2016 DS3 Voltage Control Workstream Plan

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EIRGRID GROUP

Context

The system voltage is determined by the balance of reactive power production and absorption. Conventional generators have traditionally been a primary source of reactive power. This 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 coordinated approach for reactive power control throughout the whole system, both transmission and distribution. Deficiencies in a local area at a certain point can have an inordinate impact on other voltages, potentially leading to 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 to and being decommissioned from the system and the location of said generation. The reactive power capability of connected plant is crucial to managing the system voltage. The DS3 report[1] published by the TSOs outlined the current issues relating to voltage control and the likely challenges that will emerge by 2020.

Objective

The key objective is to ensure that transmission voltages are maintained within acceptable ranges. In addition, the performance of the system following voltage steps and disturbances must remain within the necessary limits. Recovery must also be achieved in a timely manner.

Work Completed

Grid Code Modifications

The work of the DS3 Grid Code workstream formed the basis of the first phase of the Voltage Control workstream. The following changes to the reactive power standards of wind farm power stations (WFPSs) were developed:

- Reactive Power Control Modes
- Steady State Reactive Power Capability
- Fault Ride-Through

The Ireland Grid Code modifications were approved by the CER on 26th February 2013. The Ireland Distribution Code modifications were approved by the CER on 8th October 2013. The WFPS Setting Schedule in Northern Ireland was approved by URegNI on 29th October 2013.

TSO Analysis

The TSOs undertook a number of studies that considered the impact of embedded WFPSs on transmission voltage performance based on the new WFPS voltage/reactive capability.

The first study 'Reactive Power from Wind Farm Clusters' considered the performance of a number of different voltage/reactive power control regimes at a number of WFPS clusters. The report presented a simple methodology for determining a static power factor setting that would compensate for the distribution network. The report also indicated that embedded WFPS operating in voltage control would deliver additional advantages although would perhaps present greater implementation challenges.

[1] http://www.eirgridgroup.com/site-files/library/EirGrid/Ensuring-a-Secure-Reliable-and-Efficient-Power-System-Report.pdf

The second study 'Voltage Stability Studies: Analysis of the Donegal Area' considered the regional impact on voltage control of an area with significant levels of WFPS penetration. The report indicated that the present practice of embedded WFPSs operating at a leading (absorbing) power factor risked potential voltage collapse of the region. The report also highlighted that by moving towards operation of WFPSs in voltage control mode, the voltage stability of the network could be significantly improved.

TSO-DSO Engagement

The TSOs and DSOs engaged throughout 2014 on the development of a 'Voltage Control Work Plan'. The agreed plan would identify and develop suitable demonstration projects to trial the operation of the new WFPS standards and control principles. These projects will provide practical examples of how the new capabilities can be utilised. The principles agreed between the TSOs and DSOs, will form the basis of future operating protocols. These will set out in detail how the TSOs and DSOs cooperate to maintain transmission and distribution voltages within standards.

TSO Reactive Power Planning

Studies have been undertaken by the TSOs to determine the medium-to long-term reactive power requirements of the transmission system. These include sensitivities of the voltage control arrangements implemented on embedded WFPSs. These studies are due to be completed in Q1 2016.

Implementation of New WFPS Capabilities

Given the approval of the DS3 WFPS modifications in 2013, an implementation programme of the new standards on WFPS with associated testing/validation has been initiated. The TSOs will manage this process for transmission-connected wind farms through the TSOs' Grid Code compliance and testing processes. The DSOs will manage this process for distribution-connected wind farms.

Key Focus Areas 2016

Nodal Voltage Control Pilot Project

Given the changes to standards, there is a need to trial solutions which best utilises the improved capability to manage both distribution and transmission system voltage. In Ireland, the TSOs are working with the DSO on a nodal voltage control pilot project. The aim of the pilot project is to develop a controller for embedded WFPSs connected to a single transmission node. Whereas, in Northern Ireland, the TSOs are working with the DNO to investigate the use of a 'smart' power factor. The aim of the trial is to implement a static power factor setting for embedded WFPSs connected to a single transmission node. Both trials will assist in supporting the transmission voltage while also maintaining voltages on the distribution system within acceptable limits. The outcome of the pilot projects will inform the TSO-DSO voltage protocol operational policy.

Transmission Voltage Trajectory Study

A study completed by the TSOs has shown that at times there may be certain scenarios where it may be possible to operate the power system safely and securely with fewer large conventional units. One aspect the study did not cover was how to safely and securely enter and exit the particular scenarios while maintaining voltages across the entire system within secure limits. The aim of this study is to take a number of these scenarios and determine if it is possible to enter and exit while keeping the system secure. It will also investigate whether the number of operator control actions required is practically implementable in the Control Centres. This study will inform the need/design of a Control Centre Voltage Trajectory tool.

