DS3 RoCoF Alternative Solutions Project Report Overview

31st of March 2016

EIRGRID SONI

1. Glossary of Terms

AC electricity – alternative current (AC), a type of power used to deliver electrical power to businesses and residences.

CER - The Commission for Energy Regulation ('the CER') is the independent body responsible for overseeing the regulation of Ireland's electricity and gas sectors. The CER was initially established and granted regulatory powers over the electricity market under the Electricity Regulation Act 1999.

Conventional Generation - Types of generation technologies in existence prior to emergence of renewable energy generators.

Delivering a Secure Sustainable Electricity (DS3) - The aim of the DS3 Programme is to meet the challenges of operating the electricity system in a secure manner while achieving the 2020 renewable electricity targets.

Demand - The electrical power consumed by the end-user.

Distribution system – is the system which consists of electric lines, electric plant, transformers and switchgear and which is dedicated to delivering electric energy to an end-user.

Distribution System Operator (DSO) - Electricity Supply Board (ESB) Networks is a DSO licenced by the CER to manage and operate the sub-transmission electricity grid across Ireland. NIE Networks (NIE) is a DSO is licenced by the UR to manage and operate the sub-transmission electricity grid across Northern Ireland.

DNV GL – an engineering consultancy company hired by EirGrid and SONI.

EirGrid – is a state-owned company that manages and operates the high voltage electricity grid across Ireland. EirGrid is responsible for planning for the future of the grid.

EirGrid Group - EirGrid and SONI are part of the EirGrid Group.

Event - An unscheduled or unplanned occurrence on the electrical grid, including faults, incidents and breakdowns.

Electrical Frequency – the number of complete cycles per second in AC direction. The standard unit of frequency is the hertz, abbreviated Hz. If a current completes one cycle

per second, then the frequency is 1 Hz. The standard electrical frequency in Ireland is 50 cycles per second, or, 50 Hz.

Generator – a machine that converts energy into electricity.

Grid – a network or 'energy motorway' made up of high-voltage overhead lines and underground cables, as well as transmission stations. The network links energy users with energy creators. It is designed to ensure that power can flow freely to where it is needed.

Inertia – is the resistance of an object to a change in its motion.

Interconnector – a high voltage transmission line connecting the electricity networks of two separate locations.

Non-synchronous (synthetic) inertia – is the injection of energy from Non-synchronous generation device in response to a system event.

Non-synchronous generation – is a generator which supplies power to the electrical Grid via power electronics. Power electronics are used to adjust the speed and frequency of the generated energy (typically associated with wind energy) to match the speed and frequency of the transmission network.

Renewable energy – is energy from a non-exhaustible resource such as the sun or wind.

Rate of change of frequency (RoCoF) – is the change in system frequency over a certain time. The unit of measurement is Hertz per second abbreviated as Hz/s.

SONI – is the licenced electricity system operator for Northern Ireland and is responsible for planning for the future of the grid.

Synchronous inertia – is the kinetic energy released by a synchronous generator directly after a change in the system frequency. The measurement unit of synchronous inertia is MW.s.

Synchronous generation (conventional generation) – in an AC power system; synchronous generators are directly connected to the grid. The speed and frequency of a generator matches the running network, changes in system transmission frequency are matched by the generator. Types of generation fuel include coal, gas, oil, water and biomass.

System Imbalance – An unscheduled or unplanned occurrence on the electrical grid where electricity supply does not meet electricity demand. This can typically occur when an electrical generator suddenly disconnects from the grid, resulting in the loss of its electrical power supplied to the grid;

Transmission grid infrastructure – is the physical structures which make up the transmission grid. These include the cables and lines used to transmit electricity, the pylons which hold the lines, and the substations used to convert the electrical current and raise or lower the voltage of that current.

Transmission line – a high-voltage power line transmits (sends) electricity across long distances. Voltages in Ireland are: 400 kV, 275 kV 220 kV, or 110 kV.

Transmission network – an electricity network made up of power lines, cables and substations. It links energy creators with the distribution system.

