

# Community Renewables Toolkit

## Grid Connection Module

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### Toolkit Structure

The Community Renewables Toolkit is intended to be used as a reference by community groups developing or planning to develop renewable generation. This module is one part of a series of documents forming the Toolkit and is designed to cover all sizes of project, although the scale and complexity of multi MW projects may require more detailed evaluation than smaller projects. Other modules that may also be of particular interest to those reading this module are as follows.

- establishing a community group
- project finance
- procurement
- securing the site
- planning
- grid connection
- the Feed-in-Tariff

This toolkit builds on the work completed for the Scottish Government's Community and Renewable Energy Scheme (CARES) by Local Energy Scotland and Ricardo-AEA.

### Module Structure

The Grid Connection Module is designed to cover all sizes of project and to assist community groups of all kinds. Information specific to scale is flagged as appropriate. The module is divided into the following sections:

**The UK Electricity System** – A brief overview of the electricity distribution system, designed to support discussions that will be required during the connection process.

**The Connection Process** – An overview of the connection process for different sizes of generation.

**The Cost of Connection** – An overview of the components of and issues around connection charges.

**Securing a Connection** – Information about the content of connection offers, and the relevant timescales around receiving and accepting them.

**Further Information** – Appropriate links to find more information.

# The UK Electricity System

Electricity supply comprises two linked systems – transmission and distribution.

**Electricity transmission** transports electricity over long distances across the country. Electricity is transported at a high voltage to reduce losses. In England, the transmission network includes network at 400kV and 275kV, and is owned and operated by National Grid.

**Electricity distribution** takes power from the transmission network and distributes it to consumers. The voltage is reduced to the correct supply voltage for the loads. In England and Wales, these networks operate at 132kV and lower. Most residential customers are supplied at 230V. These networks are owned and operated by licenced Distribution Network Operators (DNOs) who are each responsible for the network within a geographic area (see Figure 1).

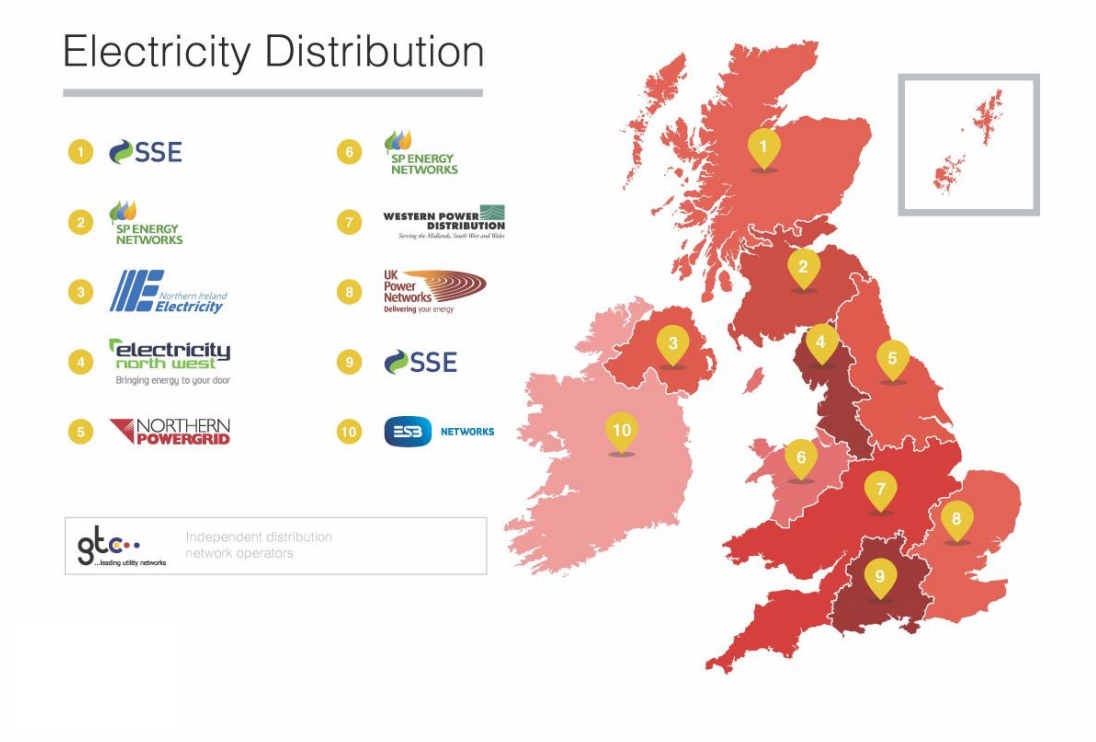


Figure 1: Electricity Distribution Network Operators (Source: Copyright to Electricity Network Association (ENA) and kindly supplied. Should not be reproduced unless given permission by ENA)

