Challenges Of Implementing Active Distribution system Management

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ABSTRACT

Previous Government incentives have resulted in increasing amounts of embedded generation being connected to the Iran distribution networks. There is now a drive to significantly accelerate this process to meet the governments targets for reducing CO2 omissions. Traditional methods of providing connections involve constructing new circuits, thereby increasing the network capacity. Whilst essential and unavoidable for many connections, such schemes can be time consuming and may have a significant cost in both monetary and environmental terms.

In order to tackle these issues and to assist developers in the cost of connection, a number of generation connections have been accepted, which apply simple constraints when the system capacity is restricted. Network constraints, such as voltage limits and thermal overloads, typically only occur under particular outage conditions and load/generation patterns. This has resulted in a number of 'hardwired' intertrip schemes being developed for individual generator connections. Whilst this offers a solution for individual generators connected to a major substation busbar, it soon becomes unacceptably complex and increasingly difficult to modify when a number of generators are connected within the same network of that busbar, and multiple constraints need to be considered. This has been found to be the case in areas of some distribution networks, with the complexity of constraints themselves becoming the most significant barrier to the connection of further generation. There have been many debates in recent years on the subject of active networks, as applied to distribution systems and it is perceived that the 'active network' is an answer to achieving the levels of Distributed Generation (DG) proposed over the coming years. Indeed, recent statements by Tavanir are indicating that in the next Price Control, active management will be the preferred solution to the connection of DG.

This paper is based around the Iran Distribution Networks, that is those systems of 33kV and. It has been written to:

An active distribution system, based on the Iran transmission models, where generation is dispatched to meet load and outage constraints is unlikely to be acceptable for the majority of (smaller) generators on technical and economic grounds. However, one alternative solution could be to utilise SCADA systems, across the network voltages, in association with an appropriate' Active Control' model. This could make it possible to monitor the network and issue signals to generator(s) to match their output to a range of network states, having the mutual benefit of allowing additional embedded generation to be connected to distribution networks, at the same time as avoiding major network reinforcement.

INTRODUCTION

The expansion of decentralized and intermittent renewable generation capacities introduces new challenges to ensuring the reliability and quality of power supply. Most of these new generators (both in number and capacity) are being connected to distribution networks
a trend that is set to continue in the coming years.
This development has profound implications for distribution system operators (DSOs). Until
recently, DSOs designed and operated distribution networks through a top-down approach.
Predictable flows in the electricity network did not require extensive management and monitoring tools.
But this model is changing. Higher shares of distributed energy sources lead to unpredictable
network flows, greater variations in voltage, and different network reactive power characteristics.
Local grid constraints will occur more frequently, adversely affecting the quality of supply. Yet
DSOs are nevertheless expected to continue to operate their networks in a secure way and to
provide high-quality service to their customers.
This paper addresses a number of fundamental questions that arise from the integration of distributed generation (DG) and other distributed energy resources (DER) into the energy system:

- ✓ How can DSOs make the most efficient use of the existing network?
- ✓ When are new infrastructure and changes in system architecture needed to better integrate DG and DER?
- ✓ Which types of system services are needed and how can they be procured?
- ✓ How can renewable energy sources (RES), DG, and DER contribute to system security?
- ✓ How should the regulatory framework develop?

ACTIVE DISTRIBUTION SYSTEM MANAGEMENT

Active distribution system management may provide some answers to these questions. Indeed, distribution management will allow grids to integrate DER efficiently by leveraging the inherent characteristics of this type of generation. The growth of DER requires changes to how distribution networks are planned and operated. Bi-directional flows need to be taken into account: they must be monitored, simulated and managed.

The barriers to entry into active network management include the circuit ratings of the Distribution infrastructure in the locus of the preferred energy collection site. Insufficient infrastructure capacity can involve substantial reinforcement costs and accompanying delays that can make an embedded generation scheme unviable.

There are three methods of optimising the network ratings:

• Examine the margins that exist in the circuit ratings – particularly the possibilities of operating with dynamic ratings

• Produce a method of limiting generation within the infrastructure ratings

• Implement both of the above mentioned Methods.

The paper focuses largely on distributed generation – a challenge many DSOs are already facing today. However, the presented possible solutions will generally also be applicable to other flexibility providers like loads and electric vehicles, which fall under the umbrella of flexibility offered by DER.

Distributed/decentralised generation (DG) are generating plants connected to the distribution network, often with small to medium installed capacities, as well as medium to larger renewable generation units.

Due to high "numbers", they are important compared to the "size" of the distribution network. In addition to meeting on-site needs, they export the excess electricity to the market via the local distribution network.

DG is often operated by smaller power producers or so-called prosumers.

