*Submission Document*

# Design of the System Restoration Plan for Ireland

## In accordance with the requirements of Articles 23 and 4(5) of the Commission Regulation (EU) 2017/2196 Establishing a network code on electricity emergency and restoration

**16th October 2020**



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# Abbreviations

- NCER – Network Code for Emergency Restoration
- PSRP – Power System Restoration Plan
- TSO – Transmission System Operation
- SDP – System Defence Plan
- DSO – Distribution System Operator
- SGU - Significant Grid User
- NCC – National Control Centre
- SONI - System Operator Northern Ireland
- SOGL – System Operator Guideline
- RfG – Requirements for Generators
- HVDC – High Voltage Direct Current
- DCC – Demand Connection Code
- OPTEL – Operational Telephony
- CRU – Commission for the Regulation of Utilities
- SRP – System Restoration Plan
- EAS – European Awareness System
- MVAr – Mega Volt-Ampere reactive
- EWIC – East-West Interconnector
- GC – Grid Code
- CDGU – Centrally Dispatched Generation Unit
- NDCC – DSO National Distribution Control Centre

# 1. Purpose

This document has been developed in accordance with COMMISSION REGULATION (EU) 2017/2196 of 24 November 2017 "establishing a network code on electricity emergency and restoration"[1] (referred to as NCER), which came into force on the 18th of December 2017. Under NCER the Transmission System Operators (TSO) of a member state is required to develop and consult on a System Restoration Plan (SRP) prior to submission to the relevant regulatory authority for approval.

This SRP has been designed based on the requirements detailed within Articles 23 to 34 of the NCER, the high-level requirements of these articles include:

- Design of the SRP
- Implementation of the SRP
- Activation of the SRP
- Measures of the SRP

The SRP provides an overview of the power system restoration measures available to EirGrid as the TSO. It also outlines the roles and responsibilities of ESBN as the Distribution System Operator (DSO) and Significant Grid Users (SGUs) that act as restoration service providers who are called upon during the implementation of the SRP.

This document defines system restoration measures and procedures that are implemented within the EirGrid TSO controlled area of Ireland. In conjunction with how they relate to the relevant articles of NCER and the Grid Code[2], whilst providing the reader with an:

- Overview of the system restoration
- The measures to be implemented by designated parties under NCER

This is not an operational document to be used by the TSO in the event a blackout state. The step by step actions used by EirGrid National Control Centre (NCC) are included in the Power System Restoration Plan (PSRP). Note that for security and confidentiality reasons, the full details of the PSRP are not included in this document.



[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2196&from=en

[2] http://www.eirgridgroup.com/site-files/library/EirGrid/Grid-Code.pdf

# 2. Introduction

There are various statutory obligations to which a TSO must adhere to from European directives, through to the applicable codes. The hierarchy order is illustrated in Figure 1 below.

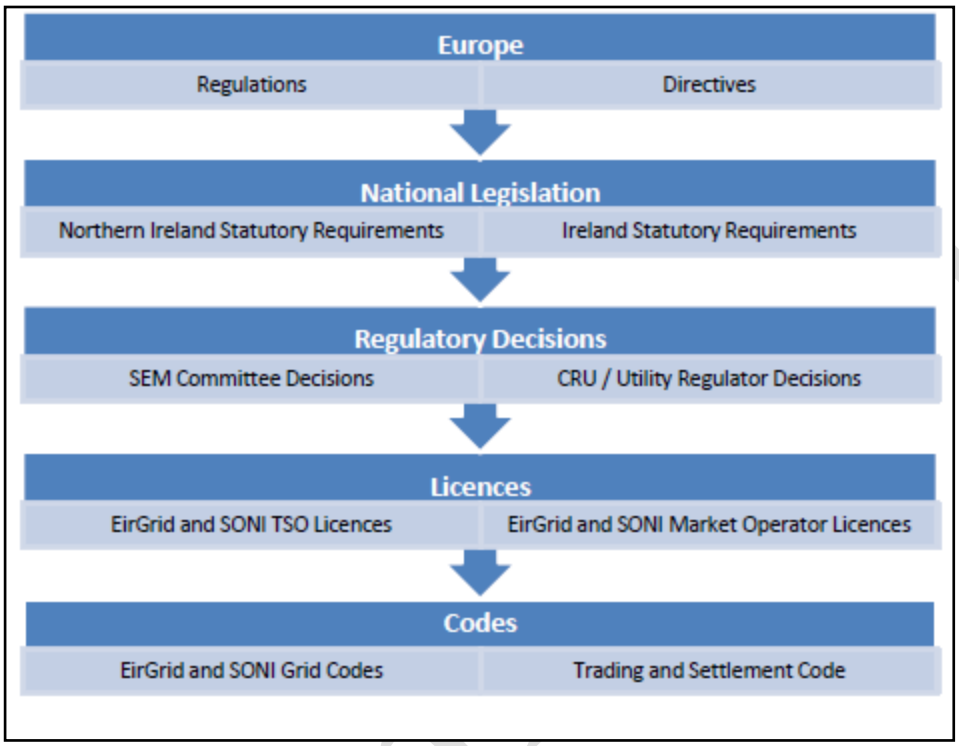


Figure 1 – Hierarchy of Regulations (for illustration purposes only)

NCER is one of a suite of European Network Codes and Guidelines that seek to achieve a fully functioning and interconnected energy market to ensure the security of supply and to benefit all consumers via competitive markets across the EU.

