An Coimisiún
um Rialáil Fóntais
Commission for
Regulation of Utilities

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Electricity Crises: A Risk Preparedness Plan for Ireland

Decision Paper

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CRU Mission Statement

The CRU's mission is to protect the public interest in Water, Energy and Energy Safety.

The CRU is guided by four strategic priorities that sit alongside the core activities we undertake to deliver on the public interest. These are:

- Deliver sustainable low-carbon solutions with well-regulated markets and networks
- Ensure compliance and accountability through best regulatory practice
- Develop effective communications to support customers and the regulatory process
- Foster and maintain a high-performance culture and organisation to achieve our vision

Public/ Customer Impact Statement

Regulation EU 2019/941 on risk preparedness in the electricity sector (RPR) sets out requirements for each EU Member State to ensure that consistent plans are in place to prevent, prepare for and manage crisis events that may result in a loss of electricity supply to customers. These events might include extreme weather conditions, for example, or technical failures.

As part of the work required under the RPR, the CRU previously collaborated with EirGrid, the electricity Transmission System Operator (TSO), to develop a set of potential 'crisis' scenarios under which a loss of electricity supply might occur in Ireland, and to calculate the level of risk associated with each scenario. The scenarios were subject to public consultation and have been used here to document the detailed preparations that are in place to manage such events.

The Risk Preparedness Plan contained in this document sets out the procedures that will be followed by actors in the electricity sector during crisis situations, such as those described by the scenarios, in order to minimise the disruption caused to customers. The Plan also covers the preventive and mitigating steps to be taken that will help to avoid crises occurring. The roles and responsibilities of different stakeholders, the communications procedures, and the calendar for regular testing of system are included in the Plan, along with the response of the CRU to comments received during consultations.

The public should note that as part of its day-to-day function to protect security of supply in Ireland, the TSO already has specific procedures in place to deal with emergency situations, and the plans presented here draw heavily on the existing measures. The purpose of this specific body of work is to meet the requirements of the recent European regulation on the matter; to bring that information together in a form that is common across Europe so that potential crisis scenarios both national and regional can be identified, assessed and subsequently managed in an enhanced and coordinated manner.

Executive Summary

In accordance with Article 10 of the Risk Preparedness Regulation (EU) 2019/941 (RPR), the CRU, as competent authority, has developed a draft Risk Preparedness Plan for Ireland ('the Plan'). The Plan includes the set of crisis scenarios developed under Article 7 of the RPR which were published for consultation in November 2020 (CRU 20/138). These consist of 26 scenarios falling into the 9 categories of: extreme weather, malicious attack, primary equipment failure, technical failure, natural disaster, primary energy shortage, human factors, market failure and Infrastructure delivery deficit. It is important to note that the scenarios have been considered here as individual events, but that whilst the likelihood of simultaneous occurrences of multiple scenarios is lower, the impact would be more significant.

The remainder of the Plan documents the steps to be taken by the electricity sector to prevent, prepare for and manage emergency situations such as those defined by the set of electricity crisis scenarios. The Plan includes the roles and responsibilities of the Competent Authority and other bodies in developing the plan; details of the national procedures and measures that are in place to be followed in the case of an electricity crisis; preventive and preparatory measures that aim to reduce the likelihood and improve the outcome of such crises; and mitigating steps that will help to avoid or minimise the severity of a crisis.

The occurrence of an electricity crisis equates to an Emergency or Blackout/Restoration state. The key procedures to be implemented in such a crisis are documented in detail within the System Defence Plan and the System Restoration Plan, as required under Regulation (EU) 2017/2196 Establishing a Network Code on Electricity Emergency and Restoration. These procedures, which include measures to manage frequency, voltage and power flows, are summarised in this Plan, along with the communications to key stakeholders.

As well as the general preventive and preparatory measures that are taken to avoid or prepare for a crisis, such as network development plans, there are many dedicated measures in place that relate to the different types of crisis scenario. These include, for example, preparations made for the occurrence of extreme weather such as the yearly winter outlook produced by EirGrid, cybersecurity precautions, technical and maintenance standards for infrastructure and business continuity plans for the system operators. The Plan contains summaries of the types of measures that are currently deployed on the Irish electricity system. The general approach to demand-side management and demand control/disconnection that may be used to prevent or during a crisis event is also presented.

The Plan documents the methods for communicating with the public during an electricity crisis, to be led by the Energy Press Officers Network in close cooperation with the crisis-coordinator and

the Joint Energy Emergency Response Team. ESB Networks also provide an information interface for customers via their PowerCheck website.

The Irish electricity system is part of the Single Electricity Market operating on the island of Ireland. Close cooperation between the two jurisdictions in the event of a crisis is provided for through a number of mechanisms, set out in this Plan. There are technical, legal and financial measures agreed through various existing processes and instruments that cover the provision of support across the SEM. In addition, the SEM is connected to the electricity system in Great Britain through two HVDC interconnectors. Each interconnector operates via an Interconnector Operating Protocol, which governs the provision of support to and from each connected system.

The Plan contains a section on consultation. This includes a summary of the responses received to the previously held consultations on the crisis scenarios and the draft version of this Plan. The response of the CRU and any changes made to the crisis scenario descriptions, risk assessments, and this Plan have been documented. The final section of the Plan covers the existing calendar, participants and actions for testing the electricity system and the response to the occurrence of a crisis scenario.

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Glossary of Terms and Abbreviations

Abbreviation or Term	Definition or Meaning
ACER	European Union Agency for the Cooperation of Energy Regulators
BECP	Blackstart Emergency Communications Protocol
BEIS	Department for Business, Energy & Industrial Strategy (UK)
BETTA	British Electricity Trading and Transmission Arrangements (GB market)
CRU	Commission for Regulation of Utilities
DECC	Department for Environment, Climate and Communications
DfE-NI	Department for the Economy, Northern Ireland
DSO	Distribution System Operator – ESB Networks (ESBN)
ECG	Electricity Coordination Group
E.DSO	European Distribution System Operators
EENS	Expected Energy Not Served
EMS	Energy Monitoring System
ENTSO-E	European Network of Transmission System Operators for Electricity
EPON	Energy Press Officers Network
EWIC	East-West Interconnector
FOR	Forced Outage Rate
FRR	Frequency Restoration Reserve
GB	Great Britain
GCS	Generation Capacity Statement
GNI	Gas Networks Ireland
HVDC	High Voltage Direct Current
ICT, IT	Information (and Communications) Technology
IE	Republic of Ireland

EERT	Electricity Emergency Response Team
LFC	Load Frequency Control
LFCBOA	LFC Block operational agreement
LOLE	Loss of Load Expectation
NCC	National Control Centre
NCER	Regulation (EU) 2017/2196 establishing a network code on electricity emergency and restoration
NDCC	National Distribution Control Centre
NECG	National Emergency Coordination Group
NGESO	National Grid Electricity System Operator, the electricity system operator for Great Britain
NGET	National Grid Electricity Transmission
NI	Northern Ireland
NIE	Northern Ireland Electricity, DSO for NI
NIS-D	Network and Information Systems Directive
NIST CSF	National Institute of Standards Cybersecurity Framework
NRA	National Risk Assessment
OES	Operators of Essential Services
PPM	Power Park Module
PSRP	Power System Restoration Plan
RPR	Risk Preparedness Regulation (EU) 2019/941
SAOA	Synchronous Area operational agreement
SCADA	Supervisory Control and Data Acquisition
SDP	System Defence Plan
SEM	Single Electricity Market (Irish all-island market)
SEM-O	Single Electricity Market Operator
SGU	Significant Grid User
SOGL	Regulation (EU) 2017/1485 establishing a guideline on electricity transmission

	system operation (System Operation Guideline or SOGL)
SVC	Static Variable Compensator
TAO	Transmission Asset Owner – ESB Networks (ESBN)
TDP	Transmission Development Plan
TSC	SEM Trading and Settlement Code
TSO	Transmission System Operator – EirGrid (IE) and SONI (NI)
TYFS	Ten-year Forecast Statement
UVLS	Under Voltage Load Shedding

General information

The designated Competent Authority in Ireland for the preparation of this plan under Regulation (EU) 2019/941 on risk-preparedness in the electricity sector (RPR) is the Commission for Regulation of Utilities (CRU).

