DS3:
Control Centre Tools & Capabilities Workstream - 2015

Glossary of Terms

CHCC: Castlereagh House Control Centre

CCTC: Control Centre Tools and Capabilities

DSO: Distribution System Operator

EIP: EMS Integration Project

EMS: Energy Management System

NCC: National Control Centre

PMU: Phasor Monitoring Unit

RCUC: Reserve Constrained Unit Commitment

RES: Renewable Energy Sources

ROCOF: Rate of Change of Frequency

SEM: Single Electricity Market

SNSP: System Non-Synchronous Penetration

STATCOM: Static Synchronous Compensator

TSO: Transmission System Operator

WDT: Wind Dispatch Tool

WEF: Wind Energy Forecaster

WSAT: Wind Secure Level Assessment Tool

1 Context

This workstream, in line with the wider DS3 programme, aims to facilitate the integration of renewable generation on the all-island power system. The evolving power system requires new principles and practices of operation, with the resultant requirement for development and implementation of new Control Centre Tools and Capabilities. As an example, the projected increase in electricity production from renewable sources, in particular wind energy, will have significant implications for the control of system voltages in steady-state and transient scenarios. Similarly, the future generation portfolio will create considerable challenges for system frequency control. New and modified operational policies and tools may be required to meet these challenges. Furthermore, enhanced staff capability will be required to manage the power system in this changing environment.

There are two transmission system Control Centres on the island of Ireland; the Dublin and Belfast Control Centres. As part of this workstream, the tools available to the engineers in both Control Centres will be reviewed and modified where necessary. In some cases new tools will be developed to enable the implementation of new operational policies. In keeping with the natural flow of DS3 from system performance to system policies to system tools, much of the activity in this workstream will be driven by the outputs of other DS3 workstreams, especially those in the policy area. Notwithstanding this, the anticipated Control Centre environment with the expected level of renewable generation will be examined to highlight requirements which may not be generated by other workstreams. It is important to note that the future requirements for the Control Centres are not yet fully defined and will continue to evolve.

Work has already been completed in many areas associated with this workstream. The Wind Dispatch Tool and Wind Forecasting projects have both been delivered successfully. The development of new functionality within the existing Energy Management System (EMS), including online inertia and rate of change of frequency (ROCOF) monitoring is also complete. Further EMS developments such as an online Short Circuit Analysis Tool are well underway. Other work areas where significant progress has been made to date include the continued development of the Reserve Constrained Unit Commitment (RCUC) software and overlaps with the Wind Security Assessment Tool (WSAT) workstream. Provision of the necessary training for Control Centre staff on any new tools or policies will be another important facet of this workstream. It should be noted that this business plan contains a subset of the development work that is on-going in the Control Centres in both Dublin and Belfast, i.e. it lists those items related to the DS3 programme.

1.1 Objective

The objective of the Control Centre Tools and Capability (CCTC) workstream is to ensure the timely provision of the Tools and Capability to enable the Transmission System Operators (TSOs) operate the power system securely with increasing levels of renewable generation.

2 Work Completed to Date

2.1 Wind Forecasting

A wind energy forecasting (WEF) project was completed in 2014 , featuring a number of initiatives to improve forecast accuracy and user interaction with the tool. At present, forecasts are supplied by two external providers and made available to the Control Centres using an internal tool. The key elements of the WEF project were:

Enhanced data provision from TSOs to forecast providers

As of Q1 2013, wind forecast providers are now supplied with enhanced real-time data for wind farms including SCADA MW, MW Availability and wind dispatch information. This data provision will improve forecast provider modelling and the accuracy of forecasts supplied to the Control Centres. It has also facilitated short-term forecast optimisation.

Implementation of forecast accuracy incentive scheme

The implementation of a wind forecast incentive scheme, whereby vendors will receive some payments linked to forecast accuracy was accomplished under the scope of the WEF project. An application for performing statistical accuracy calculations was delivered in June 2013 and following a period performing benchmark analysis on wind forecast data, the incentive scheme came into effect in January of 2014. This incentive scheme aims to encourage forecast accuracy and improve the quality of data available to the Control Centres.