**Independent Distribution Network Operators (IDNOs)** also exist and operate small areas of network. These are often associated with major developments like business parks and industrial sites where the developer has chosen to maintain control of their network.

The operation of electricity networks is a separate business from electricity supply. Suppliers are responsible for buying electricity from generators, and selling it to consumers, and carry out activities such as metering, billing, and customer services. While customers can choose and change their electricity supplier, this is obviously not possible for DNOs.

In a traditional power system, large power stations feed into the transmission network, and the electricity is then transported to the distribution Networks. The distribution networks carry the

electricity to loads, such as homes and businesses. The transmission and distribution networks are also called transmission and distribution systems.

However, an increasing number of small power stations are being developed, often connected to distribution networks. Generation connected to the distribution network is called Distributed Generation (or Embedded Generation). Distributed Generation can result in electricity flows in both directions; from the distribution network to customers, and from customers with Distributed Generation back into the distribution network. The system is no longer a “waterfall” system, with electricity flowing from the large power stations in one direction towards customers. Instead, electricity flows are more unpredictable.

This Guide is aimed at community renewable energy schemes aiming to connect to the distribution network. Therefore it will be your DNO who is your main point of contact for connection. However, there can also be constraints at the transmission network level which can affect the operation of embedded generation projects.

## The Connection Process – Embedded Generation

A number of technical standards are in place to govern the requirements for grid connection. These standards serve several purposes, including:

- to ensure that the generator will be able to operate safely on the network, and will not cause any issues with network protection or power quality (such as voltage level and frequency), and
- to protect the generator from any faults that may occur on the distribution network.

The processes used for connection of embedded generation depend on the size of electricity generator, and falls under two sets of Engineering Recommendations (EREC); G83 and G59.

Engineering Requirements	Criteria	Examples
<b>G83 Single Premises</b>	<p>Applies to ‘Small Scale Embedded Generation’, defined as generation up to:</p> <ul style="list-style-type: none"> <li>• 3.68 kW on a single-phase supply,</li> <li>• 7.36kW on a two-phase supply, or</li> <li>• 11.04 kW on a three-phase supply.</li> </ul> <p>This limit applies to the aggregate capacity of the installation on one supply point.</p> <p>The generation equipment must also be tested and approved according to the G83 requirements (known as ‘type tested’ equipment).</p>	<ul style="list-style-type: none"> <li>• Solar panels on a roof (domestic scale or small commercial scale)</li> <li>• Small single wind turbines</li> <li>• Very small single hydro power turbines</li> </ul>
<b>G83 Multiple Premises</b>	<p>If a developer is installing G83 compliant generators to more than one premises (e.g. with separate supply connection points) in a ‘Close Geographic Region’, then they have to follow a slightly more complex process.</p> <p>The DNOs will be able to give advice on this, but a general rule is that if the sites are within 500 meters of each other, or if the</p>	<ul style="list-style-type: none"> <li>• Solar panels installed on multiple roofs within one community</li> </ul>

	post codes are the same at least up until the last two letters, then they are likely to be within a close geographic region.	
<b>G59</b>	Applies to all other generation, including those that are too large to fall under G83, and those that are not type-tested.	<ul style="list-style-type: none"> <li>• Solar farms</li> <li>• Wind farms</li> <li>• Hydro turbines</li> </ul>

The process of connecting generating equipment that falls under G59 and G83 (single and multiple installations) is summarised in the sections below.