The Annex of the RPR sets out the template adopted in this document for the risk preparedness plan.

Connected Regions

The Irish electricity system is not directly connected to that of another Member State.

A synchronous system and single electricity market are in operation over two jurisdictions within the island of Ireland – the Republic of Ireland and Northern Ireland. Following Brexit, the Northern Ireland Protocol ensures the continued operation of the SEM and application of EU energy market rules in Northern Ireland. The island of Ireland is connected to Great Britain (GB) via two HVDC (High Voltage Direct Current) interconnectors.

Related Documents

- Regulation (EU) 2019/941 on risk preparedness in the electricity sector[1]
- S.I. 342 of 2020, designating CRU as Competent Authority[2]
- CRU/20138, consultation on “Identification of National Electricity Crisis Scenarios for Ireland”
- CRU/21098, consultation on “Electricity Crises: A Draft Risk Preparedness Plan for Ireland”

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0001.01.ENG

[2] https://www.cru.ie/document_group/designation-of-the-commission-for-regulation-of-utilities-cru-as-the-competent-authority-responsible-for-the-implementation-of-the-measures-set-out-in-regulation-eu-2019-941/

1. Summary of the Electricity Crisis Scenarios

1.1 Development of the scenarios

A set of regional electricity crisis scenarios was developed by ENTSO-E under Article 6 of the RPR. A set of national electricity crisis scenarios, consistent with the regional scenarios, was developed in a parallel process for Ireland under Article 7, in close collaboration with the Irish Transmission System Operator (TSO, EirGrid). These were subject to public consultation in November/December 2020 to ensure that reasonable range of nationally relevant crisis scenarios has been identified, and that their likelihoods and possible impacts on the Irish electricity system have been fully considered.

The impact, likelihood and risk ratings assigned to each scenario follow the prescribed methodologies developed by ENTSO-E. The combinations of likelihood and risk have been derived based on the following:

- Likelihoods have, where possible, been strongly based on the classifications from the National Risk Assessment,[3] (NRA) but modified to reflect different scenario assumptions where required. Some of the weather-related scenarios have been adjusted to reflect potential increases in occurrence of extreme events due to climate change, other expert judgements, available statistics and the TSO's own experience.
- The level of impact associated with each scenario is based predominantly on the expert judgement of the TSO and known outcomes from historical events. In some cases, likely future trends have been considered. During the risk assessment process, two quantities were estimated to help categorise the impacts: EENS, Expected Energy Not Served, and LOLE, the Loss of Load Expectation.

The final risk rating is assessed from the combination of ratings assigned to the impact and likelihood of each scenario[4].

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[3] NRA: https://www.emergencyplanning.ie/en/news/national-risk-assessment-ireland-2017
Note that the NRA considers the likelihood of a general energy supply crisis to be in the 'unlikely' category overall

[4] Detailed methodology as per table in ENTSO-E guidance document.

An additional rating, the cross-border severity, is estimated to provide an indication of how likely the risk is to 'spill over' into connected Member States and other connected regions, based on expert judgement. In this case it is primarily NI, with some impact possible on GB, and vice versa.

It is important to note that the scenarios have been considered here as individual events, but that whilst the likelihood of simultaneous occurrences of multiple scenarios is lower, the impact would be more significant. This is particularly relevant to note in the case of a shortage of renewable energy sources, where there is assumed to be sufficient alternative capacity to protect against impact. In the case of a long-acting scenario, such as a simultaneous outage of multiple standard generators, or infrastructure delivery deficit, the impact of a simultaneous renewable energy source shortage becomes much more significant.

1.2 Electricity Crisis Scenarios

A total of 26 scenarios were considered appropriate for risk assessment. The scenarios fall under the categories of,

- Extreme weather
- Malicious attack,
- Primary equipment failure
- Technical failure
- Natural disaster
- Primary energy shortage
- Human factors
- Market failure
- Infrastructure delivery deficit

This section sets out the basis and key assumptions applied for the risk assessments under each category of crisis. An expanded version of the assumptions is available in the consultation document[5]. Those scenarios rated most severe are highlighted in red text.

1.2 (a) Weather

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border

[5] https://www.cru.ie/document_group/identification-of-national-electricity-crisis-scenarios-for-ireland/

Extreme weather	Storm	Possible	Critical	Major	Major
	Cold Spell	Unlikely	Critical	Minor	Major
	Heatwave and dry spell	Unlikely	Critical	Minor	Major
	Winter Incident	Unlikely	Major	Minor	Major
	Heavy precipitation and flooding	Possible	Major	Minor	Minor
	Solar Storm	Very unlikely	Major	Insignificant	Major

- Storm:
  - Based on assumption of sustained 10-minute wind speeds peaking at over 90 km/h and gusting over 130 km/h at multiple locations (similar to Storm Darwin, 2014).
  - Historical occurrence is once per 15-30 years, may increase due to climate change; duration is 3 days plus additional clean-up time; probable impact on NI and GB within a similar timeframe.
- Cold spell:
  - Assumes cold, calm spell lasting 1 week in winter.
  - Likelihood once in 10-100 years as per NRA; assumes some level of rota load-shedding and issues with conventional plant cooling; significant cross-border interdependencies including interconnector flows.
- Heavy precipitation and flooding:
  - Extreme precipitation event resulting in flooding of key transmission and distribution infrastructure, total duration 7 days but most severe over 2-3 days.
  - NRA likelihood is 1 in 10 years, considered here at the less frequent end of that scale as not all flooding/precipitation events are expected to affect the electricity system; impact not system-wide but localised loss of load over several days; typically minor cross-border impacts.
- Winter incident:
  - Based on high winds during snowfall event causing ice accretion on overhead lines.
  - Considered to be unlikely; impact localised to a few stations but may result in lost load and possible permanent damage; major cross-border impacts if simultaneous events in NI or GB.
- Heatwave, dry spell:
  - Scenario based on record-breaking summer temperatures occurring for at least 10 days, accompanied by a simultaneous dry spell.
  - Unlikely as per NRA (but frequency may increase due to climate change); widespread and long duration loss of load relating to sag on power lines reducing

capacity, and overheating transformers; very likely to affect NI and GB simultaneously.

- Solar storm:
    - Very unlikely, as historical events very rare.
    - TSO protocol in place to forecast and minimise impact, but possible long-term damage and associated loss of load; likely simultaneous impacts in NI and GB.

