

ACTIVE NETWORK MANAGEMENT – GOOD OR BAD FOR IPP?

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ABSTRACT

Active Network Management seems to be viewed entirely as a technical exercise which can be solved through good engineering coupled with some telecommunications.

In reality the engineering side could be quite simple – the problem will lie in the interaction of the contractual rights of the generators connected to the Active Network.

As the impact of generation is cumulative from one voltage level to the next, strategies for coping with an increase in one area may also have ‘knock on’ impacts elsewhere, further complicating the issues.

Accordingly the optimum solution is likely to lie in the use of Active Management to increase the overall hosting capacity of the network whilst imposing minimal imposing restrictions on generators connected

INTRODUCTION

As Ireland is a largely isolated synchronous island network with minimal interconnection and a high and rapid penetration of windfarms, it seen by some as a leading edge testbed for System Operation with high levels of DG

The pattern of initial development in Ireland from 2000 2004 similar to that in most other utilities, with wind farm developers being connected on a ‘first come, first served’ basis to the existing network. This form of connection allocation has advantages and disadvantages, on the advantage side it provides significant ‘first mover’ advantage to those first in the queue, but for those later in the queue costs can rise steeply if the connection required requires network reinforcement. In turn this can lead to a situation whereby they tailor their application to what is available on the network rather than what they initially desired. Furthermore, the costs of such network reinforcement fall initially on the first connectee involved, with no certainty that further applicants will arrive and share costs.

This method also leads to a piecemeal development for

the network with the least cost option for each individual applicant being applied, although in hindsight this may have proved to be a less than optimal overall solution for the windfarm group when taken together.

In 2004 the Transmission Grid Operator required a moratorium on new connections until various technical requirements were mandated in Codes. However during this one year moratorium windfarms were still free to apply for connections, with the result that there were hundreds of new applications lodged.

After the lifting of the moratorium, processing such applications on a serial basis would have made no sense, given that all the applications were visible to the SO’s. The alternative approach which was then used was to establish tranches of applications received, with an eligibility criterion, and each tranche being called a ‘Gate’, with for example, Gate 3 having 3,500MW.

In turn, all these windfarms could be seen on a map, clustering around certain locations where wind speeds were high. This meant that the connection method designed was designed for the cluster, with the costs associated with shared infrastructure elements within Groups, being divided amongst the applicants on a per MW basis.

This approach meant, once they satisfied the criterion for a given Gate, would only pay for their share of the overall cluster so that ‘first mover disadvantage’ disappeared.

Furthermore, whilst pre-moratorium connections were relatively small and made by interested private individuals, once banks began providing finance the minimum size of the investment investment required to cover the banks overheads was in the 10-15MW area, more than what would typically be available on most existing MV networks, but which was readily available from a cluster 110kV/MV station.

In other words a move toward ‘cluster’ stations was inevitable, but the moratorium accelerated this process and meant that all the connections required for the next decade were known in advance.

This process is illustrated in the attached Figures:

Example of Sequential Approach with Reinforcement

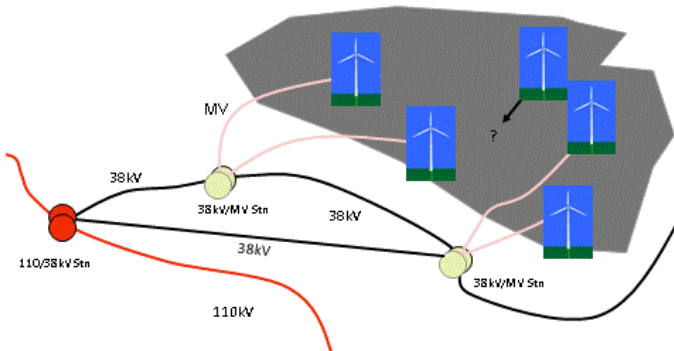


FIG. 1 SEQUENTIAL WITH REINFORCEMENT

In Fig. 1 it is seen that each windfarm is connected separately, with each connection being the ‘least cost’ method for that individual connection method.

