DS3:
Control Centre Tools & Capabilities Workstream

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 operators 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 commenced on many areas associated with this workstream. The Wind Dispatch Tool and Wind Forecasting projects are at advanced stages. The development of new functionality within the existing Energy Management System (EMS), including online inertia and rate of change of frequency (RoCoF) monitoring is complete. Further EMS developments such as an online Short Circuit Analysis Tool are well underway. Other work areas 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 ongoing 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 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 is ongoing – it features a number of initiatives to improve forecast accuracy and user interaction with the tool. At present, forecasts are supplied by two external providers. The WEF project is nearing completion and some key elements are as follows:

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 WEF project also includes the implementation of a wind forecast incentive scheme, whereby vendors will receive some payments linked to forecast accuracy. An application for performing statistical accuracy calculations was delivered in June 2013. This application has been performing benchmark analysis on wind forecast data since July 2013 as a means to determine a practical and effective incentive scheme. 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.

2.2 Wind Dispatch Tool

The publication of the SEM Decision paper on the "Treatment of Price Taking Generation in Tie-Breaks in Dispatch in the SEM and Associated Issues" (SEM-11-105) has instigated substantial change to the functionality of the Wind Dispatch Tool (WDT) used in the Control Centres. In particular, the decision to introduce defined constraint groups, within which dispatch down is "grandfathered" based on firmness and gate, is a significant change from the current dispatch process. This tool will be implemented within the separate Energy Management System (EMS) of each Control Centre. This will be the first such tool available to the Castlereagh House Control Centre (CHCC), thereby ending the current "rota" system of wind dispatch in Northern Ireland.

A detailed specification of the requirements for the new Wind Dispatch Tool was compiled and forwarded to the supplier for review and pricing in May 2013. The final project specification was subsequently agreed in late July 2013.

2.3 EMS Integration Project

A major upgrade of the EMS is due to be completed by the end of Q3 2015 which will result in 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. The scope for the integrated EMS was compiled and the specification was agreed with the EMS Supplier in December 2012. A work statement phase followed during which detailed project notes were agreed to clarify the project specification. This phase was completed in Q1 2013. Although the EMS Integration Project falls outside the scope of DS3, the relevance of the programme and any known requirements were taken into account in the specification process.

2.4 Ongoing EMS Developments

Inertia/RoCoF monitoring: 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.

3 Focus Area 2013 – 2014

As the DS3 programme continues to advance, an increased focus is beginning to fall upon the CCTC workstream. 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 Ongoing EMS Developments

As a result of work initiated by both the DS3 Programme and other change drivers, there is continuous development of the SONI and EirGrid EMSs. These EMS systems are currently separate, allowing only jurisdictional control of the power system. On saying that, to facilitate integrated operation there is some data flow between the two Control Centres e.g. all-island demand, conventional generation, renewable generation, DC interconnector flows etc.

Some of the areas where DS3 has initiated modifications to the EMSs are as follows:

Wind farm voltage control grid code modifications:

Enhanced wind farm voltage control options for the system operators will require EMS work to implement the enhanced functionality. Additionally, with the increasing use of windfarms for voltage

control, the EMS wind farm voltage control tool will be reviewed with a view to providing a more efficient and user friendly dispatch method to control centre engineers.

Wind generator frequency control grid code modifications:
Enhanced wind generator frequency control options for the TSO will require EMS work to implement these controls. In addition, changes to frequency control settings of wind generators need to be considered in the context of wind dispatch from the EMS.

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. The EMS short circuit analysis functionality will become available to SONI in 2015 as part of the EMS Integration Project.

3.1.3 EMS Integration Project

Alstom are currently in the factory development phase with factory testing scheduled for late 2013/early 2014. The focus of the project will then switch to site integration and site testing.

3.1.4 Wind Dispatch Tool

It is envisaged that the WDT will become operational in both control centres in Q2 2014. The work breakdown is as follows:

- Detailed design phase (continuous liaison between EirGrid and supplier)
- Factory and Site testing of the EMS tool
- Modifications to downstream systems in EirGrid and SONI and testing of interfaces
- Roll-out of the tool and downstream systems in EirGrid and SONI

3.1.5 Reserve Constrained Unit Commitment (RCUC)

RCUC is the day-ahead and in-day generation unit commitment and scheduling tool used jointly by National Control Centre (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.

Investigations have commenced with the supplier of this tool to include Inertia and RoCoF considerations. To ensure optimised and secure generation schedules, these metrics must be integrated into the scheduling process. The outcomes of further DS3 studies and other workstreams will dictate exactly how these metrics are used.