The NCER aims to establish a set of common minimum requirements and principles for the measures and procedures of TSOs, DSOs and SGUs when a power system is in emergency, blackout or restoration state. This SRP concentrates on operating the power system when in blackout or restoration state. The NCER links and interacts with a number of other Network Codes, including but not limited to:

- System Operation Guideline (SOGL), EU Regulation 2017/1485[3]
- Requirements for Generators (RfG), EU Regulation 2016/631[4]
- High Voltage Direct Current (HVDC), EU regulation 2016/1447[5]
- Demand Connection Code (DCC), EU Regulation 2016/1388[6]

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN

[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1447&from=EN

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1388&from=EN

From Figure 1, EU Regulations supersede national legislation and have primacy over other regulations. Specifically, the design of this SRP is compiled in accordance with NCER Article 23 and is consulted upon in in accordance with Article 7.

The first revision of the design of the SRP proposal was consulted on from the 14th November 2018 to 12th December 2018 and received no responses. On 18 December 2018, a proposal was submitted to the Commission for Regulation of Utilities (CRU) for consultation. On the 2nd September 2019, the CRU published a decision to not endorse the proposal and sought amendments to the document submitted by EirGrid plc. The purpose of this document is to consult on the revised proposals.

This design of a SRP is not intended to replace any provisions in existing operating procedures, it is providing an overview of how the system restoration measures specified in NCER will be satisfied, including reference to existing codes.

The EirGrid Power System Restoration Plan (PSRP) provides a detailed plan for TSO to restore the power system following a total or partial blackout in Ireland. EirGrid, and previously ESB National Grid, has had a PSRP in place for many years as per EirGrid Grid Code requirement OC 9.5.

Version 11 of the Power System Restoration Plan is the latest version of the plan and is to be implemented in April 2020. Updates to the plan in accordance with the Network Code requirements on Emergency and Restoration (NCER) have been included, where appropriate. The plan has also been updated to reflect the changing characteristics of the power system since the last publication. A number of additional 220 kV and 110 kV transmission stations have been energised and these have been included in the priority stations list where appropriate. New control synchronising facilities in designated transmission stations have been commissioned providing additional locations on the transmission system for resynchronising subsystems. Generators that have been decommissioned have also been removed from the plan. There have been no changes to the Black Start Units.

Note that for security and confidentiality reasons, the full details of the PSRP are not included in this documentation.

## 2.1. Relevant Legislation

The System Restoration Plan has been drafted taking into account the operational security limits set out in Article 25 of Regulation (EU) 2017/14857, and Article 23 of the NCER.

Table 1 below provides a summary of each subsection of Article 23 of the NCER and where compliance is demonstrated in the relevant legislation or documents:



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| Article Subsection | Requirement | Relevant Documentation |
|---|---|---|
| **23(1)** | *By 18 December 2018, each TSO shall design a restoration plan in consultation with relevant DSOs, SGUs, national regulatory authorities or entities referred to in Article 4(3), neighbouring TSOs and the other TSOs in that synchronous area.* | This document (the System Restoration Plan) will be subject to public consultation in accordance with Article 7 (public consultation) of NCER. This consultation will include the relevant stakeholders, such as regulatory authorities, DSO, SONI as TSO and Significant Grid Users. |
| **23(2)** | *When designing its restoration plan, each TSO shall take into account, at least, the following elements:*<br>*(a) the behaviour and capabilities of load and generation;*<br>*(b) the specific needs of the high priority significant grid users listed pursuant to paragraph (4);*<br>*and*<br>*(c) the characteristics of its network and of the underlying DSOs networks.* | The System Restoration Plan (SRP) and Power System Restoration Plan (PSRP) have been designed to take into account the operational security limits set out in accordance with Article 25 of Regulation (EU) 2017/1485[8].<br><br>In conjunction with Article 23(2) of NCER, the behaviour and capabilities of load and generation is outlined within the following sections of this document 3.3, 3.4.1 and 3.4.3.<br><br>No high priority SGUs have been identified as part of the SRP.<br><br>The characteristics of the network and the underlying DSO network are considered when identifying restoration paths and covered in section 3.3 of the SRP. |

| Article Subsection | Requirement | Relevant Documentation |
|---|---|---|
| **23(3)** | *The restoration plan shall contain at least the following provisions:*<br>*(a) the conditions under which the restoration plan is activated, as provided for in Article 25;*<br>*(b) restoration plan instructions to be issued by the TSO; and*<br>*(c) measures subject to real-time consultation or coordination with identified parties.* | The PSRP and SRP comply with article 23(3); the condition for which the restoration plan is activated is contained in section 3.3 of the SRP taking into account the system states as defined within SOGL.<br><br>Details of activation of the PSRP are provided in section 3.3.<br><br>Following activations of the PSRP a blackout signal is sent which automatically triggers communications and procedures to be implemented by the TSO, Black Start Units (in accordance with EirGrid Grid Code OC.4.7.1.1) and the DSO are outlined in 3.3 of this document.<br><br>The PSRP contains, step by step instructions, detailing the applicable measures to be applied in real time by different parties. These measures are implemented in close coordination with the DSO or neighbouring TSOs as required. For the purpose of top-down restoration close real-time coordination with SONI TSO (for restoration from NI) will be required. For top-down restoration from GB the TSO will consult NGESO in real time as per the Interconnector Operating Protocol that exists between these parties. |
| **23(4)** | *In particular, the restoration plan shall include the following elements:*<br><br>*(a) a list of the measures to be implemented by the TSO on its installations;* | The SRP and PSRP, comply with the requirements of 23(4),<br><br>Black Start Station specific procedures and DSO transmissions station specific procedures detail the list of measures to be carried out during a blackout in close |