### Connection under Standard G83 – Single Premises

In most cases, the installation of Small Embedded Generation into a single premises will have very little effect on the network. Therefore the connection process is relatively simple, and can be summarised as “fit and inform”. The key tasks are needed to connect G83 compliant generation to the network are listed below. There is no charge or delay for connection of embedded generation under G83. Hence, some schemes are carefully sized to fall within the maximum limits of G83.

<b>Design, Construction and Commissioning</b>	Find a competent installer to install and commission generation and connection equipment. A competent installer will be aware of the technical requirements of G83 and ensure that construction and commissioning is in line with these.
<b>Inform the DNO</b>	There is a legal obligation for anyone wishing to install this type of generation to notify the DNO of their proposal within 28 days following the date of commissioning. An installer will often offer to submit the notification as part of its scope of work.
<b>Ongoing Responsibilities</b>	The equipment needs to be maintained throughout its lifetime to ensure that it is in good working order and continues to meet the requirements of G83.

### Connection under Standard G83 – Multiple Premises

Where customers, developers or installers wish to install more than one G83 unit within a close geographic region, there is a much greater chance that the connected generation will have an impact on the local network. DNOs may have to upgrade existing equipment, or install new equipment, to ensure that the network can maintain proper operation when the generation comes online. Therefore an agreement must be made with the DNO before the connection is made, and the generation developer will be pay a connection charge to cover the cost to the DNO.

The list below presents the key actions that you have to complete to connect multiple to the electricity distribution network. This is alongside the other elements of the project such as design and construction of the installation itself, and any commercial arrangements to sell the electricity that the system will produce.

<b>Review Information and Discuss with the DNO</b>	<p>DNOs provide information to support generation developers on their websites, such as maps that show the existing spare network capacity. Many also hold dedicated generation ‘surgeries’ or ‘drop in’ sessions to discuss projects.</p> <p>Early engagement with the DNOs is important to identify any potential grid connection barriers to the project. This is important to ensure grid connection timelines and costs are commensurate with project ambitions. See the Further Information section for</p>
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	links to the DNO websites.
<b>Formal Application and Connection Offer</b>	<p>Before the connection to the network is constructed, a formal connection offer must be agreed with the DNO. To do this, an application form must be submitted in the format given in <a href="#">Appendix 2 of EREC G83</a>, which is available on the Energy Network Association’s website. The form is often submitted by the installer.</p> <p>Once the DNO has reviewed the form and conducted any assessments, they will produce a connection offer. This will specify the conditions for the connection and any connection charges that apply. You should ensure that you fully understand this offer before accepting it, and can discuss questions with your DNO if you are unsure.</p>
<b>Construction and Commissioning</b>	<p>The DNO may need to carry out some work to prepare for the connection, for example to increase the capacity of the local network to ensure that your generation can connect safely. Close communication with the DNO throughout this process will allow coordinated planning of construction and connection.</p> <p>Again, a competent installer should be aware of the technical requirements of G83 and ensure that construction and commissioning is in line with these.</p>
<b>Inform the DNO</b>	<p>Once the installation is complete, the DNO needs to be made aware of your generating unit(s) and the technical detail of the installation. An installation commissioning confirmation form must be submitted for each installation within 28 days of commissioning. This is usually completed by the installer.</p>
<b>Ongoing Responsibilities</b>	<p>The equipment needs to be maintained throughout its lifetime to ensure that it is in good working order and continues to meet the requirements of G83. The DNO must be informed if any change is made to the generation or connection equipment, and when the equipment is decommissioned.</p>

## Connection under Standard G59

The tasks for connecting generation equipment under G59 are similar to those to connect multiple generators under G83, in that there needs to be a connection agreement with the DNO before the connection is made. However, the process is potentially more complex, and the cost of connection could be significantly higher if the infrastructure and planning required to make the connection may be much greater. The list below presents the key actions that you have to complete to connect multiple to the electricity distribution network.