New Forecast Functionality and improvements to Graphical User Interface (GUI)

An updated WEF Graphical User Interface (GUI) was implemented successfully in September 2013. New features include all-island and regional forecasts as well as short-term forecast and confidence interval displays.

Wind Forecast Tender

Separately, a tender process is underway to select future wind forecast providers. During 2014, the CCTC workstream provided input into the Operations related tender requirements. This involved consultation with Control Centre staff as well as other interested parties. The new contracts are expected to take effect in early 2015.

2.2 Wind Dispatch Tool

The new EMS Wind Dispatch Tool (WDT) went live successfully in the National Control Centre (NCC) on the 7th of May and in the Castlereagh House Control Centre (CHCC) on the 24th of July 2014. The primary driver for the implementation of the enhanced tool was the SEM decision paper on tie-breaks in dispatch. This decision determined that defined constraint groups of wind farms be implemented to alleviate certain network constraints – within these groups dispatch down is "grandfathered" based on category, firmness and gate. A new WDT was developed to ensure this requirement was manageable from a Control Centre perspective. The opportunity was also taken to incorporate a number of other additional features including Design Minimum Operating Level, Frequency Control Settings, enhanced Achievement Tracking, Test Mode, Category 1 dispatch and

the tagging of each dispatch instruction issued by a tool with a Reason for Dispatch code. This is the first such tool available to CHCC, thereby ending the current "rota" system of wind dispatch in Northern Ireland. Modifications to downstream systems were required in both EirGrid and SONI to manage the output from the new tool.

2.3 EMS Integration Project

A major upgrade of the EMS is due to be completed by the end of 2015 which will provide a single all-island EMS; thereby facilitating all-island power system operation. The EMS Integration Project (EIP) is outside the scope of the DS3 programme - it is a separate project that is being undertaken by the EirGrid Group. However, many elements of EIP will facilitate the DS3 programme and the relevance of the programme and any known requirements were taken into account in the specification process. Factory testing and initial site integration of the new platform was completed in 2014 and the focus for 2015 will switch to extensive site testing and operational readiness.

2.4 On-going EMS Developments

Initial versions of Inertia monitoring and ROCOF monitoring have been implemented in the EMSs. These implementations will be reviewed and developed as more information becomes available from other workstreams in DS3 e.g. Modelling and Studies workstream.

2.5 Phasor Monitoring Display Project

A project was delivered in Q2 2014 to present data recorded by Phasor Monitoring Units (PMUs) to the Control Centres in a useful fashion. PMUs are currently installed at a small number of locations on the transmission system and may be rolled out further in future. The data measured by PMUs is of a substantially higher resolution (approximately 20ms) than the SCADA data (seconds) which is currently used in the EMS. An interface was created which allows Control Centre engineers to monitor system frequencies, relative phase angles and power oscillations across the locations where PMUs are installed. Alerts are provided if certain measured values violate operational limits. This is useful, for example, in the detection of islanding by frequency comparison between PMU locations. The PMU system offers a backup transmission system display in the event of an EMS failure and is particularly useful for the investigation of system events.

2.6 Reserve Constrained Unit Commitment (RCUC)

RCUC is the day-ahead and in-day generation unit commitment and scheduling tool used jointly by NCC and CHCC. Among other inputs, RCUC uses the technical and commercial data from the Single Electricity Market (SEM) and produces an optimised generation schedule framed by reserve, transmission and other constraints.

A RCUC update was implemented in November 2014 which integrates minimum system inertia and maximum ROCOF metrics into the scheduling process to ensure optimised and secure generation schedules.

2.7 Wind Secure Level Assessment Tool (WSAT)

There is on-going interaction between the CCTC workstream and the WSAT workstream - WSAT is an all-island tool deployed in both Control Centres. Two particular areas of mutual interest for 2014 were:

WSAT Frequency Monitoring:

One element of the DS3 WSAT Plan undertaken during 2014 was the inclusion of on-line monitoring of frequency security. Frequency security involves checking to see if system frequency remains within secure limits following major disturbances on the power system. Results from WSAT modelling of significant frequency events have been benchmarked against PMU data from actual events. WSAT frequency analysis was made available in both Control Centres in December 2014.