| Article Subsection | Requirement | Relevant Documentation |
|---|---|---|
| | *(b) a list of the measures to be implemented by DSOs and of the DSOs responsible for implementing those measures on their installations;*<br>*(c) a list of the SGUs responsible for implementing on their installations the measures that result from mandatory requirements set out in Regulations (EU) 2016/631, (EU) 2016/1388 and (EU) 2016/1447 or from national legislation and a list of the measures to be implemented by those SGUs;*<br>*(d) the list of high priority significant grid users and the terms and conditions for their disconnection and re-energisation;*<br>*(e) a list of substations which are essential for its restoration plan procedures;*<br>*(f) the number of power sources in the TSO's control area necessary to re-energise its system with bottom-up re-energisation strategy having black start capability, quick re-synchronisation capability (through houseload operation) and island operation capability; and*<br>*(g) the implementation deadlines for each listed measure.* | coordination with the TSO. A high level summary of these activities are included in 3.3. For security and confidentiality reasons these procedures are not included as part of the SRP.<br><br>The details of the Black Start Units are included in 3.1 and in Figure 1 also. These are procured as an ancillary service under SI 445/2000 Part 3 8(1) (a), (b) and stated under Grid Code section OC.4.7.3.2.<br><br>In addition to Black Start Units the requirements for generator units to trip to house load following loss of external supply are detailed under Grid Code CC.7.3.2.3<br><br>No high priority SGUs have been identified as part of the SRP.<br><br>The PSRP identifies and lists the substations classified as priority for restoration purposes that are automatically staffed by the DSO and the target times for staffing these stations. High level details are included in 3.3 but for security reasons they are not individually listed in the SRP. |

| Article Subsection | Requirement | Relevant Documentation |
|---|---|---|
| **23(5)** | *The restoration plan shall include at least the following technical and organisational measures specified in Chapter III:*<br>*(a) re-energisation procedure, in accordance with Section 2;*<br>*(b) frequency management procedure, in accordance with Section 3; and*<br>*(c) resynchronisation procedure, in accordance with Section 4.* | The re-energisation procedure; in terms of power system restoration and allowing for the provision for the restoration plan is within grid code under section OC.9.5.1.<br><br>An overview of re-energisation is provided within section 3.4 of the SRP. In conjunction with frequency management within section 3.5 and re-synchronisation within section 3.6. |
| **23(6)** | *The measures contained in the restoration plan shall comply with the following principles:*<br>*(a) their impact on system users shall be minimal;*<br>*(b) they shall be economically efficient;*<br>*(c) only those measures that are necessary shall be activated; and*<br>*(d) they shall not lead the interconnected transmission systems into emergency state or blackout state* | The System Restoration Plan has been designed to comply with the requirements of 23(6),<br><br>• their impact on system users shall be minimal<br>• they shall be economical<br>• only measures that are necessary shall be activated<br>• they shall not cause neighbouring TSOs to enter emergency or blackout state |

# 3. Public Consultation

EirGrid held a consultation on our proposed Design of the System Restoration Plan for Ireland in accordance with the requirements of Articles 23 and 4(5) of the Commission Regulation (EU) 2017/2196 establishing a network code on electricity emergency and restoration of the Commission Regulation (EU). This consultation opened on 8 July 2020 for an extended period of 6 weeks until 21 August 2020. It was available to download on the EirGridGroup and ESBN websites and was discussed at the All Island Forum on 12 August 2020.

## 3.1. Summary of Responses

EirGrid (TSO) and ESBN (DSO) received no submissions on the consultations.

# 4. Design of the System Restoration Plan

In accordance with the various provisions of Article 23 of NCER, the PSRP details a plan of action to restore the power system after a power system blackout has occurred. The PSRP is to be used by NCC operators who are certified in accordance with SOGL, and familiar with, power system restoration procedures. In parallel with this plan there are individual Black Start Station and transmission station specific procedures to be followed by the relevant personnel following notification by NCC that the system is in blackout. The purpose of this document, the System Restoration Plan is to provide an overview of how the PSRP is designed, activated and implemented.

## 4.1. Introduction

The majority of generators on the Irish power system require external power supply to start-up and supply energy to the power system. The TSO has contracts in place with a number of Black Start Units that have the ability to start up without an external power supply. The providers include a diversity of fuel types, such as hydro generators, pumped storage, gas turbines, and an interconnector.

During a blackout, the power system is divided in to four smaller systems referred to as the North, East, South and West subsystems. Each subsystem has at least one Black Start Unit. Once each subsystem has supply restored to enough customers to allow multiple generators operate stably, those subsystems are joined together to form a single system and restoration continues. Synchronising facilities are available at various locations on the transmission system for this purpose.