As the capacity of the existing network is exhausted and a new windfarm arrives, the network must now be reinforced at least cost, to make provision for this new customer, in this case by building a 38kV line between two HV Stations. This allows the connection of the new windfarm but provides minimal additional benefits to the existing or future connectees.

The alternative approach now used is called the Group Processing (‘cluster’) Approach (GPA).

Here the windfarms nominate what capacity requirements are needed, and the optimal network is designed to feed all the Windfarms requesting connection, which effectively means all the Windfarms in Gate ‘X’ which are in this geographic area.

Example of GPA

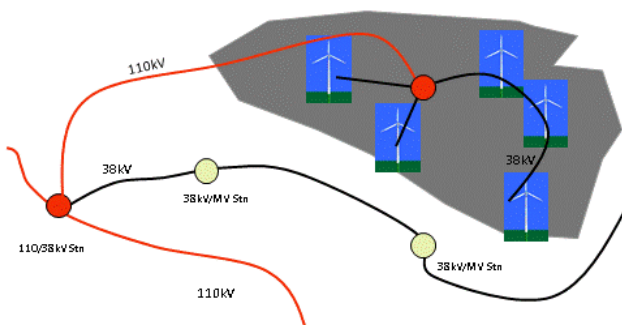


FIG. 2 GROUP PROCESSING APPROACH (GPA)

It is clear from Fig. 2 that the connection method for all windfarms in the cluster has been optimised with one centrally located 110kV/MV station providing the necessary capacity in volume – typically a 110kV Line will have c. 80MVA capacity whereas a 38kV line might only have 20MVA. In turn the central location of the 110kV station is designed to minimise the overall cost of all windfarm connections.

To date on a system with a peak load of 5,0900 MW there is connected Windfarm Generation of 2,039MW, with the Summer Night Valley amounting to 1,786MW, and Winter Night Valley to 2,928MW, with limited interconnection of 500MW to the UK and up to a similar amount on the Tandragee – Louth Interconnector to Northern Ireland.

Consequently circumstances can arise where on occasion either for system conditions or transmission circuit limitations, not all wind can be accepted onto the system.

Given that there is c. 2,000MW wind already connected and a further 3,600MW contracted to connect, with a further 10,000MW which would like to connect, it is clear that even for the accommodation of the connected and contracted windfarms the Transmission system will need to be operated in a different manner, and that a considerable amount of system reinforcement will be required, as described in EirGrid’s Transmission development proposals [1, {2}].

ACTIVE SYSTEM MANAGEMENT - TSO

It is also clear from the above description that a substantial amount of Active Management is required on the Transmission system in order to manage the Constraints and Curtailments associated with this amount of Wind Generation,.

Such TSO control requirements will also include the capability to control reactive power from the larger windfarms, including those connected to the Distribution system.

The extent to which distribution connected windfarms can contribute to reactive power support to the Transmission System is a function of the degree to which they are embedded and the technical basis upon which the connection was designed. In the Republic of Ireland, a substantial portion of such windfarms can only import VARs and export of reactive power would cause Distribution voltage and other technical limits to be breached.

ACTIVE MANAGEMENT - DSO

Given that the TSO is already in the Active Management space as described above, then in an environment where the DSO, for whatever reason, also enters that space, conceivably, circumstance could arise where a generator could find itself having its output ramped down by both the TSO and DSO.

In these circumstances, a process would need to be determined, but where the requirement to 'turn down the output' is in order to manage network constraints, the most onerous command would have to have priority.

Circumstances could equally arise where Transmission constraints in a given geographical area are very low, in which case, the remaining 'white space' after these needs are met is then available for DSO Active Management (where it can provide a cost effective solution), but this will necessarily be a constrained space due to the above requirements.

Application of DSO Active Management:

In many papers Active Network Managements is seen solely at the Distribution level as a way of accommodating marginal extra generation on an existing network through the use of control systems which ensure that limitations on the generators are only applied when required, and that generators can generate at full output for the remaining time.