Transmission System Operator (TSO) - The TSO is responsible for managing and operating the high voltage electricity grid. EirGrid and SONI are licenced by the CER and UR as the Transmission System Operator for Ireland and Northern Ireland respectively.

System Non-Synchronous Penetration (SNSP) - is a measure of the non-synchronous generation on the system at an instant in time.

Utility Regulator (UR) - an independent non-ministerial government department set up to regulate the electricity, gas and water and sewerage industries in Northern Ireland.

2. Introduction

As Transmission System Operator (TSO) in Ireland and Northern Ireland, it is our job to manage the electricity supply and the flow of power across the island of Ireland. This work is done from the National Control Centre (NCC) in Dublin and the Castlereagh House Control Centre (CHCC) in Belfast.

Electricity is made from gas, coal and renewable sources (such as wind and solar power) at sites across the island. Our high voltage transmission network then transports electricity to cities, towns and industrial sites. These are called high demand centres. EirGrid and SONI operate the transmission system in a safe secure and economical way.

One of our key jobs is to maintain balance between electricity supply and electricity demand. “Electrical frequency” measures the balance between supply and demand. When supply and demand are balanced, the electrical frequency is at 50Hz. We must keep this balance on the system always.

From time to time, the supply and demand are not balanced. For example, a large electrical generator might suddenly disconnect and its electrical power supply is lost. In this case, the supply from the system is temporarily below the demand and the system frequency begins to fall bleow 50Hz.

We are responsible for restoring the balance in the seconds and minutes after the event occurs. Restoring the balance returns the electrical frequency to 50Hz.

When a system imbalance event occurs, we monitor the rate at which the frequency falls. This is known as the rate of change of frequency (RoCoF). RoCoF is a measure of how fast the frequency falls – the motion in a power system. Events that result in high RoCoF levels can potentially lead to instability in the power system.

A natural element on all power systems is inertia. This is a resistance that the system has to minimise the impact of the motion. The inertia on the power system resists the RoCoF and helps maintain system stability.

3. Outline of RoCoF Project

Our governements' strive to reduce our use of fossil feuls. To do this, we have to connect the other sources of electricity such as wind and solar to our grid. We must also deliver electricity all day, every day. We came up with the project called 'Delivering a Secure Sustainable Electricity System (DS3) programme'. DS3 seeks to address challenges of integrating renewable generation onto our power system. Renewables don't have built in inertia so they won't react like more traditional sources. We want to make sure that high RoCoF events do not happen because of sudden changes on the grid. This is a key project in the DS3 programme.

Our studies, show that when severe RoCoF events occur, they could threaten the security of the power system. There are two ways to solve this challenge. We can allow the RoCoF to be higher or increase inertia to reduce RoCoF. The Commission for Energy Regulation (CER) and Utility Regulator (UR) decided to increase RoCoF across the island if appropriate to do so. The project to increase RoCoF for electrical generators came out of this decision. We are also working with the Distribution System Operators (DSOs), ESB and NIE, to bring about this change.

The regulators have also asked us to see if we can find other solutions such as increasing inertia. The alternative solutions look at increasing inertia rather than changing to a higher RoCoF standard.

4. Outline of RoCoF Alternative Solutions Project

There are two phases to the alternative solutions project. This report is the end of the second phase. The first phase started in November 2014. In this first phase we asked industry representatives for their input. We finished the project plan after their comments.

We hired DNV GL to carry out phase one. This was the technology assessment of all the options to increase inertia and reduce RoCoF. In June 2015, DNV GL gave us a report called "RoCoF Alternatives Technology Assessment".

We published the phase two report in December 2015 – 'RoCoF Alternative & Complementary Solutions Project Phase 2 Study Report'. Here, we look at using

different sources of inertia. We also looked at how these can help restrict RoCoF following large system imbalances.

5. Phase 2 Report Outline

In this report, we carried out a study of RoCoF alternative solutions. We looked at how much inertia we need to reduce RoCoF. We also looked at what types of inertia and how much would be needed.