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# Ireland's Approach for the Connection of Large Amounts of Renewable Generation

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**Abstract**-- This paper discusses the connection policies adopted to facilitate the large number of wind farms seeking access to the Irish power system. A key feature is a grouped connection offer process that provides certainty for wind project developers and optimises the development of the network. A further interesting feature is the development of a "wind cluster" concept which permits semi-dedicated MV networks for the connection of a group of adjacent wind farms, together with equitable arrangements for sharing the financial burden of construction between developers.

**Index Terms**-- Distributed generation, Generator connection, Power Distribution Planning, Power System Planning, Power Transmission Planning, System Access, Wind Power Generation

## I. INTRODUCTION

IRELAND enjoys one of the most favourable wind regimes in Europe. It also has limited indigenous fossil fuel resources. Accordingly, government and European Union policies require the effective connection and integration of a large amount of renewable generation, especially wind [1], [2]. The electricity market in Ireland is open to competition, and the transmission and distribution network operators provide non-discriminatory network access to generators. Many potential developers thus seek network connections ranging from single turbine schemes, to ambitious projects of 100 MW or more. This has raised a serious challenge: how can connections be offered in a regulated, rigorous and transparent manner, while ensuring the economical development of the transmission and distribution systems? How can the interactions between diverse schemes be accommodated fairly?

## II. INITIAL WIND GENERATION CONNECTIONS

In the early 1990s, Ireland had just one wind power facility, a 6.45 MW scheme. Since then, the government has introduced a number of support mechanisms to incentivise wind power development. The growth in installed wind power capacity from 1997 to 2009 is shown in Fig. 1. Initially, each individual request for a network connection was evaluated in

isolation. Where a distribution connection was found to be technically infeasible, a transmission connection was offered. In either case, the shallow connection cost was borne by the applicant. The ability to offer a distribution connection was often limited by a number of possible technical criteria, among them: thermal limits, voltage rise, voltage step change due to generator tripping and power losses.

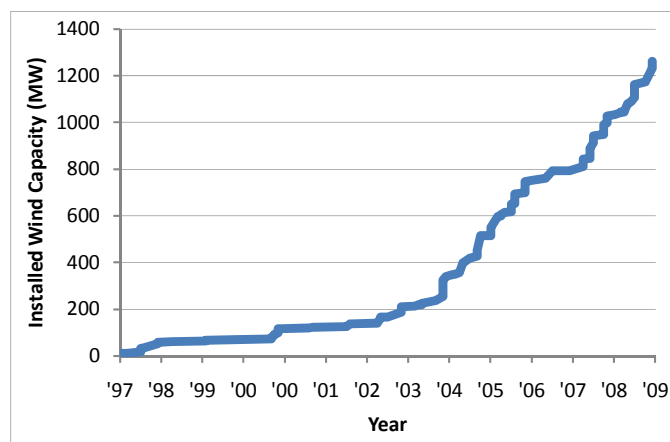


Fig. 1: Installed capacity of wind on the Irish system, 1997 to 2009

## III. GROUP PROCESSING OF CONNECTION APPLICATIONS

### A. Moratorium on Connection Offers

During the 1990s, the growing interest in renewables created an influx of connection applications. With each connection being treated individually and evaluated considering only other existing and firmly contracted connections, acceptance of one offer often led to the withdrawal of other outstanding offers and their re-evaluation taking account of the newly offered connection. In late 2003, the volume of applications on hand, together with the lack of suitable technical standards (Grid Code) for wind generation connections, and the lack of models to enable evaluation of system stability, led to a moratorium on new connection offers until these issues were addressed satisfactorily [3].

### B. Need for a new approach to connection applications

Applications for connection continued to be received during the moratorium, highlighting the need for a new approach to connection methods and procedures.

To coincide with the lifting of the moratorium in mid-2004, a "group processing" approach was introduced. The main features of this approach are:

- Generator applications are processed in a "Gate" system

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whereby a group of applications is processed in one batch.

- In accordance with a pre-determined rule-set, the applications within the Gate are divided into groups by the system operators for processing purposes.
- Each applicant is assigned to a node in the transmission or distribution system.
- The system operators propose optimised connection methods to connect all applicants. A clustering approach is used where appropriate.
- The relevant system operator issues the connection offer to the individual applications within each group.

The advantages of the group processing approach are:

- Connection offers are issued more quickly overall.
- Uncertainty resulting from interacting offers and applications is removed.
- Development of a more optimal network with minimum connection infrastructure is achieved.
- Network congestion problems are recognized earlier and resolved more quickly.
- System operator resources are used more efficiently.

### C. Gates 1 and 2

Three groups or “gates” have been approved since 2004. Gate 1 covered applications that had been submitted but not processed at the date of the moratorium, amounting to 381 MW. Gate 2 covered the next 500 MW in the queue, which were called “Drivers”, extensions to existing facilities and developments that would share a Least Cost Technically Acceptable method of connection with a “Driver”.

### D. Gate 3

Gate 1 and Gate 2 developments, when considered in conjunction with other generation and load developments, required significant reinforcement to the main transmission grid. For Gate 3 it was decided that the connections would be based on using main transmission grid capacity as it becomes available from the transmission grid development strategy, Grid25 (see 3 below). Gate 3 includes those applications, selected by date order, whose capacity is estimated to be required to meet the government target of 40% of electricity from renewable sources by 2020. This amounts to 3,900 MW.