There are a total of twenty Black Start Units (incorporating units for top-down and bottom-up restoration) located across seven Black Start Stations, as shown in Figure 1. Ancillary Service Agreements are in place with each of these Black Start Stations to provide this service. Operational and testing requirements for Black Start Stations are detailed in EirGrid Grid Code OC 4.7 and OC.10.5.7 respectively. Based on the location of the current Black Start Stations, subsystems for restoration have been identified and incorporated in to the PSRP. If the number or locations of these Black Start Stations were to change then the subsystems would be reviewed to ensure restoration to all parts of the power system could be achieved. The PSRP would then be updated to reflect the characteristics of the network. They receive payments for every half hour they are available to black start. Payments for black start services are reviewed annually and subject to the approval of the Regulatory Authority. One or more Black Start Units in each Black Start Station is tested annually.

The Network Code on Emergency Restoration distinguishes between top-down and bottom-up re-energisation strategies (Article 26). Top-down refers to re-energisation with assistance from a neighbouring TSO, and in the case of Ireland, this would mean using EWIC's blackstart capability, or getting supply from Northern Ireland if those systems are not also in a blackout state. Bottom-up re-energisation details a scenario

using a black start unit such as a hydro or diesel unit to energise the system. There are nineteen providers available for use in a bottom-up re-energisation. It is expected that to restore the system back to normal state in an efficient manner, that a combination of top-down and bottom-up re-energisation strategies would be used in the event of a blackout in Ireland.

The sections of this document that follow give a high-level summary of the restoration process. For security reasons, some specifics of the PSRP are not included in this document.

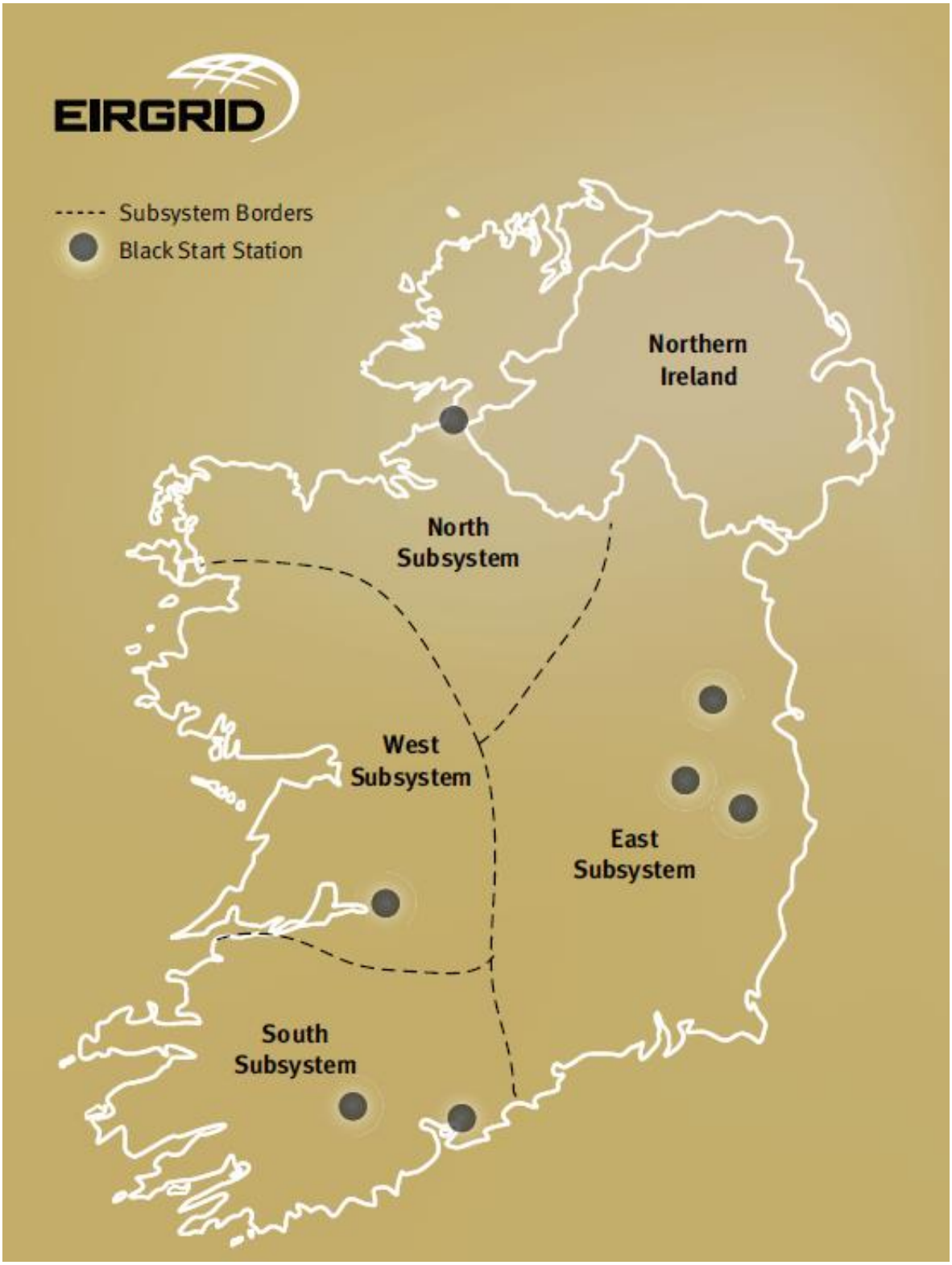


Figure 1- Simplified overview of Black Start Stations and Subsystem Borders

## 4.2. Assumptions of the System Restoration Plan

The power system failure that is addressed in this SRP is a total power system failure, with the following assumptions:

1. A total blackout of the power system has occurred
2. There is no damage to generation plant or significant damage to transmission equipment
3. Black Start Stations remain fully operational
4. Sufficient water is available in all hydro and pumped storage stations in order to energise a restoration path
5. No major loss of telecommunications facilities (voice/data) has occurred
6. No major loss of NCC computing facilities (hardware/software) has occurred

The above assumptions are made when designing the PSRP, however additional details and alternative options are presented to allow the restoration plan reflect the reality of the blackout scenario. If any of these scenarios are encountered restoration activities will continue but a delay to restoring the power system to normal state may take longer than anticipated. The following scenarios are provided to expand on the above assumptions:

In accordance with Grid Code CC.7.3.2.3 if a generator has tripped to house load or a small stable island remains, this may be incorporated in to a restoration path. However, generators that have switched to house load may not be able to remain in that state for long period of time, hence black starting stations remains a priority.

As part of the TSO's generator outage management process overlapping outages of Black Start Units are minimised, as far as possible to ensure there is always sufficient units available. The PSRP includes detailed technical information and alternative restoration paths that can be used to adapt to scenarios where there is a partial system failure and/or plant) is unavailable. The PSRP sets out guidelines and procedures, and provides tested and proven restoration examples.

In the event of a blackout the PSRP has been designed so that one or two units are black started in each of the four subsystems. As there are twenty Black Start Units contracted by the TSO it is expected that sufficient units will be available. Once a unit has been black started it can energise and synchronise additional units in normal operation as the restoration path develops. The four separate subsystems will be restored in parallel to speed up overall system restoration.

NCC Control Engineers are certified in accordance with the requirements of SOGL including restoration activities. In addition to this certification, every two years NCC partake in hypothetical blackout scenarios where they manage and respond to a blackout in a simulated environment. Following an update of the PSRP training is provided to all NCC Control Engineers and other staff who have a role during the blackout and restoration states.

The Black Start Units include a diversity of fuel types, including hydro generators, pumped storage, gas turbines, and an interconnector so the success of the restoration is not completely dependent on water levels. Arrangements are in place with pumped storage and designated hydro units to ensure sufficient water levels are maintained year round for black start.

As far as possible, all communications should be directed through the operational telephone system OPTEL, which is owned by the DSO and used by the TSO for voice communication with designated users. This communication system is independent of the public telephone system. It is assumed that the mobile network will survive the initial immediate onset of a blackout. Hence, when the blackout alert state is issued a text message is also sent to key personnel who have standing instructions to attend their place of work on receipt of such a text. A complete failure of all communication systems including OPTEL is highly unlikely but is still a potential risk. If this method of communication is the only method available the restoration time will be significantly slower.

If there is a significant loss of NCC computing facilities at the time of the blackout then restoration activities can be carried out from the TSO's back up control centre. Oncea blackout alert is issued the System Manager will decide if the back up control centre needs to be staffed and operations will be transferred from the primary control centre. If there is a failure of software at both locations then there is a number of 24/7 on call support arrangements available to the TSO to resolve these issues.

## 4.3. Activation of the Restoration Plan

The system is considered to be in blackout state if any of the following conditions has occurred:

1. Loss of more than 50% of demand load
2. Loss of voltage across the transmission system for 3 mins
3. The Power System Restoration Plan has been activated

Following the system entering a blackout state the first priority is to establish the extent of the blackout on the system. This involves determining the status of the Northern Ireland system and if sufficient capacity is available for top down restoration. If parts of the system are not blacked out then identify suitable locations for resynchronisation.

Once it has been established that the system is in blackout, TSO's National Control Centre (NCC) issues a blackout alert in accordance with Article 25(1) of NCER. This notifies all centrally dispatched units, DSO, relevant TSO staff and key external stakeholders. The ENTSO-E Awareness System (EAS) is also updated which notifies other European TSOs that synchronous area of Ireland is in blackout. Once a plan has been formulated and restoration has commenced the EAS state is updated to restoration.

The primary objective of the PSRP is to achieve restoration of supply to all consumers as quickly and as safely as possible with minimum adverse consequences.
The following objectives also apply:

- Prevent any plant damage
- Conserve station batteries and compressed air supplies whilst in islanded operation
- Restore supply as soon as possible to conventional generation stations
- Restore supply as soon as possible to customers or locations where loss of power involves significant risk as identified by DSO via their National Distribution Control Centre (NDCC)

The PSRP sets out guidelines and procedures, and provides tested and proven restoration examples. The PSRP does not supersede standing operating instructions or safety rules regarding operation of the transmission system.