<b>Review Information and Discuss with the DNO</b>	<p>Use the information provided by the DNOs during the design of your project. For example, their Long Term Development Statements which will lay out the plans that they have to develop their networks in the future, and network capacity information including capacity heat maps. Many also hold dedicated generation ‘surgeries’ or ‘drop in’ sessions to discuss projects.</p> <p>Early engagement with the DNOs is important to identify any potential grid connection barriers to the project. This is important to ensure grid connection timelines and costs are commensurate with project ambitions.</p>
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<p><b>Gain Information and Plan Provision of Connection</b></p>	<p>Seek initial meetings with the DNO to discuss the proposed generation project, discuss the process of connection, and clarify the contestable and non-contestable work required for the connection.</p> <p><b>Non-Contestable Work:</b> The tasks that DNOs must do themselves, so that they can maintain co-ordination and control of their networks. Generally this includes reinforcing existing network equipment.</p> <p><b>Contestable Work:</b> The work that is open to competition it is called Contestable work, and can be conducted by the DNO or Independent Connections Providers (ICPs). This will be an individual project decision. Often, this work includes installation of new infrastructure, such as cables, transformers etc., that do not yet exist on the network.</p>
<p><b>Formal Application and Agreements: Connection Agreement, Adoption Agreement and Sire Responsibility Schedule</b></p>	<p><b>Connection Application:</b> All DNOs use the same common application form for G59 connection applications, and the DNO will specify what information they need. There is also a simplified form specifically for smaller generation projects (50kW or less three phase, or 17kW or less single phase), which is type tested under G59 or G83. This form may be submitted by the developer, installer, or the ICP.</p> <p><b>Connection Agreement:</b> Once the DNO has reviewed the form and conducted any assessments, they will produce a connection offer. This will specify the conditions for the connection and any connection charge that apply. You should ensure that you fully understand this offer before accepting it, and can discuss questions with your DNO if you are unsure.</p> <p><b>Adoption Agreement:</b> Where an ICP has been used to construct some of the connection infrastructure, an Adoption Agreement may be necessary to lay out the terms under which the DNO will take ownership of these connection assets.</p> <p><b>Site Responsibility Schedule:</b> (sometimes called a Joint Operational Agreement) In some cases it will be necessary to have a formal agreement for the operation of the connection interface between the generation project and the distribution network.</p>
<p><b>Construction</b></p>	<p>Clear communication is essential between the developer, the DNO and the ICP (where applicable) in order to coordinate construction of the generation equipment itself and the construction of the connection infrastructure.</p> <p>Once the equipment is constructed, the final generation equipment parameters will need to be submitted to the DNO. Where this is different to those supplied before the connection offer, then the DNO may need to review the offer.</p>
<p><b>Commissioning</b></p>	<p>Clear communication is also required during planning and carrying out the commissioning and connection, as both the generation unit and the connection equipment will need to be ready for the connection to be made.</p> <p>The generation equipment will need to be commissioned according to the requirements of G59, and the DNO may need to witness this. You must inform the DNO of the proposed commissioning schedule at least 15 working days before the intended date. After commissioning, a Commissioning Form will need to be submitted to the DNO. This must be within 30 days of commissioning.</p>
<p><b>Ongoing Responsibilities</b></p>	<p>The equipment needs to be maintained throughout its lifetime to ensure that it is in good working order and continues to meet the requirements of G59. The DNO must be informed if any change is made to the generation or connection equipment, and when the equipment is decommissioned.</p>

## Generation Embedded within a Building's Electrical System

If the proposed installation is to be connected to the system after the fuse protecting the DNO electricity supply and there is no intention to export electricity to the grid, then a connection agreement is not required. Under these circumstances, you must put the appropriate technology in place to prevent overspill of electricity on to the grid. Again, all work should be carried out to the necessary health and safety requirements and wiring regulations. Such detailed evaluation of the electrical systems should be completed by a qualified electrical engineer and is likely to form part of the technology supply agreements.

## Islanded or Off Grid Generation

If the planned system is not to be connected to the distribution or transmission networks (either directly or indirectly through private network), then the generation is classed as 'islanded' or 'off grid', and there is no need to contact the DNO. However, all current electrical and wiring regulations must be adhered to, and appropriate health and safety requirements met. Circuits that are fed by this generation (which will be entirely separate from the mains supply) must be marked.

Off-grid systems can be useful where there is very little or no electricity network in the area. However, the design will be bespoke, which is beyond the scope of this Toolkit.