In the Irish case, of cluster stations, the space available to be exploited for Active Management would be severely limited by the absences of diversity, given that it is all wind.

On windfarms connected to the existing Distributions Network loads may not coincide with windfarm outputs, and several small windfarms may share a section of network with a common constraint. This would traditionally be the area in which Active Management would be best placed to provide extra capacity.

At a high level what would be involved is a control system which checked when the constraint was going to restrict output, take action to minimise this condition and then schedule which generators would run at which times to use the extra available capacity, subject always to any overriding TSO or DSO system requirements which may be in operation.

An example of such a situation might be where voltage rise is the limiting factor on extra generation and that this can be initially mitigated through lowering the system voltage whilst still ensuring load customer are

within standard.

Next would be where generators attempt to access the extra capacity available, but if not every generator can be fully accommodated there must be some system of allocation, and this area has seldom been covered in the literature until recently.

Essentially the generators will have some contractual right to access the extra capacity based on either existing or new contracts, although the extra capacity available may be different for each generator at any particular time depending on the position on the network at which the limitation occurred. This will involve an extensive real-time communication system with low latency and high bandwidth, and of high resilience (i.e. redundancy) to provide the control and communications required.

So the key problem here is how to allocate the extra capacity created amongst the existing generators and any new generators who would apply. As the extra capacity will only be available at certain times and intermittently (as all generators will either be on or off together) this means that existing generators are likely to find the most attractive, as only marginal increases in capacity will be available.

One way of releasing this extra capacity would therefore be to auction it off amongst existing generators, with sequential rights to access. In practice this would require communication with all generators in real time, measurement of the constraint in real time, and the ability to wind down the generators in sequence if the constraint were likely to be exceeded.

All of the above would require investment in the initial installation and in the ongoing operation, but the extent to which extra capacity would in practice be available would be very difficult to model, resulting in the generators incurring investment costs for a benefit which is not well defined.

Furthermore, if the distribution network configuration changed e.g. through the reduction of connected load via the movement of a Normally Open point or the connection of a new generator (e.g. if extra load had been installed), then the extra capacity from the original Active Management scheme would change.

Quantification of the uncertainty:

In such an Active Management Scheme someone, either the Generator or the DSO, will need to take responsibility for the quantification of when network constraints are likely to occur, as it only on the basis of such a report can the generators make investments.

Such quantifications by the DSO are likely to result in overly conservative assessments as the financial consequences of an erroneous assessment would be very high. Accordingly it is probably the generator who, if given the raw data is best placed to make such an assessment.

However such assessment are being made with past data, and out of the control of the generator is the impact of future network developments, and outages.

Alternative application of Active Network Management:

An alternative approach would be to examine how the overall connection capacity for generators could be increased thorough Active Network Management.

Decisions on how much generation can be connected in an area on an unconstrained basis are based on conservative assumptions as to how different factors on the networks will coincide, such as the likelihood of maximum generator output at valley periods when system voltage is high. If such conditions could be known instantaneously, and reacted to using suitable controls then less stringent criteria could be used which would allow for an increase in overall capacity on a year round basis.

Furthermore this would also avoid the situation where each Active Management System becomes a legacy system once a new way of operating the system is required, with the possibility of excessive complication once several legacy systems all have to be operated simultaneously whilst respecting each others rights.

CONCLUSION:

Accordingly the meaning of Distribution Active Network Management (D – ANM) in Ireland is likely to focus on how the TSO and DSO systems cope with the overall level of IPP's connected, rather than on trying to increase the capacity of the shallow connection.

Ultimately this suggests that the evolution of ANM is on the operation of the whole network, Transmission and Distribution, rather than on optimizing on a single part, and this is facilitated by not having many existing legacy systems which would hinder the introduction of such system developments.

REFERENCES

- [1] All Ireland Ten Year Transmission Forecast Statement 2013, Eirgrid.
(<http://www.eirgrid.com/media/TenYearTransmissionForecastStatement2013.pdf>)
- [2] Grid 25 Eirgrid
(<http://www.eirgrid.com/media/GRID%2025.pdf>)