irishhydo.com Web: http://www.irishhydro.com

RECI Register of Electrical Contractors of Ireland Unit 9, KCR Industrial Estate Ravensdale Park Kimmage Dublin 12. Tel: 01 - 492 9966; Fax: 01 - 492 9983. E-mail: info@reci.ie Web: http://www.reci.ie/	**Electro-Technical Council of Ireland Ltd,** ETCI Offices, Unit H12, Centrepoint Business Park, Oak Road, Dublin 12, Ireland Tel :+353-1-4290088 Fax :+353-1-4290090 Email : info@etci.ie
Meitheal na Gaoithe (Irish Wind Farmers Co-operative Society Ltd.) Jane Wickham 42 Parliament Street Kilkenny Ireland Telephone: +353 (0) 56 775 2111 Fax: +353 (0) 56 775 2333 Email: info@mnag.ie	

15 Appendix I–references

15.1 Legislation and miscellaneous documents

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