1.2 (b) Malicious

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Malicious attack[6]	Cyber-attack on business-critical ICT infrastructure of entities which are physically connected to the power grid	Unlikely	Disastrous	Major	Major
	Insider attack	Very unlikely	Disastrous	Minor	Major
	Threatening/blackmailing/hostage-taking of key employees	Very unlikely	Critical	Minor	Major
	Physical attack against critical assets	Unlikely	Minor	Insignificant	Major
	Physical attack against control centres	Unlikely	Minor	Insignificant	Minor
	Cyber-attack on business-critical ICT infrastructure at market participants (not physically linked to the power grid)	Very unlikely	Insignificant	Insignificant	Minor

- Cyber-attack on grid connected systems:
    - Assumes attacker acting as employee, gaining access to critical grid-connected system such as TSO Control Centre, causing wide-scale blackout.
    - Unlikely, as per NRA and TSO evaluation; assumes restoration may take longer than 2 days using local operations; shared EirGrid-SONI facilities and synchronous operation with NI would lead to major cross-border implications.
- Insider attack:
    - Assumes insider attack on control centre.
    - TSO consider this to be a very rare situation; a knowledgeable attacker would be able to quickly cause system-wide blackout, equipment damage and a lengthy

[6] These scenarios include consideration of all power-system related assets, including those on the distribution system.

restoration time; single control system with NI, and additionally EWIC is controlled from the control centre too so GB would be affected.

- Threatening/blackmailing/hostage-taking of key employees:
  - Assumes attacker has complete control of the grid and would potentially cause a system wide black out for one day.
  - Very unlikely situation; potential for lost load lasting up to two days; single control system with NI so could spill over, EWIC also controlled from the control centre so impact on GB.
- Physical attack against critical assets:
  - Based on an attack on the NI-IE infrastructure.
  - NRA likelihood is 10-100 years; NI and IE systems operable separately but financial implications and possible loss of load; link between NI and IE would be severed.
- Physical attack against TSO control centre:
  - Scenario assumes system is left to drift out of limits rather than intentional blackout.
  - NRA and TSO assessment consider it an unlikely scenario; system could drift to black-out, particularly with large ramps in wind generation, but back up control available from SONI so impact minimised; expect minor impact on the NI system.
- Cyber-attack on systems not physically connected to the grid:
  - Specific scenario considers attack on market ICT systems.
  - Considered less likely than attack on grid-connected systems; central scheduling and dispatch and non-automated control systems minimise the impact; minor cross-border dependency due to less-efficient dispatch schedule for all-island market.

1.2 (c) Primary equipment failure

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Primary equipment failure	Local technical failure with regional importance	Unlikely	Critical	Minor	Major
	Serial equipment failure due to a systematic defect of system elements	Possible	Minor	Minor	Minor
	Simultaneous failure of power system primary elements	Unlikely	Minor	Insignificant	Major
	Simultaneous unplanned long-term outages of major power plant	Possible	Major	Major	Major

- Local technical failure with regional importance:
    - Scenario features a transformer explosion which forces out a station critical to cross-border activity or interconnection.
    - There have been past occurrences but would be considered generally unlikely; would cause lost load over a couple of days; involves a break in connection with either NI or GB.
- Simultaneous failure of power system primary elements:
    - Scenario involves an incorrect detection of a separation of the two power systems on the island (IE and NI), causing three large generators to drop out and under-frequency load-shedding scheme to trigger.
    - On the basis of previous experience, this is an unlikely event; a limited amount of load would be lost for a relatively short period; NI could be greatly impacted, depending on the specific element affected.
- Serial equipment failure due to a systematic defect of system elements:
    - Scenario based on possible failure of DC contactors, HTLS conductors, fluid-filled cables. The key assumption is that the power grid may have to continue to be operated despite the risk of failure until it can be resolved fully.
    - Considered possible based on these previous experiences; limited lost load over a short period; assuming only specific locations would be involved so not likely to affect NI.
- Simultaneous unplanned outages of major power plant:
    - Scenario based on a recent occurrence of two unrelated equipment failures at two large generators that resulted in prolonged outages of several months. The failures, representing capacity equal to c.15% of winter peak demand, caused major impact on system adequacy.
    - Considered possible based on recent experience, the age of the generation fleet, and recent trends in FOR – over the last 5 years an increase in the average annual FOR from under 5% in 2015 and 2016 constantly increasing to 20% in 2021; could result in intermittent lost load over the period so overall impact is major; cross-border impact major due to interdependencies with NI and impacts on interconnector flows.

1.2 (d) Technical failure

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Technical Failure	Loss of ICT tools or telecommunication infrastructure required for electric power system operation in or near real-time	Unlikely	Critical	Minor	Minor
	Complexity of power system control mechanism	Unlikely	Insignificant	Insignificant	Minor

- Loss of ICT tools or telecommunication infrastructure required for power system operation in or near real-time:
  - This scenario considers a potential failure of the ICT system behind a key dispatch tool.
  - Has not happened previously, considered unlikely; depending on conditions on a particular day it could lead to a limited duration blackout; same dispatch tools used in NI so some cross-border dependency.
- Complexity of power system control mechanism:
  - Event begins with one failure on an ICT system or grid protection component causing a signal to other grid/production/control component resulting in a cascading failure.
  - Future innovation and integration with balancing market control will increase the complexity in future but considered to be a low possibility currently; limited impact in current circumstances; same systems deployed in NI so some cross-border dependency.

1.2 (e) Natural disaster

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Natural disaster	Forest fire	Unlikely	Major	Minor	None

- Forest fire:
  - Scenario envisages the potential for a forest fire to impact on the network infrastructure.

  - Review of historical incidents indicates it is unlikely, potential for prolonged duration of lost load; no cross-border impacts expected.

1.2 (f) Primary Energy Shortage

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Primary energy shortage	Fossil fuel shortage (incl. natural gas)	Unlikely[7]	Disastrous	Major	Major
	Renewable energy source shortage	Possible	Insignificant	Insignificant	Major

- Fossil fuel shortage (incl. natural gas):
  - Based on either a curtailment of GB gas supply over a prolonged period (up to one month) from Moffat or full loss of supply (e.g., technical failure) for a shorter period.
  - NRA sets the likelihood as between 10 and 100 years; impact is heavily influenced by wind power availability during the crisis, it would likely cause significant lost load for a prolonged period; NI similarly dependent on gas and is also predominantly fed from Moffat, and in the case of a supply issue, GB will be simultaneously affected.
- Renewable energy source shortage
  - Irish power system increasingly powered by wind, which is non-dispatchable and variable. When capacity factor is low, other power sources are required.
  - Unusually low annual capacity factors were seen in 2021 and in 2010, so a 'possible' estimate seems reasonable for likelihood; errors have been seen in forecast wind output in recent years, considered to be a possible short-term event during medium to high wind output.

[7] The 'unlikely' is based on the NRA from 2017. It is to be noted that under circumstances relating to European gas supply, alongside policy on climate action and fossil fuels, this may escalate in severity by the next iteration of this Plan.

- Potential for lost load is insignificant considering wind output as a single factor, and it is intended to remain so as planning standards and adequacy studies capture the variability. Coupled to variations in the available dispatchable generation (e.g., scenario 1.2(i)) there could be lost load relating to a joint occurrence where wind is accurately forecast to be low. Alternatively, large forecast errors could have impacts where wind is forecast but does not turn up. The time required to start-up other generation could incur loss of load, but no evidence of this having previously been the case so considered insignificant.
- Cross-border impact is Major as both jurisdictions likely to be similarly affected, same forecast vendors are used in NI, and if related to unusual conditions, GB could also be under-forecasting and unable to provide support.