High-Level Plan

Task No.	Task	Responsible	Original Due Date	Due Date
Development & Implementation of New WFPS Capabilities				
VC.01	Decision: Steady state Reactive Power Control from wind farms	TSOs, DSOs	Q3 2012	Complete
VC.02	Engagement between TSOs and DSOs on universal wind farm standards and appropriate controls for embedded conventional plant	TSOs, DSOs	Q1 2012	Complete
VC.03	Grid Code and Distribution code changes brought to industry for discussion	TSOs, DSO, All	Q2 2012	Complete
VC.04	Decision: Steady-State Reactive Power Control for embedded conventional plant	TSOs, DSOs	Q2 2012	Complete
VC.05	Decision: Dynamic Reactive Power Provision from transmission- and distribution-connected conventional plant	TSOs, DSOs	Q4 2012	Complete
VC.06	Decision: Dynamic Reactive Power Provision from transmission- and distribution-connected wind farms	TSOs, DSOs	Q4 2012	Complete
VC.07	Controllability of Wind farms	TSOs, DSOs	On-going	On-going
VC.08	Complete implementation of new Grid & Distribution Code standards and consideration of retrospection	TSOs, DSOs	Q1 2012	Complete
PM&T.5.4	Develop standard processes based on new Grid Code modifications which require testing	TSOs	Q4 2012	Complete
PM&T.5.5	Consideration of standardised testing processes arising from Distribution Code Modifications	DSOs	Q4 2012	Complete
TSO Analysis and Policy				
VC.10.01	Review of relevant ENTSO-E Network Codes	TSOs	Q1 2013	Complete
VC.10.02	Review relevant legislation in Northern Ireland	TSOs	Q1 2013	Complete
VC.10.03	Review relevant legislation in Ireland	TSOs	Q1 2013	Complete
VC.10.04	Consolidate Network Code / legislation reviews	TSOs	Q1 2013	Complete
VC.10.18	Study: 'Reactive Power from Wind Farm Clusters'	TSOs	Q1 2013	Complete
VC.10.19	Study: 'Voltage Stability Studies: Analysis of the Donegal Area'	TSOs	Q3 2013	Complete
VC.10.20	Study: Pilot PV (Power-Voltage) study at wind-farm cluster with existing operational practice to determine the level of reactive compensation required in the locality	TSOs	Q4 2013	Complete
VC.10.21	Develop methodology and approach to assessing system-wide reactive compensation requirements including input from DSOs on distribution network assumptions	TSOs, DSOs	Q1 2014	Complete
VC.10.22	Complete system-wide reactive compensation requirement studies with sensitivities on operational practice	TSOs	Q3 2014	Complete

VC.10.23	Transmission 'voltage trajectory' study	TSOs	Q3 2014	Q4 2016
VC.10.24	Steady-state and dynamic voltage study of 2017 system given best available information on load and connected plant and capabilities.	TSOs	New Task	Q4 2016
VC.10.25	Steady-state and dynamic voltage study of 2020 system given best available information on load and connected plant and capabilities.	TSOs	New Task	Q4 2017
VC.10.27	Investigate solutions to VDIFD	TSOs	New Task	Q4 2016
VC.10.28	Check using 2020 model that short-circuit levels are not below the minimum required	TSOs	New Task	Q2 2017
VC.10.26	Review of current Voltage Control Policy and propose 2020 policy based on results of VC.10.23 and VC.10.24	TSOs	New Task	Q1 2017
VC.10.29	Deliver Transmission Voltage Control Policy (including agreed TSO-DSO protocol)	TSOs	Q1 2014	Q2 2017
TSO-DSO Engagement – Requirements				
TDV1.1	Develop common understanding of 2020 reactive power requirements and potential contribution of distribution-connected generation	DSOs / TSOs	Q1 2014	Complete
TDV1.2	Agreement on interim voltage control arrangements, signalling and commissioning requirements pending development of the enduring arrangements	ESBN / TSO	Q1 2014	Complete
TDV1.3	Agreement on interim voltage control arrangements signalling and commissioning requirements pending development of the enduring arrangements	NIE / TSO	Q1 2014	Complete
TDV1.4	TSOs to articulate preferred voltage control requirements for 'cluster' type stations	TSOs	Q4 2013	Complete
TDV1.5	DSOs consideration of TSOs preferred voltage control requirements and how/if they can be implemented in a DSO Nodal Voltage Control solution	NIE	ON HOLD	ON HOLD
TDV1.6	DSOs consideration of TSOs preferred voltage control requirements and how/if they can be implemented in a DSO Nodal Voltage Control solution	ESBN	Q1 2014	Complete
TDV1.7	Agree approach to voltage control pilot project	NIE / TSO	ON HOLD	ON HOLD
TDV1.8	Agree approach to voltage control pilot project	ESBN / TSO	Q1 2014	Complete
TSO-DSO Engagement – Analysis				
TDV2.1	Agree scope and location for Northern Ireland cluster study	NIE / TSO	Q1 2013	Complete
TDV2.2	Agree scope and location for Ireland cluster study	ESBN / TSO	Q1 2013	Complete
TDV2.3	Exchange of appropriate models and data	NIE / TSO	Q1 2014	Complete
TDV2.4	Exchange of appropriate models and data	ESBN / TSO	Q1 2014	Complete
TDV2.5	TSO analysis complete and report shared	TSOs	Q1 2014	Complete
TDV2.6	DSO analysis complete and report shared	NIE	Q2 2014	Complete
TDV2.7	DSO analysis complete and report shared	ESBN	Q2 2014	Complete
TDV2.8	Recommendation (technical/commercial/priorities) to DSOs/TSOs Oversight Committee and decision on next steps	NIE / TSO	ON HOLD	ON HOLD