In theory, due to its proximity to the loads, distributed generation should contribute to the security of supply, power quality, reduction of transmission and distribution peak load and congestion, reduced need for long distance transmission, avoidance of network overcapacity, deferral of network investments and reduction in distribution grid losses (via supplying active power to the load and managing voltage and reactive power in the grid).

In reality, integrating distributed generation into DSO grids represents a capacity challenge due to DG production profiles, location and firmness.

DG is not always located close to load and DG production is mostly non-dispatchable (cannot control its own output). Therefore, production does not always coincide with demand (stochastic regime) and DG does not necessarily generate when the distribution network is constrained. In addition, power injections to higher voltage levels need to be considered where the local capacity exceeds local load.

This poses important challenges for both distribution network development and operation.

- Network Reinforcement

The ability of DG to produce electricity close to the point of consumption alleviates the need to use network capacity for transport over longer distances during certain hours. However, the need to design the distribution networks for peak load remains undiminished and the overall network cost may even increase.

- Distribution Network Operation

In addition, distributed generation, in particular intermittent RES, poses a challenge not only for system balancing, but also for local network operation.

The security and hosting capacity of the distribution system is determined by voltage (statutory limits for the maximum and minimum voltage ensure that voltage is kept within the proper margins and is never close to the technical limits of the grid) **and the physical current limits of the network** (thermal rates of lines, cables, transformers that determine the possible power flow).

In systems with a high penetration of DG, both types of unsecure situations already occur today. As a result, DSOs with high shares of DG in their grids already face challenges in meeting some of their responsibilities. These challenges are expected to become more frequent, depending on the different types of connected resources, their geographic location and the voltage level of the connection.

- Traditional Design of Distribution Networks

The fundamental topological design of traditional distribution grids has not changed much over the past decades. Up until recently, DSOs have distributed energy and designed their grids on a top-down basis.

Under the paradigm "networks follow demand", their primary role was to deliver energy flowing in one direction, from the transmission substation down to end users. This approach makes use of very few monitoring tools and is suitable for distribution networks with predictable flows.

The use of an advanced distribution management system proved itself invaluable to efficiently manage key aspects of the control centre operations during a severe outage and restoration event that took place some points.

The various functions of an advanced DMS convey vital information to the control engineers that improves and streamlines decision-making,

particularly when operating under pressure. The efficient use of the embedded network analysis tools in the DMS.

to restore safely customers as soon as possible, and reduce load only when absolutely necessary without overloading critical interconnecting feeders.

Business case summary of Advanced DMS advantages in active fault management:

• More rapid restoration of customers due to better network analysis and load forecasting,
• Potential network overloads and other similar problems were predicted and managed,
• Prevented catastrophic failure of strategic assets; this, in turn, helped WPC avoid a major unplanned outage,
• Minimised the additional disruption in a planned and controlled way,
• All affected customers kept informed of restoration progress via OMS and the OMS interface to trouble call telephone bureaux,
• Operations & senior management are kept informed of progress via embedded DMS Reporting/Information Services.

There is no one-size-fits-all solution because distribution networks are rather heterogeneous in terms of grid equipment and DG density at different voltage levels. Every distribution network should be assessed individually in terms of its network structure (e.g. customers and connected generators) and public infrastructures (e.g. load and population density). Nevertheless, the needed development towards future distribution systems which meet the needs of all customers can be described in the three schematic steps pictured below: from (1) passive network via (2) reactive network integration to (3) active system management.

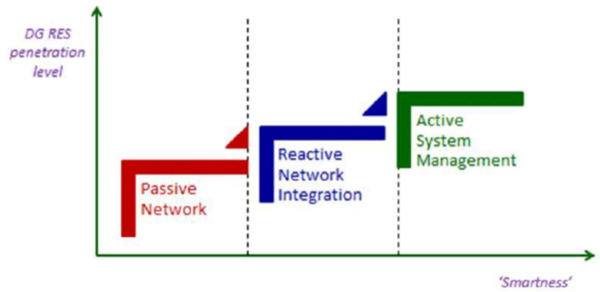

Fig1. Three-Step Evolution Of Distribution Systems

CONCLUSION

The advances described in this paper illustrate that the selection of an advanced DMS can facilitate further advanced network management developments, each of which are capable of delivering significant business benefits to network operators. The future business environment for network operators will continue to present challenges similar to those already identified here and elsewhere, including staff attrition and the impact of supply-side demands for more embedded, renewable generation; the selection of an advanced DMS can help meet these challenges.

REFERENCES

[1] Active Distribution System Management A key tool for the smooth integration of distributed generation, *full discussion paper*, *A EURELECTRIC paper*, *FEBRUARY 2013*