1.2 (g) Human factors

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Human factors	Pandemic	Unlikely	Major	Minor	Major
	Accidental (unintended) violation of N-1 criterion due to human error	Possible	Insignificant	Insignificant	Minor
	Strike, riots, industrial action in power supply chain	Unlikely	Minor	Insignificant	Minor

- Pandemic:
  - Scenario envisages a more immediate impact on power system operation than that caused by Covid-19.
  - NRA sets pandemics as occurring once in every 10 and 100 years; impact primarily relates to maintenance of generators, related supply chain constraints and requirements for expertise from overseas; this could cause delayed loss of load due to forced outages during a later period of high demand; very likely to affect NI and GB in a similar fashion.
- Accidental (unintended) violation of N-1 criterion due to human error:
  - Scenario related to increase in complexity of system operations with the introduction of new tools and management of new technologies.
  - Considered a possibility as human error events have occurred in the last 5 years; previous events have been resolved quickly with little or no impact on load; some potential errors could have cross-border impact.
- Strike, riots, industrial action in power supply chain:

- Scenario assumes action lasts at least 4 weeks but very unlikely to incur any significant lost load for the full period; historical events of this type have not been frequent or regular; unlikely to occur in other states simultaneously.
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1.2 (h) Market related

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Market failure	Unwanted power flows due to the fact that physical flows don't follow market related scheduled flows	Likely	Minor	Minor	Major

- Unwanted power flows due to the fact that physical flows don't follow market related scheduled flows:
  - Scenario relates to flows occurring within Ireland or at the border, between SEM and BETTA (the Irish all-island and GB electricity markets), via the Moyle interconnector and EWIC; typically related to poorly forecast renewables.
  - Considered to be a likely scenario based on recent experience in SEM; the TSO has direct control of the vast majority of renewable power output, so impact is limited to minor, i.e., can invoke constraint/curtailment and bring on compensatory generation; flows can drive alerts in NI.

1.2 (i) Infrastructure delivery deficit

	Scenario Name	Likelihood	Impact (greater of LOLE or EENS)	Rating	Cross Border
Infrastructure delivery deficit	Planned infrastructure projects accounted for in TSO system planning does not deliver on time	Unlikely	Major	Minor	Major

- Infrastructure delivery deficit
  - TSO system planning takes into account planned and contracted infrastructure, such as interconnectors and new generation plant, to forecast system supply/demand margins and inform future capacity requirements. Delays to, or non-delivery of projects can result in future supply deficits that cannot be addressed by standard market processes, e.g. Construction timeline for new

generation plant is estimated at 3 to 5.5 years. Successful candidates terminating their contracts within 3 years of their scheduled energisation date can result in a future capacity shortfall.

- In excess of 500MW of generation plant in Ireland scheduled for energisation from October 2022 was terminated close to the capacity year in 2021.Future risk of recurrence is considered unlikely given subsequent updates to the associated processes; the impact is considered Major, given the timelines required to respond should a significant amount of new capacity not be delivered, so overall risk is minor; Cross-Border ‘major’ rating reflects impact to the SEM, given mutual support provided by the North-South tie-line.

2. Roles and Responsibilities

2.1 Role of the competent authority

The **Commission for Regulation of Utilities (CRU)** is the Regulatory Authority for electricity, gas and water in Ireland, with statutory responsibility for monitoring and ensuring security of gas and electricity supplies. The CRU has been designated by the Department for Environment, Climate and Communications (DECC) as the Competent Authority under Article 3 of the RPR[2] to facilitate the implementation of the regulation, and along with DECC, attends the Electricity Coordination Group (ECG) meetings. The role of CRU under the RPR is:

- Article 7: To identify the most relevant national electricity crisis scenarios, and consult with the relevant stakeholders
- Article 10, 11, 12: To establish a risk-preparedness plan, after consulting with the relevant stakeholders, and publish this on the CRU website
- Article 14: To issue an early warning to the Commission and other Member States that a possible electricity crisis may occur, its causes, measures planned or taken to prevent a crisis and the possible need for assistance; after consulting with the TSO, to declare an electricity crisis and inform other Member States and the Commission, along with the causes, measures planned or taken to mitigate it, and the need for assistance from other Member States.
- Article 17: To provide the ECG and the Commission with an *ex post* evaluation report on the crisis within 3 months of the end of an electricity crisis

The CRU has not formally delegated any section of its role as competent authority under the RPR.

2.2 Roles and Responsibilities of relevant other bodies

Department of the Environment, Climate and Communications (DECC)

The **Department of the Environment, Climate and Communications (DECC)** is the Government Department responsible for the formulation of energy policy including security of supply.

The role of DECC under the RPR is to designate the CRU as Competent Authority under Article 3; to inform the ECG and the Commission of their assessment of the risks in relation to the ownership of infrastructure relevant for security of electricity supply under Article 7; to cooperate with other

Member States and provide assistance in a crisis, where possible, having agreed on the necessary technical, legal and financial arrangements beforehand as per Article 12.

Transmission System Operator (EirGrid)

EirGrid is the designated Transmission System Operator (TSO) in the Republic of Ireland, with responsibility for maintaining security of supply. As TSO, EirGrid is also responsible for system defence, emergency management and system restoration.

The role of EirGrid under the RPR is to contribute to the development of the regional electricity crisis scenarios as part of ENTSO-E under Article 6; to work with the CRU to develop the set of complimentary national electricity crisis scenarios under Article 7; and to contribute expertise to the relevant sections in the preparation of the Risk Preparedness Plan under Article 10.

Distribution System Operator and Transmission Asset Owner (ESB Networks)

ESB Networks (ESBN) is the Distribution System Operator and Transmission Asset Owner in Ireland. ESBN manages the operation of the electricity distribution network in Ireland and provides the interface with the distribution network operator in Northern Ireland, Northern Ireland Electricity (NIE). In particular, ESBN work closely with the TSO on the load-shedding aspects of the System Defence Plan. Within the System Restoration Plan, ESBN will work with the National Control Centre (NCC) to restore the electricity system to normal configuration. Further information is provided on these plans in section 3.1(a).

The role of ESBN under the RPR is to contribute expertise to the relevant sections in the preparation of the Risk Preparedness Plan under Article 10.

3. Procedures and measures in an electricity crisis

3.1 National procedures and measures

The procedures and measures in place to address an electricity crisis relate to three different types of measures, namely:

- Emergency Response measures: Measures that are in place, or that are planned, to mitigate the consequences of an electricity crisis.
- Preventive measures: Measures that are in place, or that are planned, to prevent the occurrence of the identified electricity crisis scenarios;
- Preparedness measures: Measures that are in place, or that are planned, to prepare a response to an imminent crisis (e.g. preparedness measures taken as part of the Procedure in the case of an Electricity Shortfall);

While not all of these identified measures fit into one of these clear-cut definitions, the following sections will briefly describe these procedures and measures and how these address the identified national electricity crisis scenarios.

3.1 (a) Procedures to be followed in the case of an electricity crisis

This section presents high level measures and procedures applicable in a crisis and outlines actions to be taken to preserve security of supply in the event of an emergency. There are a number of plans, protocols, processes and procedures that determine the actions of the TSO and the DSO in the event of a crisis situation. Regulation (EU) 2017/2196 establishing a network code on electricity emergency and restoration (NCER) sets out procedures and systems that determine actions to be taken in response to an emergency situation. EirGrid has an internal set of business processes in place that ensure the correct steps are taken to restore the system to its normal operational state as quickly as possible. The Grid Code[8] governs the use of the Irish transmission system by all users, and as such, contains rules for actions to be taken in emergency situations.