## The Cost of Connection

The cost of connection charged by a DNO will include a number of elements. The most obvious element is the cost of the infrastructure to connect the generation unit. This is made up of:

- Network Extension – the cost of any new infrastructure built to connect the generation project to the network will be charged to the developer through the connection charge.
- Network Reinforcement – a proportion of any infrastructure associated with reinforcement of existing network will be charged to the developer through the connection charge.

The connection charge will also include other elements, such as the cost of any investigations and studies carried out in order to deliver the connection offer, site visits and administration.

DNOs publish information on how they determine connection charges (often called 'charging methodologies'), and these can be used to gain an idea of the likely charges that will be included before the formal offer is made. This information will be on the DNOs' websites.

Budget or indicative estimates for connection charges may be gained by a DNO or a third party consultants, though these should be interpreted carefully as they may not be accurate. While DNOs cannot charge when giving formal quotes, some may charge to give estimates.

In some cases, the planned generation will impact the transmission network, and additional studies will need to be carried out by the Transmission System Operator, National Grid. This is known as the Statement of Works process, and is more likely where the generation is larger, though it may apply to even smaller generation under certain circumstances. The DNO will interface with National Grid to carry out this process, but it may have a significant impact on the cost of connection.



Grid connection costs can range from £100,000/MW to £1,700,000/MW. In addition, it should be noted that the initial cost of connection identified at the feasibility stage can vary significantly from the final cost of the connection. See Further Information for more example of connection costs.

## Securing a Connection

Available capacity and connection capability on the network is a limited resource, and is sometimes in high demand from developers. Therefore, if you are developing projects under G59 or G83 Multiple Premises, then it is a good idea to secure an agreement quickly.

## Accepting Connection Offers

The DNO must provide the Connection Offer within certain timescales after submission of the connection application. These timescales are different depending on if the DNO is completing just non-contestable work, or if they will also be carrying out contestable work, and they also depend on the voltage level within the distribution network that the generation is connecting to. The maximum timescales are given in the table below:

Maximum timescale for DNOs to provide a connection offer (From date of application submission)		
Voltage Level	Where DNOs are completing non-contestable work	Where DNOs are completing contestable and non-contestable work
Low Voltage: Less than 1kV <b>In practice, this is 400/230V</b>	30 working days	45 working days
High Voltage: 1kV – 22kV <b>In practice, this is 6.6kV, 11kV or 20kV</b>	30 working days	65 working days
Extra High Voltage: Above 22kV <b>In practice, this is 33kV, 66kV or 132kV</b>	3 month	65 working days

Though DNOs are obligated to provide connection offers, it is possible that the date at which the connection can be made is a significant time, as much as several years, in the future. This is generally in areas where the local network requires significant upgrade in order to make the connection, and is more likely if the generation to be connected is larger. Uncertainty over the future level of FIT payments may increase the risk of developing community projects in this area. However, deposits may not be requested in these cases, and it may prove valuable to secure a place in the queue as circumstances may change, for example if other planned projects do not go ahead, or if changes in regulations or technology allow more generators to connect.

## Constrained Connection Agreements

In most cases, to provide a connection offer, the DNO has to take into account all of the worst-case conditions that could occur, and will design the connection so that the generation can output at full capacity under all normal network circumstances. This can lead to high costs of connection.

It may also be possible for generators in areas of grid capacity constraint to enter into connection agreements that are constrained according to a specific set of circumstances. This is sometimes



called a 'non-firm' connection agreement. A connection may be possible, in return for agreement that the DNO may need to restrict or switch off the generator. Such agreements can be useful to allow generation to connecting heavily congested networks without needing to pay very large connection charges, but the conditions will introduce additional risk and uncertainty in predicting revenue.

It should be noted that even with a standard connection agreement, in very rare cases the DNO may need to curtail generation in order to ensure safe operation of the network or to maintain power quality.

## Accepting a Connection Offer

Once the offer is issued by the DNO, you have a limited time in which to respond, generally between 30 and 90 days. Once this time is over, then there is no guarantee that the offer can be made in the same terms again, for example if the conditions on the network have changed, or the available capacity has been assigned to another application.

Since obtaining a grid connection is required to pre-accredit for the Feed-in Tariff (FIT) and to secure financial close, the connection application must usually be made at risk, in advance of funding being available. This makes it essential to identify a source of any deposit prior deciding to secure a connection. The deposit can be as much as 25% of the cost of the non-contestable works. This is often negotiable with the DNO.

