

## RENEWABLE CONNECTIONS ON THE WEB: SERVICES FOR DISTRIBUTED GENERATION CONNECTIONS

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### ABSTRACT

*This paper describes an innovative new software system designed to automate the initial assessment of connecting new distributed generation plants to an electricity distribution network. A pilot web site has been developed to prove the concept of automating the engineering knowledge underlying the connection assessment process. A web based interface helps the user to locate their generation site through an interactive mapping tool supported by a Geographic Information System (GIS) database, and automatically produces an initial connection assessment report for that site. The paper also includes the results of a UK industry-wide evaluation of the pilot web site.*

### INTRODUCTION

Distribution Network Operators (DNOs) in the UK are required to publish statements detailing both the current state of their network system and any future planned developments. These statements provide a geographic overview of the network, electrical schematic diagrams, detailed information on network assets as well as information on existing load and generation connected to the network.

The information is made available in a Long Term Development Statement (LTDS), which DNOs are required to publish under the current terms of their Licence. The clause in the Licence which relates to the publication of the LTDS is numbered 25, so the LTDS is often referred to as the LC25 (Licence Condition 25).

The information in the LTDS is made available in the public domain with the aim of assisting any person in identifying and evaluating opportunities for connecting generation (and load) to the distribution network. This is part of a range of UK government incentives for increasing the amount of renewable generation, which is often connected to the distribution system.

The LTDSs are provided in static format (paper, PDF), which vary in content and presentation between different DNOs. The information in the LTDS includes tables listing the electrical properties of the Distribution Network assets, such as transformers, circuits and switchgear, as well as detail of loads and generation plants connected to the

distribution network. LTDSs also include maps showing the approximate location of primary substations and circuits, but they do not provide accurate geographic grid coordinates for these.

A good level of knowledge of electrical power systems and their modeling is required in order to interpret the information in the LTDSs and derive an assessment of the capacity of the distribution network to accept a new generation plant. This is typically carried out by experienced power system electrical engineers, which may work for the DNO, a generation site developer or an independent consultant.

The initial assessment of the grid connection for a generation site is a manual process which takes time. Larger generation site developers may consider a range of potential sites before deciding on the most promising to take forward into development. Smaller generation site developers may not have the in-house electrical engineering skills to carry an initial assessment of the grid connection for their site.

Automating such assessment and providing easy access to the LTDS data is of real value to those involved with the development of distributed and renewable generation sites.

### THE PROJECT

A joint collaboration between specialist electrical engineering and software development company, Econnect Ventures Ltd, and specialist Geographical Information System (GIS) company, IMASS Ltd, was setup with the remit of improving the usefulness of the LTDSs by creating electronic versions of the LTDSs and a web based initial grid connection assessment tool. This project was designed to be proof of concept and aimed at establishing the methods for both automatically carrying out initial assessments of grid connection for distributed generation plants and demonstrating that the public domain LTDS information could be successfully transformed into an electronic format integrated into a GIS system.

The main focus of the project is on:

- Providing an initial connection assessment service aimed at generation site developers
- Providing a single point of access for all distribution network information in the UK

- Bringing a consistent and seamless integration and presentation of the geographical and electrical data in the LTDS

Such a service has the potential to save generation site developers and other interested parties, including DNOs, substantial time and expense by automating an otherwise drawn-out manual process. The main benefits of the service would be to increase the speed at which renewable generation plants can be integrated into the distribution network and to avoid wasteful investigation of potential renewable energy sites which are too difficult or too costly to connect to the distribution network.

### PILOT WEB SITE

The pilot web site has been built around a GIS, which provides the underlying data store for all the information required by the web services. This includes the geographical maps and the electrical information.

There are three services that make up the electronic LTDS:

- A data loading service, which takes the public domain information currently provided in the LTDS and loads it to the GIS
- A data visualisation service, which provides web pages for the user to examine the data available
- An initial connection assessment service, which interprets the geographical and electrical data and provides the results in a user-friendly report

### Loading data into the GIS

The GIS has been developed to include:

- Background geographical maps
- Boundary information (DNO, regional and national areas)
- Environmental information (national parks, sites of special scientific interest etc.)
- Electrical network data (from the information in the LTDS)
- Existing and planned generation sites (from the LTDS and other sources)

The background maps, boundary information and environmental data are deemed static, so they are loaded into the GIS first. The other information, comprising the electrical network data and existing and planned generation sites is loaded second.

Manual and automatic processes have been developed to load the electrical network data. These processes include manual editing to accurately identify the geographic location of network substations and circuits, and resolve any missing cross-reference between the geographical and electrical data sets. The automatic loading also deals with the variations from one DNO's LTDS to another. These loading processes require substantial manual effort, which

once completed gives a solid base for the electronic LTDS.