It is important to note that due to the integrated nature of market and system operation on the island of Ireland, there is intimate knowledge of operation between Ireland and Northern Ireland and seamless communication at an operational level. There is also close cooperation between the

[8] https://www.eirgridgroup.com/customer-and-industry/general-customer-information/grid-code-info/

islands of Ireland and Great Britain with respect to interactions between the two markets (SEM and BETTA respectively), response to weather conditions, and operation of the two interconnecting HVDC links. A set of SEM business processes contain procedures to be followed throughout the synchronous system during an emergency situation (further detailed in 3.2 (b)).

(i) System Alerts

Regardless of the category of the crisis as listed in Section 1, the actions taken by the TSO will be determined by the severity of the situation. The level of crisis occurring in the system is defined by the System Alert level. These System States range from Normal, to Alert State, Emergency State, Blackout and Restoration State[9], each with an associated set of defining criteria. OC9.4 of the EirGrid Grid Code outlines the criteria for the issuing of System Alerts in the event of a System Emergency Condition or imminent shortfall in capacity. The published SEM business process detailing the details and criteria is BP_SO_9.2 Declaration of System Alerts[10]. There is a complementary internal procedure, the "System Alerts Procedure Ireland and Northern Ireland" that is used by the control centres in the event of a change in system state. This procedure, summarised in Table 1, details the steps the control centres and managers would take during an alert. It covers aspects such as the initial determination of change in system state, the communication of the alert to relevant stakeholders, and the options available to restore the system to normal state. The Grid Code specifies that procedures are activated for both the TSO and Generators in response to a change of system state.

Table 1 System alerts – criteria and measures to be deployed under each state

State	Criteria for establishing this state	Key actions triggered
Normal	The transmission system shall be considered to be in the 'normal' state when all of the following conditions are fulfilled: a) voltage and power flows are within the operational security limits; b) frequency meets the following criteria: i) the steady state system frequency deviation from nominal is within ± 200 mHz; *or* ii) the absolute value of the steady state system frequency	System is run with N-1 contingency monitoring. Sufficient reserve on the system to meet peak demand.

[9] The Alert, Emergency, and Blackout states are locally referred to as Amber, Red and Blue Alerts, respectively
[10] http://mt.semopx.com/documents/general-publications/BP_SO_09.2-Declaration-of-System-Alerts.pdf

<table>
<tr><td></td><td>deviation from nominal is not larger than 500 mHz and the system frequency limits established for the alert state are not fulfilled;

c) active and reactive power reserves are sufficient to withstand contingencies from the contingency list without violating operational security limits;

d) operation of the All-island transmission system is and will remain within operational security limits after the activation of remedial actions following the occurrence of a contingency from the contingency list.</td><td></td></tr>
<tr><td>Alert</td><td>The Alert state should be initiated when voltage and power flows are within operational security limits (base case secure) and one or more of the following conditions are fulfilled:

• Frequency meets the following criteria and the absolute value of the steady state system frequency deviation from nominal is within ± 500 mHz but has continuously exceeded:
    ○ ± 200 mHz for a time period longer than 15 minutes; or
    ○ ± 250 mHz for a time period longer than 10 minutes; or
• At least one contingency from the contingency list leads to a violation of operational security limits, even after the activation of remedial actions; or
• Multiple contingencies are probable because of adverse weather; or
• The jurisdictional margin is such as the tripping of the largest set, would give rise to a reasonable possibility of failure to meet the System Demand or
• The All-Island reserve capacity is reduced by more than 20% for longer than 30 minutes</td><td>Generators, Market, NG-ESO and NDCC notified.

If alert is due to insufficient margin, the steps below are taken:

• All available conventional units are maximised.
• All expensive and energy limited plant is dispatched.
• Trade or Emergency Assistance is considered on interconnectors.
• North-South tie line maximised if spare capacity there.
• The Power System Emergency Communications Plan (PSECP) will</td></tr>
</table>

	and there are no means to compensate for that reduction in real-time system operation.	be invoked if there is a high possibility that a System Emergency state may be issued and Demand Control invoked

Emergency	The Emergency state should be initiated when the System enters an "Emergency state" i.e., when any of the following criteria are satisfied:
	
	• There is at least one violation (base case) of voltage limits, short-circuit current limits, or current limits in terms of thermal rating; or
	• Frequency does not meet the criteria for the normal state or alert state definitions; or
	• Any of the following system defence plan measures are activated:
	  o activation of UF load shedding where frequency does not recover within +/- 500mHz less than 1 minute; or
	  o widespread (multiple station) UV load shedding; or
	  o activation of manual demand disconnection; or
	  o activation of system separation protection.
	• There is a failure in the functioning of:
	  o EMS / SCADA or
	  o Phones (Corporate and Optel / Tetra) resulting in the unavailability of those tools, means and facilities for longer than 30 minutes.
		All actions for Alert state are implemented.
		
		If emergency state is due to insufficient margins the steps below are:
		
		• Emergency Instruction may be implemented on interconnector to NGUK-ESO.
		• Operating Reserves are eroded.
		• Non-market measures dispatched[11].
		• Demand Control is implemented by the TSO and DSO.
		• The Power System Emergency Communications Plan (PSECP) will be invoked if a System Emergency state is declared.

[11] Where possible and appropriate, non-market-based measures may be readied when in Alert status to enable timely dispatch when in Emergency

	The "RED ALERT" signal should also be initiated by NCC or CHCC when: • it is likely/ imminent that in the period immediately ahead (i.e., in the next four (4) hours) there is a high risk of failing to meet System Demand • Dynamic reserves (excl. batteries) have been reduced to 70MW (50MW IE and 20MW NI). • The steady state system frequency is outside a range of ± 500 mHz for more than 1 min. • LSAT (real time) continually forecasts a freq Nadir of below 49 Hz for a period of 30 min and there are no means are available to address this	
Blackout	The Blackout state should be initiated by the NCC to inform relevant parties that all or part of the transmission system must be started from black i.e., when the System enters a "Blackstart" state, that is, any of the following: • Loss of more than 50% of demand load • Loss of voltage across the transmission system for 3 min • The Power System Restoration Plan has been activated	Power System Restoration Plan activated. BECP (Blackstart Emergency Communications Protocol) Activated

(ii) System Defence

Regulation (EU) 2017/2196, establishing a Network Code on Electricity Emergency and Restoration (NCER) details the requirements for each TSO to develop a System Defence Plan

(SDP)[12]. The System Defence Plan contains (manual) procedures and automatic schemes available to the TSO to prevent the further deterioration towards an Emergency state when one is forecast, or to manage the system when it is in an Emergency state. There are a number of automatic actions also defined in the System Defence Plan which should prevent the system going into an alert or emergency state such as automatic under frequency and under voltage load shedding relays.

EirGrid's System Defence Plan[13] (SDP) contains the following provisions:

- The conditions under which SDP is activated;
- The SDP instructions to be issued by the TSO;
- The measures subject to real time consultation or coordination with the identified parties.

The automatic schemes include:

Automatic under-frequency control scheme

This scheme is designed and implemented in collaboration between TSO and the DSO to ensure sufficient demand can be disconnected in the event of an exceptional low frequency event on the power system in Ireland. Under-frequency load shedding relays are installed at designated substations around Ireland with the capability of disconnecting up to 60% of system demand, triggered at an initial frequency of 48.85 Hz, which is within the Emergency state.

Automatic Over-frequency control scheme

This scheme is implemented by the TSO on the protection relays at designated transmission substations and is to help manage the frequency when facilitating a full export on an interconnector. In this scenario EWIC will be the largest loss on the system and this is currently only likely when wind farms in Ireland are near full capability; therefore, only wind farms are selected in this scheme. Note this scheme is from 50.50Hz to 50.75Hz and is an action within the Emergency state if the frequency deviation remains above 50.5Hz for more than one minute.