#### 1) Assignment to Transmission Nodes

The first step in the Gate 3 process is to assign each connection application to a node on the transmission or distribution network. This may be an existing node, or a newly declared node. The rules for node allocation are codified in [4]. All those applicants connecting to a particular node form a sub-group within the gate.

#### 2) Least Cost Technically Acceptable Connection

The Distribution System Operator generates a range of options for connecting all the applications to their assigned transmission node, and determines the “least cost, technically acceptable” method for the group as a whole from the candidate options. A similar approach is used for those developments large enough to justify a connection directly into the transmission system.

#### 3) The Grid Development Strategy [5]

The transmission system operator, has prepared and pub-

lished a grid development strategy for the transmission system out to 2025. This strategy, known as Grid25, takes account of growth in system demand, targets for renewable generation, conventional generation development scenarios and future DC interconnections with UK or mainland Europe. Renewable generation to meet government targets is included based on locations and capacities identified in the “All Island Grid Study” [6]. Implementation of the strategy is forecast to require the construction of about 1,150 km of new transmission circuits, along with upgrading some 2,300 km of existing transmission assets in the period to 2025.

#### 4) Firm Access Quantities

Based on Grid25 the Transmission System Operator calculates the amount of additional power that the transmission system can accommodate on a firm basis. This available capacity is then allocated to the Gate 3 applicants on an application date-order basis.

At the end of the process each Gate 3 application will have a Firm Access Quantity for each year from 2010 to 2025, which takes account of the grid reinforcements expected to be built and generation expected to be connected by that year.

Thus, unlike with Gates 1 and 2 and earlier developments where the connection of wind generation led the transmission reinforcement, in Gate 3 the transmission reinforcement based on the approved grid development strategy will lead the wind generation connections. This approach is essential to ensuring the development of an economical system to meet renewable targets, given the magnitude of the connections in Gate 3: 3,900 MW of additional renewables on a system with a record peak load to February 2010 of 4,950 MW.

### E. Non Gate Process Connections

There is provision for the connection of generation outside the Gate process. This allows for the connection of small wind schemes (less than 500 kW), some non-wind renewable projects and some non-renewable projects that are deemed to be in the public interest and that meet certain other conditions.

## IV. WIND CLUSTERS

It is quite common for a number of separate wind farms to locate adjacent to each other. This clustering effect can be explained by meteorological considerations. A particular ridge or group of hills may offer a particularly attractive wind resource.

Given the batch-processing Gate system in place, and the mutual proximity of many developments, it becomes apparent that a “collectivised” approach to grid connection is often more efficient.

This is facilitated at the transmission node assignment stage. If more than 40 MW of applicants are concentrated within a given geographical area, than the system operators reserve the right to declare a new transmission node for those applicants [4]. This would then form a new sub-group which can be connected to a central node. Conceptually, the new transmission or distribution node will be situated towards the centre of the sub-group, and each applicant will typically be offered a radial 38kV or MV connection to this node. In prac-

tice, a number of potential connection arrangements will be developed, and the least-cost, technically-acceptable option will be selected, the costs used being based on a regulator-approved costing schedule.

A clustered wind connection network is typically free from loads, and effectively functions as an energy-harvesting network. Even where there is very limited potential for load growth, as in the typical rural case, standard distribution planning criteria still pertain. No part of the network may be sterilised to load use. Fig. 2 shows a typical large Gate 3 cluster assigned to a new 110kV node at Kilgarvan. The new node will be connected by a 110 kV line to a suitably-located new switching station on the existing 110 kV system. The cluster incorporates eight new windfarms in an area of about 25 km x 25 km with capacities ranging from 6 MW to 62.2 MW and totalling 178.44 MW.

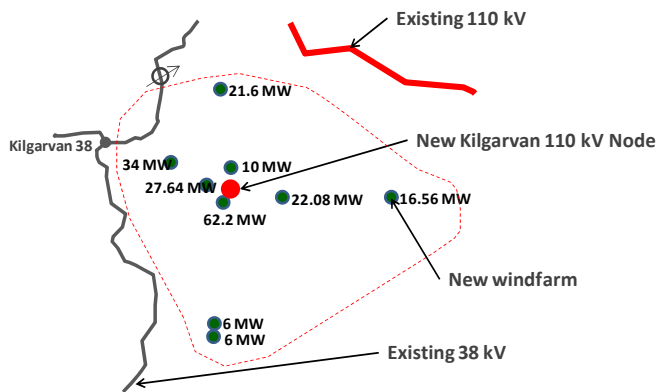


Fig. 2 Example of a Windfarm Cluster

Shallow connection costs are borne by the applicant; that is, the applicant pays for the least-cost, technically acceptable connection arrangement that connects them to their assigned node. Applicants do not bear the cost of any transmission "deep" network reinforcement that their connection may cause but distribution upstream "deep" re-enforcements are charged to the applicant.

## V. CONCLUSION

The rapid rate of development of renewable generation, much of it embedded and non-renewable generation, in Ireland requires the optimization of network development. On the other hand the competitive electricity market requires the facilitation of fair and non-discriminatory access to the transmission and distribution grids to any generation developer who wishes to participate in the electricity market. The wind

cluster approach to connection of wind farms in remote areas with good wind potential and the group connection offer process attempt to reconcile these two objectives and contribute to the achievement of national and renewable policies for renewable electricity generation.

## VI. ACKNOWLEDGEMENT

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## VIII. BIOGRAPHIES

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