Overload Transfers:

WSAT has the capability to perform overload monitoring. As the EMS provides basecase online overload monitoring, it is not proposed that WSAT should replace this functionality. Rather, the transfer analysis capability of WSAT can be used to identify potential overloads in the network with changing wind, load or conventional generation. This functionality can be used to predict how much wind generation should be dispatched down to reach a secure operating point. Conversely, it can also be used to inform how much wind generation can be increased before insecurity is reached. Multiple individual power flow studies would currently be required to garner such information.

A Donegal Constraint Group transfer was implemented in live WSAT in November 2014 following a monitoring period on the Pre-Production server. The transfer aims to assist in the management of constraints in the area. This transfer provides NCC with guidance on the level of wind generation headroom available before transmission constraint issues become binding and also how much constraint must be applied to solve an insecurity in the region.

3 Focus Area 2014 – 2015

Outputs from other areas, in particular the Frequency Control and Voltage Control workstreams, will begin to drive operational policy and in turn define the need for new and updated tools in the Control Centres. This section of the CCTC business plan has been divided into three categories based on the tasks and deliverables which apply to each area. The categories in question are “Establishing the Necessary Tools for the Operation of Today’s Power System”, “Development of Tools to Accommodate 75% System Non-Synchronous Penetration (SNSP)” and “Building Operator Confidence and Capability to Operate at World Leading RES Levels”.

3.1 Establishing the Necessary Tools for the Operation of Today’s Power System

3.1.1 EMS Integration Project

Significant site testing of the integrated EMS is planned this year with go-live expected in Q3 2015.

3.1.2 EMS Short Circuit Analysis Tool

A project was initiated before the launch of DS3 to implement online short circuit rating monitoring in the EirGrid EMS. This will enable more dynamic monitoring of such ratings as opposed to reliance on explicit offline studies, (although an off-line study functionality will still be available). Due to the changing nature of the power system and the increased variability in magnitude and geographical location of both renewable and conventional generation, such dynamic analysis is seen as an important tenet in managing the power system safely and securely. As such, this project has been brought under the umbrella of DS3. Following a period of significant testing, it's expected that the tool will be made available to NCC in Q1 2015. The EMS short circuit analysis functionality will become available to CHCC in 2015 as part of the EMS Integration Project.

3.2 Development of Tools to Accommodate 75% SNSP

To achieve the target of 40% of electricity generation from renewable sources by 2020, the power system must be capable of operating at SNSP levels of up to 75%. The manner in which system voltages and frequency are managed at such high SNSP levels must be carefully considered and developed to achieve this target. The CCTC workstream will therefore engage in on-going interaction with the Frequency Control and Voltage Control workstreams, providing input regarding the practicality of new operational policies as well as developing tools to implement said policies.

3.2.1 Frequency Control

There are a number of areas of investigation proposed by the Frequency Control workstream which may result in new operational policies and tools. These new developments are being principally driven by the paradigm shift from traditional provision of frequency response and reserves by conventional generators to a power system with a lower percentage of such units, with a resultant need for different sources of system services. For example, the frequency regulation characteristics of windfarms may be utilised to complement that of the conventional generators – it's expected that this will be trialled in 2016.

Adding to the challenge is the increasing uncertainty faced by TSOs in developing generation schedules. To meet this challenge, different timescales of frequency response and reserve may be defined, varying from fast response available in a few seconds to longer term reserves and ramping considerations. To account for unavoidable errors in wind power forecasts, sufficient ramping capability (both positive and negative) must be available on conventional generators. Current policies in this area will be reviewed and developed to ensure they are robust enough to manage the changing power system. The area of frequency regulation will also be investigated by the Frequency Control workstream.

3.2.2 Voltage Control

As the generation portfolio continues to diverge away from large thermal units towards smaller-scale wind generation, a number of challenges are presented. Generation units are becoming more geographically dispersed and the different capability of the units themselves influences the system services which can be provided. Newly designed system services and/or equipment such as STATCOMs may be necessary to maintain the transmission system voltages within operational limits with a high penetration of non-synchronous generation. This prospective new equipment, combined

with the increased number of transmission-connected wind farms which will require reactive power control, means that Control Centre procedures and tools may be required to ensure the system voltage can be managed securely.