Automatic Scheme against Voltage Collapse

There is one main automatic scheme installed to prevent voltage collapse, a scheme for low voltage demand disconnection known as Automatic Under Voltage Load Shedding (UVLS).

[12] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_System_Defence_Plan_Proposal_Ireland.pdf

The manual procedures include:

Frequency Deviation Management Procedure

Frequency regulation is managed through the provision of different types of reserve products described in Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation (System Operation Guideline or SOGL). For all reserve providers, the reserve capability is mandated by the Grid Code and contracted via System Services agreements. These measures to control frequency are available for the TSO to select the most economic service providers.

Voltage Deviation Management Procedure

The TSO is obliged to operate the transmission system with the operational security limits defined in SOGL, see Table 3. However, EirGrid has a more stringent set of voltage limits in operational timescales. The voltage management of the system is achieved in a number of ways designed to ensure the system remains within the Normal System voltage range with sufficient voltage support (reactive power) reserves to limit the voltage step change post contingency within the post-contingency limits and hence avoid an Emergency state. These include,

- Switching reactive compensation equipment
- Capacitors
- Reactors
- Instructing reactive power on synchronous generation
- Changing target voltage set points
- Static Variable Compensators (SVCs)
- Power Park Modules (PPM)
- Switching out high reactive gain circuits
- Simultaneous tap changing of NCC controlled grid transformers
- Tap staggering of parallel NCC controlled system transformers

Power Flow Management Procedure

Power flows across the synchronous area of Ireland are managed by the TSOs with the objective of ensuring that the system is operated within the thermal limits of the transmission equipment. Standard remedial actions to maintain the system in Normal State include:

- Re-switching circuits to restrict flows
- Return of outage plant to remove system overload
- Re-dispatch active power set points for generators online

- Schedule additional generation
- Tap change of transformers
- Adjust active power flows through HVDC systems with other TSOs

Assistance for Active Power Procedure

Dispatch instructions are available to the TSO to ensure the security standards in accordance with SOGL are maintained. The TSO may also issue an Emergency Instruction (either pre- or post-fault) to a User in respect of any of its Plant. These will generally involve a dispatch instruction for an active (or reactive) power change (increase or decrease), or a change in required Notice to Synchronise (or, in the case of a demand unit or pump storage unit or energy storage unit, a change in the relevant effective time) in a specific timescale on an individual unit or groups of units. To ensure the security standards in accordance with SOGL are maintained, the TSO may also select a Special Protection Scheme for stability or thermal reasons.

Manual Demand Disconnection Procedure

In accordance with NCER, the Manual Demand Disconnection procedures for the SDP are to be used when necessary, to avoid prolonging an Emergency state. The demand control arrangements may also apply where there is insufficient generation or transfers to meet demand in all or any part of another TSO's system where the TSO is able to assist the other TSOs.

In the EirGrid policy and ESBN Distribution System Operator Load Shedding Plan there are three types of manual load shedding available to the TSO:

- Emergency Load Shedding (urgent)
- Emergency Load Shedding (planned)
- Rota Load Shedding

These are further explained in Section 3.1 (d).

Figure 1 shows the mapping of the different providers of the SDP services according to the grid users involved – Significant Grid Users (SGUs) and non-SGUs.

			SGUs								Non-SGUs
NCER Article	NCER Chapter II Section 2 Technical & Organisational Measures	Individual System Defence Measure / Service	Type D Generator (T-Connected)	Type D Generator (D-Connected)	Type C Generator	Type B Generator	Aggregators of Gen/ Dem	T-Conn Demand Facility	Interconnector Owners	T-Conn closed Distribution System	DSO Demand Customers
15	Automatic Under Frequency Control Schemes	LFDD (Low Frequency Demand Disconnection									X*
16	Automatic Over-Frequency Control Schemes	Over Frequency Generator Shedding Scheme	X								
		Step wise linear disconnection	X	X	X	X					
17	Automatic Scheme Against Voltage Collapse	UVLS (Low voltage Demand disconnection)									X**
18	Frequency Deviation Management Procedure	Operational Reserve (FRR) (Inc. Turlough Hill)	X	X	X	X	X				
		Replacement Reserve (RR)	X	X	X	X	X				
		Active power set points when Frequency is outside Alert Limits.	X	X	X	X	X				
		Authority to disconnect SGUs	X	X	X	X	X	X	X		
19	Voltage Deviation Management Procedure	Reactive power set-points	X								
		Other TSO's making Mvars available							X		
20	Power Flow Management Procedure	Active power set points when power flow is outside Alert Limits.	X	X	X	X	X				
		Special Protection Schemes	X	X	X	X					
21	Assistance for Active Power Procedure	Active power set points when system adequacy is lacking.	X	X	X	X	X				
		Interconnectors Emergency Assistance (MWs)							X		
22	Manual Demand Disconnection Procedure	Emergency load shedding (inc. 5m , 10m & Rota)									X*

* Unless Exempted
** At locations designated by the TSO

Figure 1 System defence services provided by different grid users

(iii) System Restoration

The Power System Restoration plan (PSRP) is a procedure that will be used in the event of a partial or total shutdown of the electricity system. As a result of the serious nature of this event, all users of the power system are obliged to maintain a high level of awareness and training on Power System Restoration. Version 11 of the PSRP is the latest version of the plan and was implemented in April 2020. The ultimate goal is to ensure customers are re-connected safely and as quickly as possible.

Most generators on the Irish power system require external supply to start-up. EirGrid has contracts in place with Restoration Service Providers or Black Start Units that have the ability to start up without an external supply. The providers include a diversity of fuel types, including hydro generators, pumped storage, gas turbines, and an interconnector. These are located strategically, to restore supply to generation stations and customers in 4 different areas at the same time. There are a total of twenty Black Start Units located across seven Black Start Stations. One or more Black Start Units in each Black Start Station is tested annually.

During a blackout, the transmission 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 to operate stably, those subsystems are synchronised to form a single system and restoration continues. Synchronising facilities are available at various locations on the transmission system for this purpose.

The NCER 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 NI 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. 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.

The stages of power system restoration are summarised in Figure 2.

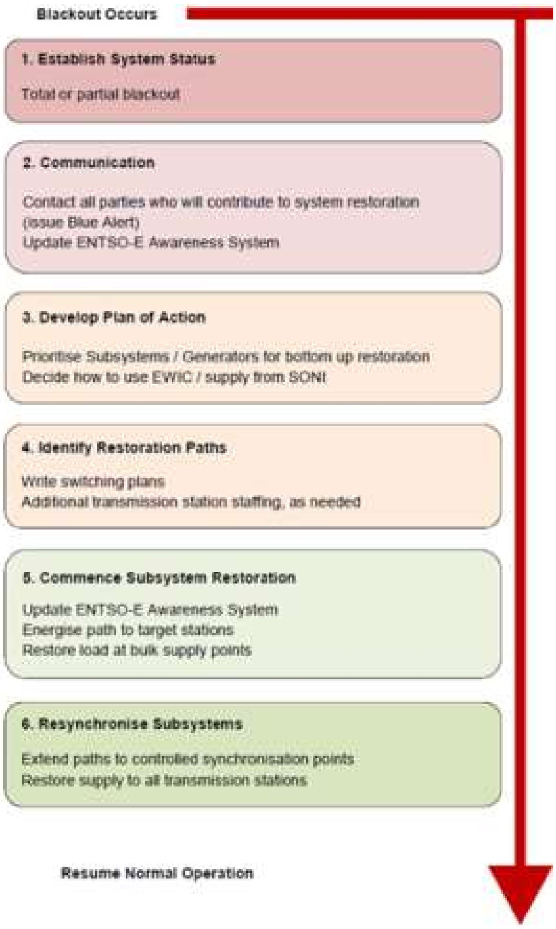

Figure 2 Overview of the stages of the power system restoration plan

(iv) Communications and information flows during system alerts

An alert communication system is employed to notify relevant parties including generators, distribution system operators, internal staff, regulators and the market operator that the system is in an unusual state. Each system user is responsible for internal procedures in receipt of this alert. System alerts are notified to all European TSOs via the control centre ENTSO-E Awareness System. CRU and DECC will communicate and work with the EU Commission and other Member States in relation to early warnings and alerts in accordance with the requirements of the RPR. Market participants are informed through market messages and for relevant entities via the control centre tools. Market participants include demand side units which provide a market-based approach to demand response prior to demand disconnection.

