DS3:
Voltage Control Workstream

BACKGROUND

The system voltage is determined by the balance of reactive power production and absorption. Generators have traditionally been a primary source of reactive power, which compensates for the reactive power produced and absorbed by consumers and by the lines and cables on the network itself. Reactive power, unlike active power, is predominately a local phenomenon, i.e. reactive power cannot be transmitted over significant distances.

The management of voltage requires a co-ordinated approach for reactive power control throughout the whole system, both transmission and distribution and Northern Ireland and Ireland, as deficiencies in a local area at a certain point can have an inordinate impact on other voltages, potentially leading to a voltage collapse.

The management of system voltage needs to evolve due to the changing nature of the portfolio of plant connected to the power system. Key changes relate to the type of generation connecting and being decommissioned from the system, the location of said generation and the reactive power capability of connected plant. The report published by the TSOs in July 2011[1] (hereafter referred to as the DS3 report) outlined the current issues relating to voltage control and the likely challenges that will emerge by 2020.

APPROACH

The key objective is to maintain the voltage standards as appropriate per the standards in the relevant jurisdiction on the transmission networks. Specifically, this means ensuring that voltages are maintained within acceptable voltage ranges on both the transmission and distribution systems. In addition, the performance of the system following voltage steps and disturbances must remain within the necessary limits and recovery should be achieved in a timely manner.

SCOPE

The scope of this work-stream can be broken into three phases of work. These are as follows:

1. Setting appropriate standards for reactive power capability and control on connecting generation both renewable plants and conventional plant
2. Designing the network while allowing for changed capabilities of connecting generation, particularly embedded in the distribution system
3. Developing appropriate system operational policies to utilise this capability, fully co-ordinated between the transmission and distribution systems of Ireland and Northern Ireland.

1. PHASE 1: REACTIVE POWER STANDARDS

This work area will examine whether standards relating to voltage control need to be updated/clarified for both transmission and distribution connected generation. This will involve consultation and discussion leveraging the industry instruments already set up under the appropriate Grid Codes and Distribution Codes in Ireland and Northern Ireland. In addition there will be a review where necessary to examine where these standards are best placed including connection agreements, grid and distribution codes.

[1] http://www.eirgrid.com/media/Ensuring_a_Secure_Reliable_and_Efficient_Power_System_Report.pdf

Steady state Reactive Capability and Voltage Control Modes for Renewable Generators

In order to provide improved operational flexibility to the TSOs in terms of voltage control for increasing number of Controllable WFPS on the Power System, three modes of operation for renewable generators are required in Ireland and Northern Ireland, i.e. 'Q-Mode' or Reactive Power / Mvar Instruction, Power Factor control modes, and Voltage Control with feedback. This, or a relevant standard need to be decided on in the short term and the standard clarified going forward for all wind farms both transmission and distribution connected, Ireland and Northern Ireland. This workstream will also review the reactive capabilities of new technologies to meet the needs of the system.

Steady State Reactive Capability and Voltage Control Modes for embedded conventional plant

Conventional plant in distribution networks currently have a relatively restricted requirement to provide reactive power control. This needs to be examined in light of the review on wind farms and a decision made should the standards for new embedded conventional plant change.

Dynamic Reactive Power Provision from transmission and distribution connected wind farms

The recent Facilitation of Renewables study showed that the transient stability of the power system would be degraded at very high wind penetrations if sufficient reactive support was not provided. However, the studies showed that these issues can be largely mitigated if wind farms act quickly to restore active power output after fault clearance. In addition, this workstream will optimise the injection of active and reactive currents during faults to maintain voltage stability. This work task will seek to define the requirements for wind farm plant in both the transmission and distribution systems in this regard. While there is a desire to standardise the requirements as much as possible, there may be challenges that require different standards. These issues will be identified and addressed in this workstream.

Covered off by Grid Code Work-stream

Dynamic Reactive Power Provision for transmission and distribution conventional plant

The capability of conventional plant to assist during voltage disturbances has a material impact on the integrity of the power system during disturbances. A examination of these standards is required to ensure that they are sufficient for the long term security of the system at high penetrations of wind generation.

Covered off by Grid Code Work-stream

Controllability of Wind farms

The lack of control of existing wind farms in Ireland, particularly in terms of reactive power, was highlighted as a source of concern in the recent DS3 report. As the levels of connected wind continue to increase, the continued monitoring of this voltage control capability is essential to ensure that the appropriate standards are adhered to. Key to this is the Grid Code compliance testingand on-going performance monitoring of all wind farms to ensure control is maintained throughout their operational lifetime.