After an alert has been issued of the blackout state, the following times are targets at which to aim to restore power to the 400 kV, 220 kV and 110 kV transmission network:

- A specific plan of action formulated by the NCC within **30 minutes** of establishment of the nature and the extent of the blackout.
- Stable operation of the Black Start Units within **1 hour** of blackout alert issuance
- External supply to primary target generation stations as specified in the PSRP within **2 hours** of plan formulation.
- Load restored to subsystems within **4 hours** of plan formation.
- Re-synchronisation of separate subsystems within **6 hours** of plan formulation

- Restoration of continuous supply to all remaining 400 kV, 220 kV, and 110 kV transmission stations within **12 hours** of plan formulation

In accordance with Article 25(3) Black Start Stations implement their own procedures immediately following notification from TSO that the system is in a blackout state, including;

- Securing all equipment to ensure the units are in a state of readiness for black start as called by the TSO
- Ensuring all Black Start Stations that are operated via remote control from another station are to be staffed immediately

The primary purpose of black starting these stations is to extend supply to target generation stations that cannot start without an external supply. All procedures are implemented in close coordination with the TSO to establish the time before these stations will be able to run up and energise the transmission system. Each Black Start Station has its own individual set of procedures that are confidential to the TSO and those stations.

Transmission stations on the preferred restoration paths from Black Start Stations to primary target generation stations that require DSO operators on site following a blackout alert are designated as priority stations. Upon receipt of a blackout alert the DSOs National Distribution Control Centre (NDCC) will dispatch operators without further instruction from the NCC. Priority 1 transmission stations have a target time to be staffed by the DSO within 30 minutes of a blackout alert being issued, and Priority 2 transmission stations have a target time of 60 minutes. Priority 3 Stations are not automatically staffed. These stations have alert procedures and may be staffed as restoration progresses, but will only be staffed following a request from NCC to NDCC. Upon arrival in a priority station the operator will acknowledge the alert signal and follow the blackout procedures for that priority station.

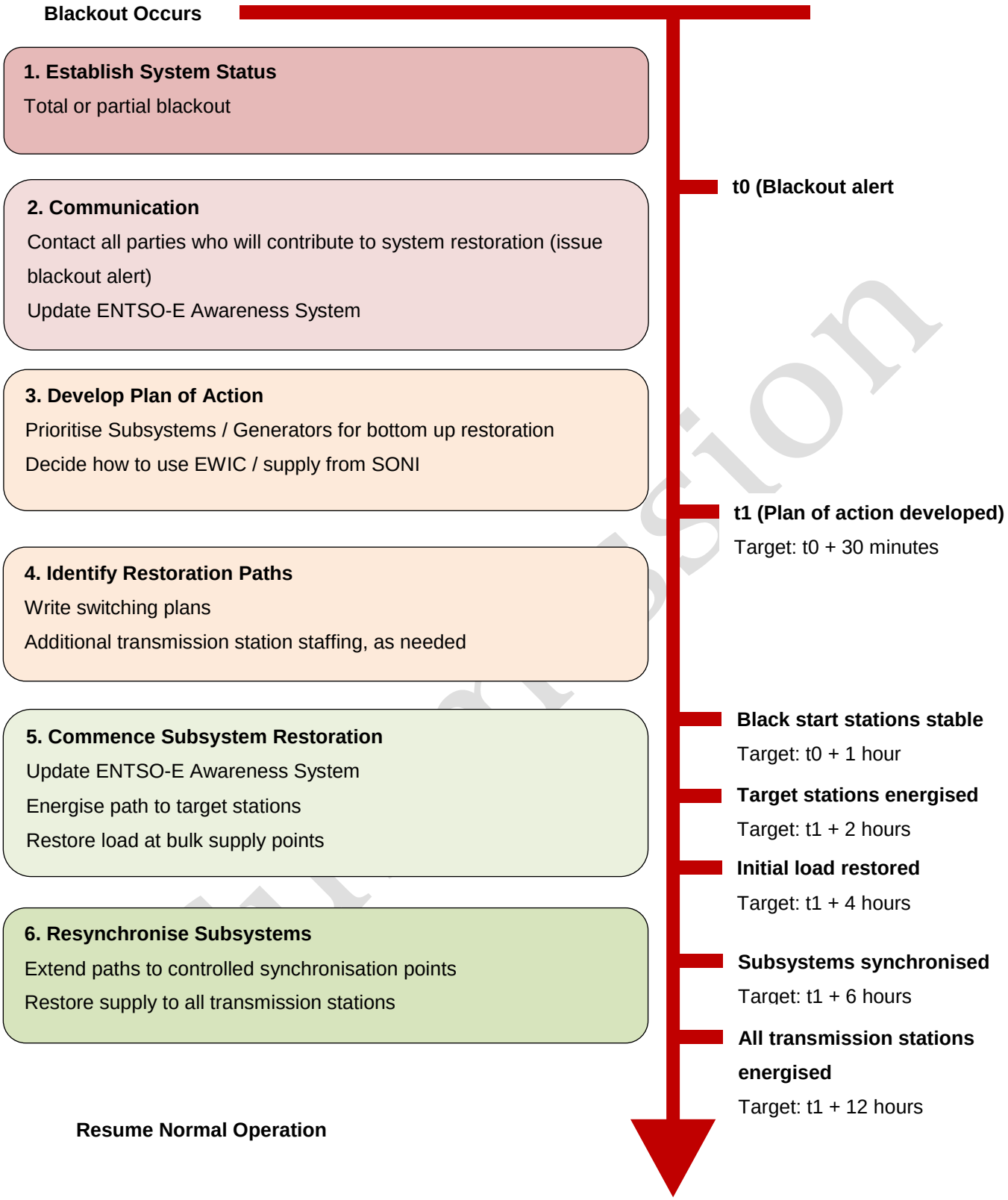


Figure 2 – High Level Timelines for Restoration

## 4.4. Re-energisation Procedure

At the initial stage of restoration, the NCC establishes the extent of the blackout, that is, whether it is total or partial. The NCC also establishes the status of the transmission system in Northern Ireland. This will determine if a top-down or bottom-up re-energisation strategy is to be employed. If there is a partial blackout the NCC should then establish the existence of island within in each subsystem.