In the event of the power system entering an Alert state, the EirGrid Real Time team will issue a power system alert and notify the relevant stakeholders. The team will also cancel the alert when the system has been stabilised. Table 2 summarises the communication methods used to contact the key stakeholders.

Table 2 Communication and information flows during a system alert

Stakeholder	**EirGrid Communication methods and information flows**
Generators	Email Market Notifications via Market Operator SCADA signals via Control Centre Energy Management System
DSO	Emergency Communications Contact Register (see Appendix) Email and SMS SCADA signals via Control Centre Energy Management System Telephone
Other TSO functions	Emergency Communications Contact Register
Regulators & Government departments	Emergency Communications Contact Register
Market operator	Emergency Communications Contact Register
Other European TSOs	SONI implicitly advised through all-island approach to scheduling and dispatch. NGET control room advised through issue of system warnings via operational telephony per Interconnector Operating Protocol Appendix H. ENTSO-E Awareness System
Market participants (e.g., DSUs)	Market Notifications via Market Operator Informed via EMS and email.
Public	Via Emergency Communications Contact Register and by extension, EirGrid Public Relations

(i) Specific communications during a Blackout state

Accompanying the Power System Restoration Plan is the Blackstart Emergency Communications Protocol (BECP). It sets out arrangements for the TSO to manage communications during a power system blackout and share information with key stakeholders. The focus of the plan is to alleviate concerns of the public/stakeholders and maintain confidence that the TSO is addressing the situation. It involves activating the communications response via structured stakeholder meetings and working closely with the DECC, CRU, ESBN and Gas Networks Ireland (GNI). It ensures that messaging is co-ordinated, consistent and timely.

As soon as the system is confirmed to be in a Blackout state, the following communications are initiated:

- Notifying System Manager (or Operations Charge Engineer if System Manager unavailable) who will oversee the restoration of the power system
- An Alert is issued notifying ESBN, all centrally dispatched units, priority transmission stations, GNI, NGESO, key EirGrid personnel and external stakeholders
- The ENTSO-E Awareness System is updated to notify other Transmission System Operators of the Blackout state

The System Manager will inform all the relevant parties as directed in the BECP and EirGrid may choose to invoke its Crisis Communications Plan if appropriate.

As far as possible, all communications should be directed through the operational telephony system, OPTEL, which is independent of the public telephone system. It is expected that the mobile network will survive the initial immediate onset of a blackout and for this reason when the Alert is issued a text message (SMS) 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 these phones are the only method of communication available, the restoration time will be significantly slower.

3.1 (b) Preventative and Preparatory Measures

A number of general measures are in place that are designed to protect and prepare the system for future changes. These measures are set out by both European and domestic legislation, and the Transmission System Operator's licence.

Section 38 of the Electricity Regulation Act 1999[14] and Part 10 of S.I. No. 60 of European Communities (Internal Market in Electricity) Regulations 2005[15] require EirGrid to publish forecast information about the power system. This includes information on the forecast flows and loadings on the transmission system along with other information useful for prospective system users such as forecast generation capacity and demand for electricity.

In line with this, EirGrid produce an annual 10-year Generation Capacity Statement (GCS) in conjunction with SONI, depicting the projected future demand and generation for the coming decade for both jurisdictions within the all-island synchronous area. The report includes an

[14] http://www.irishstatutebook.ie/eli/1999/act/23/enacted/en/print
[15] http://www.irishstatutebook.ie/eli/2005/si/60/made/en/print#partiii-article6

adequacy assessment, including projections of peak demand. This aids in identifying potential adequacy gaps ahead of time that may threaten security of supply.

In accordance with condition 8 of the TSO licence[16] and Article 8(6) of SI 445 of 2000[17], each year EirGrid also prepare a Transmission Development Plan (TDP), which sets out the intentions for the development of the Irish electricity transmission network and interconnection over a ten-year period. It presents projects that EirGrid has considered are needed to reinforce the transmission network and which will help to achieve the strategic objectives laid out by national and EU policies, including ensuring the security of electricity supply. Additionally, Eirgrid also prepare an annual Ten-Year Transmission Forecast Statement (TFS) containing forecasts of capacity, flows and loading on the transmission network. This allows prospective users of the transmission system to understand opportunities for new connections.

In order to test the response of the electricity system and its actors to a crisis event and ensure that the communications proceed as planned, the BECP is tested annually, involving all key stakeholders in the exercise. Additionally, one or more Black Start Units in each Black Start Station is tested annually.

Alongside the general measures, there are a number of preventive and preparatory plans related to each category of risk scenario which are employed to ensure the system does not enter a change in system state should such a crisis scenario occur. The remainder of this section details these measures.

(i) Extreme weather

The Transmission and Distribution networks are designed for continuity of service and safety within economic constraints. The design is in accordance with EN 50341 (Overhead electrical lines exceeding AC 1 kV), including requirements relating to weather conditions such as wind and ice loading. The distribution network is generally exposed to less severe wind loading than the transmission network because it is closer to the ground (generally less than 10 m).

A number of different plans and documents are prepared to address particular features of weather-related scenarios:

[16] https://www.cru.ie/wp-content/uploads/2017/07/CER17036c-Eirgrid-Transmission-System-Operator-March-2017-clean-version.pdf

[17] http://www.irishstatutebook.ie/eli/2000/si/445/made/en/print?q=445

- The EirGrid Winter Outlook Brochure[18] is an annual summary providing information on expected electricity demand and capacity margin on an all-island basis over the winter months from November to February. It is normally published in the preceding months. This published outlook brochure informs stakeholders and the public of the available capacity margins during the winter months.
- The Winter Readiness Report is an EirGrid internal document which captures the state of preparedness of the power system for the following winter. It is a more detailed analysis of the generation capability to withstand an emergency such as poor weather, lack of gas etc. It also considers the transmission system and any forced/planned outages which could impact the security of supply.
- A severe weather plan is created internally to EirGrid when the national forecaster establishes a risk of a storm. Within this plan, a number of different elements of the power system are considered including transmission, generation and scheduling, resourcing and communications. The communication flow is from EirGrid to DECC and CRU, as well as ESBN in their role as both the Transmission Asset Owner and Distribution System Operator. This plan allows the early intervention in the power system to ensure it is as secure as possible before the arrival of a storm.
- In the event of Geomagnetic Induced Currents there is an internal policy document which details steps that the control centre must take to secure the transmission system.