The electrical network data changes on at least an annual basis, so a repeatable loading process has been developed in order that annual updates can be automatically loaded. This also provides the opportunity to carry out more frequent updates as required throughout the year.

### Displaying the electrical data on maps

The data held in the GIS is presented on a web page, consisting of a map and a section showing the technical detail of the assets displayed on the map, as shown in Figure 1.

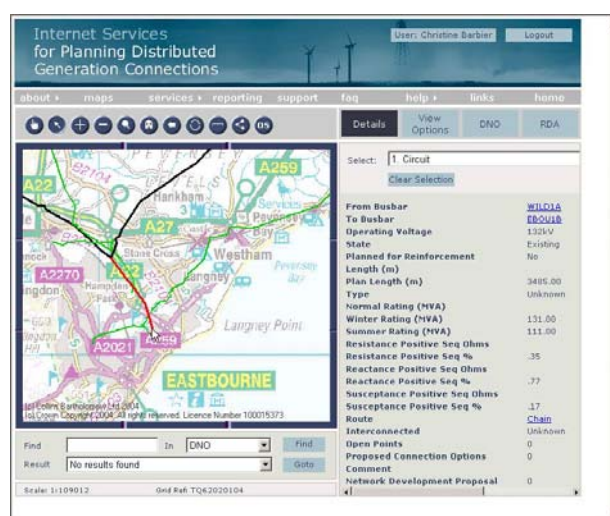


Figure 1: Web page, which shows the map and electrical data (© Econnect Ventures Ltd and Imass Ltd)

The map is interactive: it can be zoomed in and out and the electrical assets can be selected to display their electrical and other attributes in tabular format on the right hand side of the screen.

There is also a facility to look for a particular geographical location by place name, electrical asset name or grid coordinates reference. The map then zooms in to the requested location.

### Assessing the grid connection

The assessment of the capacity of the distribution network to accept the connection of a new distributed generation plant usually involves checking that:

- the thermal capacity of the circuits in the network are not exceeded
- the new generation plant's contribution to fault current does not cause the existing switchgear equipment capacity to be exceeded
- the network limits for voltage levels are not exceeded

The LTDSs provide information about primary substations and circuits ranging from 33kV to 132kV (in England and Wales, 33kV only in Scotland), including 11kV busbars but excluding 11kV circuits. At these voltage levels, the main issues are usually thermal capacity and fault current levels.

For the pilot web site, the connection assessment service has been designed to automatically evaluate all potential connection points within a radius of a proposed generation plant and assess the most promising connection points based on least cost and whether thermal or fault level capacity would be exceeded. Where it is found that these technical limits are exceeded, the connection assessment service provides information on the maximum generation power that could be connected without the technical limits being exceeded.

The connection assessment service evaluates the cost of connection using an underlying cost database based on manufacturer information. In order to estimate the cost of connection, the electrical arrangement of the assets needed to connect a generation plant to the distribution network is established and the cost information is provided with reference to that particular electrical arrangement.

The connection assessment service is operated using a simple step-by-step ‘wizard’ tool, which automatically creates an initial connection assessment report for a proposed generation site. In order to generate the report, the location of the proposed generation plant is placed on the map with a mouse click, and a few details about the site are entered.

Figure 2 shows the wizard tool started from the menu, the location of the proposed generation plant on the map, and the entry of the required details on the right hand side.

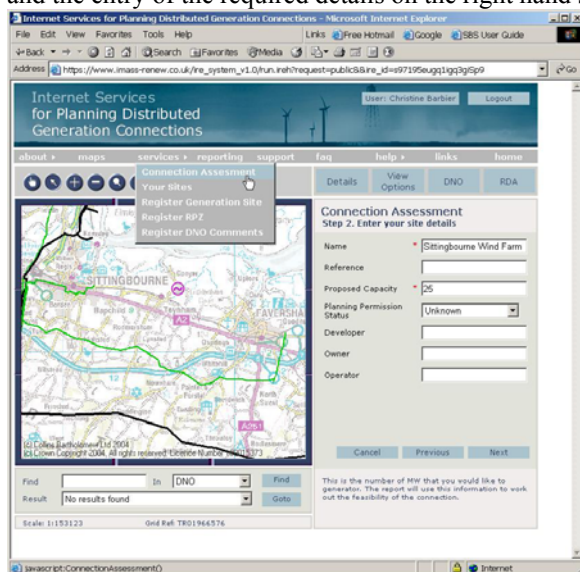


Figure 2: Wizard tool for initial connection assessment (© Econnect Ventures Ltd and Imass Ltd)

The last step in the wizard tool automatically creates a connection assessment report in a PDF format. This can then be viewed directly on the web page, as well as being printed and saved.