3.1.6 Wind Secure Level Assessment Tool (WSAT)

There is ongoing 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 are:

- Assessment of frequency analysis in WSAT prior to roll-out of frequency monitoring: One element of the DS3 WSAT Plan for 2014 is inclusion of on-line monitoring of frequency security. Frequency security will involve checking to see if system frequency remains within secure dynamic limits following major disturbances on the power system. The accuracy of this analysis will be reviewed before launch in the Control Centres.

- Investigation of potential implementation of overload transfers: WSAT does not presently perform overload monitoring, but has the capability to do so. 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 would be used to identify potential overloads in the network with changing wind, load or conventional generation. As an example, this functionality could be used to predict how much wind generation should be dispatched down to reach a secure operating point. Conversely, it could also be used for informing how much wind generation can be increased before insecurity is reached. Multiple individual power flow studies would currently be required to garner such information.

3.1.7 Wind Forecasting

Although a number of initiatives have been carried out to improve the accuracy of wind forecasting, there remains a body of ongoing work in the area. Following the completion of benchmark accuracy analysis, consultation with the wind forecast providers is due to take place in December 2013 to agree appropriate incentive criteria. The first incentive payments are scheduled to be paid in April 2014. These initial payments will be based on the accuracy of the forecasts supplied over the Q1 2014 period.

Separately, a tender process will be carried out during the first half of 2014 to select future wind forecast providers. The CCTC workstream will be tasked with providing input to tender requirements. This will involve consultation with Control Centre staff and other interested parties as well as identification of other requirements. The contracts are scheduled to be awarded by Q3 2014 and will be effective as of January 2015.

3.1.8 Demand Side Management

Glen Dimplex Pilot Project

A demonstration project is presently underway in partnership with Glen Dimplex which aims to demonstrate the principles behind intelligent domestic demand side participation. More specifically the project hopes to demonstrate the provision of system services (frequency response and ramping capability) to the TSOs from aggregated sources at a domestic level, via flexible storage heaters with embedded communications capabilities. The pilot project involves the installation of 1000 Glen Dimplex heaters, providing up to 10 MW of flexible demand. Over the course of this project, a

suitable trial dispatch method will need to be specified and implemented in the relevant Control Centre. The trial project aims to be operational in time for the winter of 2014/2015.

3.1.9 Phasor Monitoring Display Project

A project is currently being undertaken to present data recorded by Phasor Monitoring Units (PMUs) to the NCC in a useful fashion. PMUs are currently installed at a 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 than the SCADA data which is currently available. The aim of the project is to make use of this data through the creation of a display which will monitor system frequencies, relative phase angles and power oscillations across the locations where PMUs are installed. The display will be browser based and provide alerts if certain measured values violate operational limits. This would be useful, for example, in the detection of islanding by frequency comparison between PMU locations. The PMU system will also offer a backup transmission system display in the event of an EMS failure. The display is due to be operational in the NCC by the end of Q2 2014.

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 ongoing 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 - this will be trialled in 2015.

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	Q2 2014
CCTC1.2.2	Design and Testing of EMS Wind Dispatch Tool in Belfast	TSOs	New Task	Q2 2014
CCTC1.2.3	Roll-out of Wind Dispatch Tool and Settlement Interface in Dublin	TSOs	Q2 2014	Q2 2014
CCTC1.2.4	Roll-out of Wind Dispatch Tool and Settlement Interface in Belfast	TSOs	Q2 2014	Q2 2014
CCTC1.3	Implementation of Online Short Circuit Analysis Tool in Dublin Control Centre	EirGrid	Q2 2013	Q4 2014
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
CCTC1.6	Glen Dimplex Demand Side Participation Trial Dispatch	TSOs	New Task	Q4 2014
CCTC1.7.1	Implementation of incentives for forecasting accuracy of service providers	TSOs	Q1 2013	Q2 2014
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	Q2 2014
CCTC1.8	Facilitate Implementation of Phasor Monitoring Display Project	TSOs	New Task	Q2 2014
CCTC1.9	Inclusion of Inertia and RoCof Considerations in RCUC	TSOs	New Task	Q4 2014
Development of Tools to Accommodate 75% System Non-Synchronous Penetration				
CCTC2.1	Trial Wind Reserve Implementation	TSOs	New Task	Q1 2015
CCTC2.2	Decision on Frequency Regulation Tool Implementation	TSOs	New Task	Q1 2015
CCTC2.3	Ramping Policy Tool Decision and Implementation Plan	TSOs	New Task	Q4 2015
CCTC2.4	Transmission Voltage Control Implementation Plan	TSOs	New Task	Q2 2015
CCTC2.5	Transmission/Distribution Voltage Control Implementation Plan	TSOs/DSOs	New Task	Q2 2015
CCTC2.6	Determine appropriate method of nodal voltage control dispatch	TSOs/DSOs	New Task	Q3 2014
Building Operator Confidence and Capability to Operate at World Leading RES Levels				
CCTC3.1	Developing the staff capability	TSOs	New Task	Q2 2015