Furthermore, a high percentage of the wind generation expected to connect to the system by 2020 will be at distribution voltage levels. While TSOs on the island of Ireland currently control the active power outputs of distribution-connected wind farms, they do not control the reactive power outputs. Discussions are underway to determine the manner in which these wind farms will be controlled going forward and the outcome of these discussions will have significant implications for both the Voltage Control and CCTC workstreams. The function of the CCTC workstream in this area will be to facilitate the implementation of agreed voltage control plans at both transmission level and at transmission/distribution interfaces and the implementation of any Control Centre tools required.

3.3 Building Operator Capability to Operate at World Leading RES Levels

3.3.1 Training of Control Centre Staff

Control Centre engineers have a wealth of knowledge of real-time power system operation – it is important to harness this knowledge and also make sure they are kept abreast of developments likely to influence how they operate the system on a day-to-day basis. Due to the 24/7 nature of Control Centre operation this will be carried out by dedicated workshops and training days. More dedicated training may be required for some of the new policies and tools which arise as part of the DS3 Programme.

4 Tasks and Actions

TASK NO.	TASK/ACTION	RESPONSIBLE	ORIGINAL DUE DATE	DUE DATE
Establishing the Necessary Tools for the Operation of Today's Power System				
CCTC1.1.1	Drafting business rules for wind dispatch into business requirement specification (BRS) (SEM-11-105)	TSOs/SEMC	New Task	Complete
CCTC1.1.2	Costs and timelines for implementing BRS (SEM-11-105)	TSOs	New Task	Complete
CCTC1.2.1	Design and Testing of EMS Wind Dispatch Tool in Dublin	TSOs	New Task	Complete
CCTC1.2.2	Design and Testing of EMS Wind Dispatch Tool in Belfast	TSOs	New Task	Complete
CCTC1.2.3	Roll-out of Wind Dispatch Tool and Settlement Interface in Dublin	TSOs	Q2 2014	Complete
CCTC1.2.4	Roll-out of Wind Dispatch Tool and Settlement Interface in Belfast	TSOs	Q2 2014	Complete
CCTC1.3	Implementation of Online Short Circuit Analysis Tool in Dublin Control Centre	EirGrid	Q2 2013	Q1 2015
CCTC1.4	Inclusion of an Inertia Monitoring Capability in Control Centres	TSOs		Complete
CCTC1.5.1	Scoping of EMS Integration Project	TSOs	Q3 2012	Complete
CCTC1.5.2	EMS Integration Project	TSOs	Q2 2015	Q4 2015
CCTC1.7.1	Implementation of incentives for forecasting accuracy of service providers	TSOs	Q1 2013	Complete
CCTC1.7.2	Implementation of Regional Forecasting	TSOs	Q1 2013	Complete
CCTC1.7.3	Sending live wind farm signals to Wind Forecast Service Providers to improve modelling.	TSOs	Q1 2013	Complete
CCTC1.7.4	Collate Operations Requirements for Wind Forecast Tender	TSOs	New Task	Complete
CCTC1.8	Facilitate Implementation of Phasor Monitoring Display Project	TSOs	New Task	Complete
CCTC1.9	Inclusion of Inertia and ROCOF Considerations in RCUC	TSOs	New Task	Complete
Development of Tools to Accommodate 75% System Non-Synchronous Penetration				
CCTC2.1	Develop revised roadmap for Control Centre Tools	TSOs	New Task	Q4 2015
CCTC2.2	Ramping Policy Tool Decision and Implementation Plan	TSOs	Q4 2015	Q1 2016
CCTC2.3	Determine appropriate method of nodal voltage control dispatch	TSOs/DSOs	New Task	Q1 2016
CCTC2.4	Decision on Frequency Regulation Tool Implementation	TSOs	Q1 2015	Q3 2016
CCTC2.5	Transmission Voltage Control Implementation Plan	TSOs	New Task	Q1 2017
CCTC2.6	Transmission/Distribution Voltage Control Implementation Plan	TSOs/DSOs	New Task	Q1 2017