Figure 3 and Figure 4 show extracts from the automatically generated report. This report is structured so that a non-technical reader can understand the general technical and financial implications for connecting their proposed generation plant to the distribution network.

Option No	Connection costs(*) for proposed capacity 35MW		Connection costs(*) for potential capacity without reinforcements	
	Using cable	Using overhead line	Capacity (**) without reinforcements	Using overhead line (**)
1	£623k (£18k per MW)	£473k (£14k per MW)	17MW	£450k (£27k per MW)
2	£649k (£19k per MW)	£484k (£14k per MW)	36MW	£486k (£14k per MW)
3	£665k (£19k per MW)	£491k (£15k per MW)	14MW	£462k (£33k per MW)

Table 1: Summary of budget connection costs  
 (\*) All budget costs exclude existing network reinforcement costs.

Figure 3: Initial connection assessment report; costs (© Econnect Ventures Ltd and Imass Ltd)

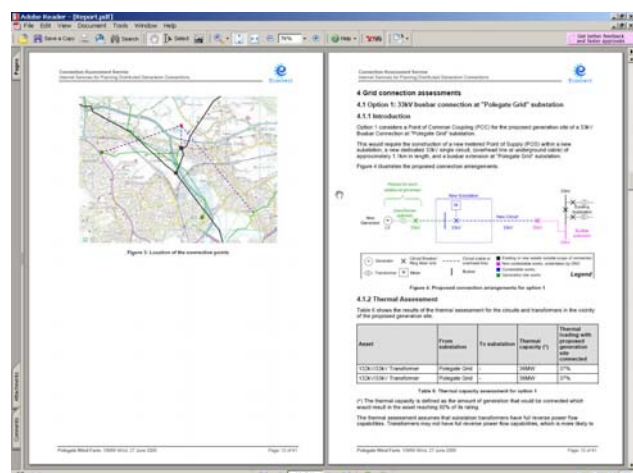


Figure 4: Initial connection assessment report; technical aspects (© Econnect Ventures Ltd and Imass Ltd)

### PILOT WEB SITE EVALUATION

Evaluation and feedback from users of the pilot web site has been extremely important, as this information is vital in assessing its viability in commercial terms and also in determining if the project team has achieved the objectives of the project.

At the start of the project a target for recruiting 50 users for evaluating the pilot web site was set as this was deemed a suitable figure for realistic use and evaluation and at the end of the project the total number of users who went through the registration process was 86.

During the evaluation phase, the users were asked to complete an online questionnaire. Any users who had not completed the questionnaire online were contacted by telephone for their comments.

The evaluation included the following items:

- the industry sector in which the user operates
- the areas of the UK in which the user is interested
- the level of knowledge of the user
- the annual number of grid assessments that the user carries out and the number that is outsourced to a third party
- the usefulness of being able to access the maps showing the location of the distribution network electrical assets
- the usefulness of the information provided in the automatically generated initial grid connection assessment reports

The results showed that:

- The industry sectors represented by the users included a majority of generation site developers, electrical engineering consultants and DNOs, with interest also from manufacturers, trade associations and government agencies
- All areas of the UK were of interest, indicating that distributed generation plants were being connected in all parts of the UK
- Most users rated themselves as having at least a basic knowledge of the grid connection issues, although around 20% considered themselves having no particular knowledge, showing that both experts and non-specialists may be interested in this web site
- There was an even distribution of assessments being carried out internally and externally to the user's organisation
- The number of assessments undertaken by the users varies from one or two a year to over forty a year, showing that both small and larger developers may be interested in this web site
- All users found the display of electrical data on the map useful, and most users were also interested in the initial grid connection assessment service

## CONCLUSION

To date, the project team has developed a pilot web site and created the associated processes to load the geographical and electrical data into the underlying GIS. The principle for providing an electronic version of the LTDS as well as automatically generating an initial assessment of distributed generation connections has been proven.

The pilot web site is now complete, with full maps, boundary and environmental information, as well as the electrical data for the three DNOs in the UK who have contributed to this research project. The web site has also undergone an industry wide evaluation throughout summer and autumn 2005, with DNOs, renewable energy generation developers and other interested parties taking part.

The feedback from the evaluators of the pilot web site has shown that there is considerable interest in this service being made available in the UK.

The next steps are now underway to extend the geographical coverage of the electrical data to the whole of the UK and to develop a commercialisation strategy to make this web site available to all parties involved in renewable energy in the UK. The web site is expected to go live during 2007 and can be found at "www.gridconnection.co.uk".

In future the service could be extended to other countries. Although LTDSs are particular to the UK, information from other sources could be incorporated via the data loading process. In countries where the network information is not publicly available, the service could be offered by participating distribution network operators.

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