The Network Code on Emergency Restoration distinguishes between top-down and bottom-up re-energisation strategies. Top-down refers to re-energisation with assistance from a neighbouring TSO, and in the case of Ireland, this would mean using EWIC's blackstart capability, or getting supply from Northern Ireland if those systems are not also in a blackout state. Bottom-up re-energisation details a scenario using a hydro or diesel unit to start larger conventional machines and energise the system. It is expected that a combination of top-down and bottom-up re-energisation strategies would be used in the event of a blackout in Ireland in accordance with Article 26 of EU NCER.

A high level plan for restoration of each subsystem should be developed within thirty minutes of the blackout alert being issued. This plan should identify the unit(s) to be black started and the generators being targeted for restoration of supplies in each subsystem.

The following should be considered when developing the plan:

- The possibility of combining top-down (EWIC, SONI) and bottom-up (Black Start Units) re-energisation
- The availability of Black Start and non-Black Start target generators
- The expected duration and risks associated with each path
- The condition of the transmission system
- Priority loads for restoration (in conjunction with DSO)

When building the restoration path from the Black Start Station to the target generator, either soft or sequential energisation is employed. Soft energisation is preferable, as the de-energised transmission path can be built in parallel to the black start generator starting up. The generator can then energise the path at a reduced voltage. However, if there is no soft energisation available, sequential energisation is recommended. This method requires the black start generator to start up before the transmission path is built, and then the path is sequentially built energising one transmission station at a time.

### 3.4.1 Load Restoration and Frequency Management

The TSO and DSO will closely coordinate all load restoration activities. Initial load restoration should be carried out in the smallest steps possible to minimise system frequency and voltage deviations for each subsystem. System or local frequency should be at least 50.0 Hz (preferably higher) before restoring any load. One generator in each subsystem should control the frequency. The other generators on the subsystem should operate with a load set point as dispatched by NCC and in normal droop governor control mode, unless otherwise instructed.

Load should be restored initially in those parts of the system that are adjacent to generation sources. Following a request from TSO to restore load the DSO NDCC will sanity check that the load is realisable before reconnection. As load restoration progresses and the subsystems are stable it will be necessary to expand the restoration paths to other parts of the system. Maintaining stability of the restored subsystems takes precedence but to the extent that it is possible to do so, account may also be taken of Significant Grid Users and priority loads following discussions between TSO and DSO. Once a number of generators have synchronised, load restoration should be in steps appropriate to the size of the subsystem.

If top-down restoration via EWIC is being used EWIC will be started in islanded mode. The TSO will request block loads of up to 50 MW from NGESO up to the maximum capacity of the link. The communications and procedures to follow in the event of a blackout are set out in the Interconnector Operating Protocol that exists between EirGrid TSO, NGESO and the Interconnector Owner.

### 3.4.2 Voltage Control during Subsystem Restoration

The system should be re-energised at as low a voltage as possible, i.e. roughly 0.9 per unit, in order to reduce the Mvar generation of unloaded transmission feeders. The target voltages on the 220 kV and 110 kV systems are 205 kV (or lower) and 100 kV (or lower) respectively. When energising transformers, the tap position should be selected to minimise inrush current and associated voltage dip. Load restoration should be suitably interspersed with feeder restoration to limit the Mvar absorption of the generators to an appropriate value.

### 3.4.3 Synchronising Generators

A sufficient number of generators should be started to ensure that units are not operating at full output. A range of partly loaded generators rather than a few heavily loaded generators provide the following advantages:

- Greater flexibility

- Increased load response
- Mvar absorption capability and consequently better control over the voltage of the developing system
- Additional MW and Mvar spinning reserve
- Increased short circuit levels and inertia

## 4.5. Frequency Management

The PSRP outlines the procedures for frequency management during restoration state in accordance with Articles 28-31.Section 3.4.1 above outlines the principles of frequency management when EirGrid is developing a number of subsystems within its area (as per Article 28(2)).

In accordance with Article 6(b) EirGrid works closely with SONI, the TSO in Northern Ireland and coordinates as restoration develops on the power systems. EirGrid and SONI operate as a single synchronous area when both TSOs are operating within normal state. As restoration develops on the EirGrid system and it is suitable to resynchronise with SONI, EirGrid TSO is the predetermined frequency leader in accordance with Article 29(4). EirGrid will act as the frequency leader until such time as the synchronous area has been completely resynchronised and the system frequency is within standard frequency range (as per Article 29 6(b)). SONI TSO will support the frequency leader in accordance with Article 30(3). The target frequency for restoration (top-down and bottom-up re-energisation strategies) will be 50 Hz in the synchronous area.

EirGrid and SONI operate as a single operational area with responsibility for dispatch of generators alternating between the two TSOs on a regular basis. As frequency leader EirGrid can consider the amount of available operating reserves and interconnector capacity available for the synchronous area.