In some cases it will be possible for multiple connection applications to affect each other, for example if they are connecting to the same area of network with available limited capacity. These applications are generally classed as 'interactive' and can be subject to a set process. In this process, the applications are considered in the order that they were received, and parties are each given an opportunity to accept the offer. Therefore, if you think your project may become interactive, it is important to submit your connection application as soon as you can. The DNO will inform all parties if their connection offer is, or becomes, interactive, and will explain their place in the queue and the process of accepting interactive offers.

It should be noted that connection offers can be withdrawn if the project is not progressing with reasonable pace. This is so that the network capacity is not set aside for projects that are not going ahead, and to allow other projects to use that capacity. The DNO may specify milestones in their connection offer that the project must meet in order to keep the agreement.

## Wayleaves and Consents

Where possible, the DNO will design any infrastructure routes so that they lie either within the boundary of your land, or on land that they have control over, avoiding the need for third-party agreement. If this is not possible, then an agreement will need to be reached with all land owners along the proposed connection route.

DNOs will require the consent of the landowner prior to beginning any work – consent is normally granted via a wayleave or servitude. This can affect the quotation offer and lead times required to complete the work. Early engagement with all parties is essential to identify any potential barriers to grid connection.

You will have to take the following into consideration when planning your project:

- timescales associated with obtaining third-party agreement can affect your project's delivery timetable;
- DNOs do not seek such consents until you have accepted their quotation;
- the charges given on quotations are given subject to all consents being agreed;
- where consents are refused, a new design and quotation will be required; and
- DNOs cannot undertake any works on third-party land until all consents have been agreed

Legal advice on securing consent from other landowners is recommended.

## **Preparing for Financial Close**

All information relating to the grid connection should be held securely in a central location. Potential lenders will want to see this information. Securing a grid connection is a key requirement before lenders will fund a project. Showing progress in securing the grid connection is important in the early stages of engaging with a lender.

## Further information

The first port of call for information to do with capacity and plans on the local network, and the process of applying for and gaining network connection should be the DNO websites:

DNO	Regions Covered	Main Website
<b>SSE Power Distribution</b>	North Scotland, Southern England	<a href="http://www.ssepd.co.uk">www.ssepd.co.uk</a>
<b>SP Energy Networks</b>	South Scotland, Cheshire, Merseyside and North Wales	<a href="http://www.spenergynetworks.com">www.spenergynetworks.com</a>
<b>Northern Power Grid</b>	North East England, Yorkshire	<a href="http://www.northernpowergrid.com">www.northernpowergrid.com</a>
<b>Electricity North West</b>	North West	<a href="http://www.enwl.co.uk">www.enwl.co.uk</a>
<b>Western Power Distribution</b>	East Midlands, West Midlands, Southern Wales, South West England	<a href="http://www.westernpower.co.uk">www.westernpower.co.uk</a>
<b>UK Power Networks</b>	Eastern England, South East England, London	<a href="http://www.ukpowernetworks.co.uk">www.ukpowernetworks.co.uk</a>

The Energy Networks Association have produced a set of Guides to support developers and owners through the process of connecting Embedded Generation under G59 and G83:

[www.energynetworks.org/electricity/engineering/distributed-generation/distributed-generation.html](http://www.energynetworks.org/electricity/engineering/distributed-generation/distributed-generation.html)

Information on connections costs and connection times that other community groups have faced can be found online. For example, see:

[www.uk.coop/sites/storage/public/downloads/cornwall\\_energy\\_report\\_overcoming\\_grid\\_connection\\_issues\\_for\\_community\\_energy.pdf](http://www.uk.coop/sites/storage/public/downloads/cornwall_energy_report_overcoming_grid_connection_issues_for_community_energy.pdf)).

If there is a dispute about the terms in the connection offer, then the first port of call is the complaints procedure of the individual DNO. If disputes cannot be resolved, the matter can be referred to the Energy Ombudsman, and then Ofgem.

Commissioned by the Energy Saving Trust.

Produced by Local Energy Scotland and Ricardo-AEA Ltd

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*This document was last updated March 2015*