TDV2.9	Recommendation (technical/commercial/priorities) to DSOs/TSOs Oversight Committee and decision on next steps	ESBN / TSO	Q2 2014	Q2 2015
TSO-DSO Engagement –Nodal Voltage Controller Pilot Projects				
TDV3.1	Scope Ireland Nodal Voltage Controller pilot projects	ESBN / TSO	Q2 2014	Complete
TDV3.3	Ireland Nodal Voltage Controller pilot project approvals	ESBN / TSO	Q3 2014	Complete
TDV3.4	Commence Ireland Nodal Voltage Controller pilot projects	ESBN / TSO	Q4 2014	Complete
TDV3.5	Ireland Nodal Voltage Controller Pilot project implemented and trial commenced	ESBN / TSO	Q1 2016	Q4 2016*
TDV3.6	Ireland Nodal Voltage Controller pilot project reports & recommendations to DSOs/TSOs Oversight Committee	ESBN / TSO	Q2 2015	Q2 2017*
TDV3.7	Scope Northern Ireland Nodal Voltage Controller pilot project	NIE / TSO	ON HOLD	ON HOLD
TDV3.8	If appropriate, obtain Regulatory approval for funding	NIE / TSO	ON HOLD	ON HOLD
TDV3.9	Northern Ireland Nodal Voltage Controller pilot project approvals	NIE / TSO	ON HOLD	ON HOLD
TDV3.10	Commence Northern Ireland Nodal Voltage Controller pilot project	NIE / TSO	ON HOLD	ON HOLD
TDV3.11	Northern Ireland Nodal Voltage Controller pilot project reports & recommendations to DSOs/TSOs Oversight Committee	NIE / TSO	ON HOLD	ON HOLD
TDV.3.12	With Nodal Controller on hold, complete study investigating use of 'Smart' Power Factor at Magherakeel node	TSO	New Task	Complete
TDV.3.13	Review 'Smart' Power Factor study and make decision whether to trial at Magherakeel node	NIE	New Task	Complete
TSO-DSO Engagement – Policy				
TDV4.1	Recommendation to DSOs/TSOs Joint Oversight Committee for reactive power / voltage control arrangements for embedded (non-cluster) wind farms and decision on next steps	NIE / TSO	Q3 2014	Q2 2016
TDV.4.1.1	Study all embedded (non-cluster) controllable wind farms connections in Northern Ireland to assess the range of power factors to ascertain if it is possible to move them closer to unity (6 connection studies complete, 14 remaining)	NIE	New Task	Q2 2016
TDV4.2	Recommendation to DSOs/TSOs Joint Oversight Committee for reactive power / voltage control arrangements for embedded (non-cluster) wind farms and decision on next steps	ESBN / TSO	Q4 2014	Complete
TDV4.3	Finalise TSO/DSO Voltage Control protocol	NIE / TSO	Q1 2014	Q2 2017
TDV4.4	Finalise TSO/DSO Voltage Control protocol	ESBN / TSO	Q1 2014	Q2 2017

* Dependent on the wind farms due to take part in the trial becoming compliant with certain reactive power requirements of the Distribution Code