One generator in the synchronous area will act as the load-frequency controller (the swing generator, operating in isochronous speed control mode). The other generators in the synchronous area operate with a load set point as dispatched by NCC and in normal droop governor control mode, unless otherwise instructed by the NCC. The load-frequency controller will be determined in real time based on generator availability and in coordination with SONI. Variable sources of generation e.g. wind farms, should remain disconnected from the system until the blackout alert is cancelled to avoid any frequency deviations.

Prior to each increment of load restoration, ensure that the load-frequency controller is operating near mid operating range and that the proposed increment of load does not exceed the remaining available capacity on that unit. As an increment of load is restored, the load-frequency controller will increase output to meet the additional load and return the system frequency to 50 Hz. Following this, the load set points of the other generators in the synchronous area should be increased (dispatched up) to take up the load increment, returning the load-frequency controller to mid operating range.

Automatic Frequency Restoration (AFR) schemes automatically reconnect distribution load on the system when the system frequency has recovered sufficiently. AFR schemes should be disabled during restoration as per Article 30(1).. The DSO blackout procedures for designated stations include steps to switch these schemes off. Where a

scheme cannot be switched off EirGrid will coordinate with the DSO to ensure mitigating steps are in place to prevent automatic reconnection of load.

## 4.6. Resynchronisation – System restoration back to Normal State

The PSRP outlines the procedures for resynchronisation in accordance with Articles 32-34.

EirGrid will act as the resynchronisation leader (Article 33(2)) during the restoration state. A designated substation has been identified with appropriate substation equipment for a controlled resynchronisation. EirGrid has real time measurements of frequency, voltage and phase angle at the resynchronisation point and the ability to control these measurements. EirGrid will act as resynchronisation leader until the two synchronous areas have been resynchronised.

Controlled synchronisation schemes are used to prevent an operator from crash-synchronising the two systems. Controlled synchronisation is used for joining two separate electrical systems together. These schemes are operated locally in the transmission station.

The following limits are applied by the resynchronisation leader during controlled synchronisation:

- Voltage difference (typically ± 2-5%)
- Slip (frequency); (standard setting is ± 0.1% = 50 mHz)
- Phase angle difference; (setting for control sync is ± 5°, setting for Check sync usually 10° - 20°)

## 4.7. Resume Normal Operation

While every effort must be made to return the system to normal state as soon as possible following the disturbance, stability and correct operating practices must be observed at all times. In principle, the NCC should establish N-1 security for the transmission system as early as possible. It is particularly important to ensure that plant is operated within normal tolerances. As the system is rebuilt the system voltage can be returned to the normal operating range. All standard sectionalising arrangements should be re-established and normal protection settings re-applied including reclosing, Automatic Frequency Restoration and Special Protection Schemes.

Non-centrally dispatched units (such as wind farms) should only be restored when frequency and voltage implications can be dealt with or otherwise as considered beneficial to the restoration requirements.

Once the restoration is deemed to be complete the blackout alert is cancelled notifying all parties involved in restoration. The ENTSO-E Awareness System is also updated to reflect the return to normal state.

# 5. System Restoration Plan Implementation

Under Article 24 of EU NCER the implementation date of the restoration plan is stated. The article requires that by 18th of December 2018 EirGrid shall implement the measures of the system restoration plan and notify applicable parties who are within the scope of NCER.

In December 2018 EirGrid submitted a proposed SRP to the CRU; this proposal was based on a minimal disruption to current business practices and procedures. EirGrid considered it would be sufficient to notify NCER applicable parties of the obligations they have to meet; since submission and publication of these proposal documents the CRU have requested amendments regarding clarity on affected parties and measures they have to meet. As detailed within this document these have been addressed in this proposal. By already complying with their bilateral agreements, connection agreements and grid code the measures required under NCER have been fulfilled.

The system restoration plan will be fully implemented and entered into force once this document has been approved by the regulating authority.

# 6. Plan Review

Article 51 of NCER requires that EirGrid is to review the measures of the SRP using computer simulation tests to determine the effectiveness of the plan every five years. Such testing procedures are in place within EirGrid's internal processes and procedures, which cover from article 51(a) - (d) every two years:

- The energising restoration path from restoration service providers with black start
- The supply of power generating modules main auxiliaries;
- The demand reconnection process; and
- The process for resynchronisation of networks in island operation.

# 7. Next Steps

This concludes EirGrid's submission to the Commission for the Regulation of Utilities of the proposal for design of the system restoration plan for Ireland in accordance with Articles 23 and 4(5) of the Commission Regulation (EU) 2017/2196 establishing a network code on electricity emergency and restoration of the Commission Regulation (EU).

# Definitions

Relevant definitions as per Network Code on Emergency and Restoration

‘restoration service provider’ means a legal entity with a legal or contractual obligation to provide a service contributing to one or several measures of the restoration plan;

‘high priority significant grid user’ means the significant grid user for which special conditions apply for disconnection and re-energisation;

‘restoration plan’ means all technical and organisational measures necessary for the restoration of the system back to normal state;

‘re-energisation’ means reconnecting generation and load to energise the parts of the system that have been disconnected;

‘top-down re-energisation strategy’ means a strategy that requires the assistance of other TSOs to re-energise parts of the system of a TSO;

‘bottom-up re-energisation strategy’ means a strategy where part of the system of a TSO can be re-energised without the assistance from other TSOs;

‘resynchronisation’ means synchronising and connecting again two synchronised regions at the resynchronisation point;

‘resynchronisation point’ means the device used to connect two synchronised regions, usually a circuit breaker.