Covered off by Performance Monitoring Work-stream

2. PHASE 2: SYSTEM OPERATION ALLOWING FOR CHANGING CAPABILITIES OF GENERATION AND WIND FARMS

This phase will consider the implications of any changes in terms of studies and operation of the system following on from changes in phase 1.

Pilot Projects

Some of the changes in standards made (e.g. reactive capability of embedded generation or change in control modes of wind farms) per Phase 1 of this work-stream may need to be trialled on a test basis. The TSOs will work with the DSOs to trial this. In particular, demonstrations of how new voltage control modes on wind farms embedded in the distribution system can be used to manage both distribution and transmission system voltage. In addition, if voltage control capabilities are sought from embedded conventional plant this may need to be demonstrated in order to develop appropriate operational policies and practices for managing voltage control.

Planning Studies (TSO & DSO)

The methodology used for both TSO and DSO connection studies will need to be updated to reflect any changes in standards for embedded plant per the Grid Codes and Distribution Codes and how this impacts on future network connection studies and agreements.

Network Solutions (TSO & DSO)

When a clear understanding has been developed of what is expected (in terms of standards of performance) from new generation, modelling of the future network can be performed to examine what deficiencies remain and how the installation of network devices may contribute to alleviating these issues.

3. PHASE 3: DEVELOPING OPERATIONAL POLICIES

Following changes in standards and analysis of the impacts of these changes, new operational policies will have to be developed and in some cases, existing policies will have to be updated. For some policies, new tools will also have to be developed/ updated.

TSO Reactive Power Management Policy

The voltage control practices currently in use in the Control Centres will have to be updated to take into account any changes in reactive power capability. Some of the control tools in use in the Energy Management System will have to be updated to take into account the change in reactive capability. Detailed studies will also have to be carried out in the operational timeframe to assess the impact of any changes. This policy will also need to consider the necessary system tools required to successfully implement these policies in real time.

TSO/DSO Voltage Control Policy

The power system is changing from one of bulk power generation and transmission to load centres into a system with high levels of embedded generation. This means that the transmission and distribution systems need to be capable of a much wider operating range: from peak demand with low embedded generation to minimum demand with high embedded generation. This is a fundamental shift and may increase the range of reactive power control that is required to maintain system voltages within limits.

The traditional method of voltage control on the distribution system was through the use of tap-changers on transformers, line drop compensators and down-line regulators. This method assumed that the voltage dropped away from the primary substation towards the load and was within a given power factor band.

There is an interaction between the actions the TSOs take to manage the High Voltage system and the actions the DSOs take to manage the Medium Voltage and Low Voltage systems. These actions

need to be carefully co-ordinated to ensure secure voltage levels on the entire power system. Due to the changing nature of connecting generation, there is a need to investigate the best method for managing the co-ordination of TSO/DSO activities. The outcome of this is an agreed TSO/DSO reactive power operating protocol.

HIGH LEVEL PLAN

Decision/Deliverable	Responsible	Due by
Decision: Steady state Reactive Power Control from Wind farms	**TSOs, DSOs**	**Q3 2012**
Engagement between TSOs and DSOs on agreed standards universal Windfarm standard and appropriate controls for embedded conventional plant	TSOs , DSOs	Q1 2012
Grid Code and Distribution code changes brought to industry for discussion	TSO, DSO, All	Q2 2012
Decision: Steady state Reactive Power Control for embedded conventional plant	TSOs, DSOs	Q2 2012
Decision: Dynamic Reactive Power Provision from transmission and distribution connected wind farms	TSOs, DSOs	Q4 2012
Engagement between TSOs and DSOs on agreed standards universal Windfarm standard including dynamic reactive power provision	TSOs , DSOs	Q1 2012
Grid Code and Distribution code changes brought to industry for discussion	TSO, DSO, All	Q2 2012
Decision: Dynamic Reactive Power Provision for transmission and distribution conventional plant	TSOs, DSOs	Q3 2012
Grid Code changes brought to industry for discussion	TSOs	Q2 2012
Controllability of Wind farms	TSOs, DSOs	On-going
Implementation of new standards and a consideration of retrospection Steady State voltage control	TSOs	Q1 2014
Implementation of new standards and a consideration of retrospection on dynamic voltage control	TSOs	Q1 2014
Pilot Projects	TSOs, DSOs	Q1 2013
Planning Studies (TSO & DSO)	TSOs, DSOs	Q2 2013
Develop TSO Reactive Power Management Policy	TSOs	Q1 2014
Develop TSO/DSO Voltage Control Policy	TSOs, DSOs	Q1 2014