(ii) Malicious attack

Cyber security

Addressing cyber security threats is an increasing concern within the energy sector as the numbers of reported attacks against utilities has increased in recent years. Regulators and legislators are attempting to address the threat through increased guidance for operators and the introduction of legislation mandating a minimum set of cyber security controls. Within Europe, the Network and Information Systems Directive (NIS-D) which came into force in 2018 attempts to address this by identifying Operators of Essential Services (OES) and recommending a minimum standard for cyber security controls and mandating reporting requirements for cyber incidents. The NIS-D mandates all OES to achieve and maintain a minimum level of cybersecurity maturity in order to mitigate against cyber risks and threats to the performance of its critical activities. DECC is the competent authority within Ireland. The Competent Authority measures the OES's compliance with NIS-D by assessing its level of adherence to security controls set out in the National Institute of

[18] EirGrid Winter Outlook Brochure 2020-21

Standards (NIST) Cybersecurity Framework (CSF). The NIST CSF is based on a Defence in Depth approach to cybersecurity where a broad range of security control domains are applied.

As the TSO, EirGrid is designated as an OES for critical infrastructure and will be subject to more formal governance and reporting arrangements on Cyber Security controls for critical systems and processes. This review completed in 2018 focused on the logical access controls for the systems and applications used by operators in the control room environment.

Logical access control is a key component in securing computing environments and can be augmented with physical access control and monitoring to manage residual risks. Standards for logical access controls in a control room environment need to be designed in such a way that they do not introduce excessive complexity that may inhibit or delay operator access in critical systems in an emergency situation and should be supplemented with robust physical access control.

As the Irish DSO, ESBN has also been designated an OES under the NIS-D. ESBN has incorporated the requirements set out in the NIST CSF to its critical systems that fall within the scope of NIS-D, specifically power system SCADA and Utility Telecommunications system.

Regulation (EU) 2019/943 on the internal market for electricity (recast)[19] provides for the development of a new EU Network code for Cyber Security. This will provide a common set of cybersecurity rules and minimum requirements across the electricity sector, including across borders. The code is currently under development, and Ireland will be contributing via involvement with ACER (the European Union Agency for the Cooperation of Energy Regulators), ENTSO-E and European Distribution System Operators (E.DSO).

Physical attack

Access to all Control Rooms on the system and associated critical infrastructure is tightly controlled with sophisticated access control systems in place. Physical building security and monitoring measures are used at the sites to ensure only legitimate entry is permitted.

(iii) Primary equipment failure

As TSO, EirGrid operates and ensures the maintenance[20] and development of a safe, secure, reliable, economical and efficient transmission system, in accordance with its obligations under

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN

[20] Maintenance Policy including operational testing: https://www.eirgridgroup.com/site-files/library/EirGrid/Guide-to-Transmission-Equipment-Maintenance-March-2018.pdf

Regulation 8(1) of S.I. 445/2000. EirGrid maintains and develops technical standards[21], including functional specifications and standard drawings that are available to assist Customers proposing to connect to the Irish transmission system. These technical standards govern the design and construction of new transmission assets namely transmission substations, cables and overhead lines as well as providing guidance when developments are proposed in proximity to existing transmission infrastructure.

It should be noted that physical maintenance works are carried out by ESBN, as Transmission Asset Owner (TAO), in accordance with its obligations under Regulation 19(a) of S.I. 445/2000. The arrangements governing the interactions and respective roles of the TSO and TAO in respect to the maintenance of the transmission system are further detailed under Section 8 of the Infrastructure Agreement[22].

Transmission System Operator - Outage Planning

As TSO, EirGrid develops and implements a Generation Outage Plan. This ensures co-ordination of “planned outages” when power stations will not be available due to maintenance or other reasons. The Generation Outage Plan takes into account security of supply in Ireland, as well as economic operation of the power systems, and the maintenance/resource needs of generators. EirGrid also develops a Transmission Outage Programme and manages transmission outages. This involves planned times when transmission infrastructure (lines, cables and substations etc.) will be out of service for maintenance. It also involves times when testing, connection of new plant and decommissioning of old plant is carried out.

A high-level description of the transmission outage planning process is available on the EirGrid website.[23]

Transmission Asset Maintenance Policy

Transmission maintenance is undertaken in accordance with the to ensure that the transmission system can operate in a safe, secure and reliable manner. The policy comprises preventive, corrective, fault and statutory maintenance tasks as well as continuous and cyclical condition monitoring (on-line and off-line). The Transmission Asset Maintenance policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice.

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[21] Design technical standards: https://www.eirgridgroup.com/customer-and-industry/general-customer-information/transmission-policies-and/

[22] https://www.cru.ie/wp-content/uploads/2006/07/cer11084.pdf

[23] https://www.eirgridgroup.com/customer-and-industry/general-customer-information/outage-information/transmission-outages/

Transmission Protection Maintenance Policy

Transmission Protection Maintenance Policy details the preventive and corrective maintenance tasks, as well as the frequency at which the protection maintenance should be carried out. The Protection Maintenance Policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice.

Distribution System Maintenance

ESBN have ‘Business as Usual’ controls that mitigate risk for all asset classes across the distribution network, i.e., substations, lines, cables, meters, protection. These include:

- Maintenance Policy & Standards
- Security Policies
- Maintenance & Inspection Procedures (that support frontline delivery)
- Risk Register that looks to capture key asset risks occurring across the portfolio and set out controls to mitigate risk
- Capital & Maintenance work programmes that support ongoing replacement/upgrading of at-risk plant

(iv) Technical failure

As the ICT behind the operation of the power system becomes more complex, it may provide more opportunities for failures. To protect against the loss of ICT or Telecoms, there is a back-up telephony system (OPTEL) in place, and procedures for IT systems to fail over to alternative servers. There is a backup software system that can be used in the event of a failure of the EMS. In the case of a physical failure in the NCC, EirGrid can move operations to a designated Emergency Control Centre.

The training programme for certification for Control Centre Staff includes responding to complex and exceptional circumstances in system operation, including alert scenarios caused by large forecast errors. Shifts are regularly scheduled to take place in the Emergency Control Centre to ensure staff familiarity, and unplanned, mid-shift moves are also rehearsed regularly.

(v) Natural disaster

Risks from forest fires are mitigated by an ESBN Company Standard – Vegetation Management and Timber Cutting near transmission and DSO 110kV overhead lines. This ensures minimum distances are maintained between vegetation and electricity infrastructure.

- For the transmission network, all trees within falling distance are removed. The height of vegetation is restricted to 3 m underneath the conductors and for a 15 m corridor on both sides.
- For the distribution network, all diseased and unstable trees within falling distance are removed. Vegetation is managed to achieve a clearance of at least 4 m below the conductors and for a 4 m corridor on both sides.

As per the Infrastructure Agreement, specifications, designs and standards can be altered by the TSO to meet changing environmental requirements.

(vi) Primary energy shortage

Natural Gas

The pipeline from which Ireland receives the majority of its natural gas supply from GB was 'twinned' in 2018, providing some additional security of supply. In order to prepare for any potential shortage of supply, Ireland's gas TSO (GNI) undertakes annual gas emergency exercises to test the effectiveness of industry response to a gas supply emergency, including for electricity generation.

CRU Decision CER/09/001[24] '*Secondary Fuel Obligations on Licensed Generation Capacity in the Republic of Ireland*' aims to mitigate against potential loss of generation due to a shortage of gas. The obligation requires that gas generators be able to run at 90% of their rated capacity on a secondary fuel and must hold a predetermined level of stock of that secondary fuel as set out in Table 3. Generators are regularly tested by EirGrid running on secondary fuel and are obliged to provide monthly reports to EirGrid on their secondary fuel stock levels. The report must show the available amount of secondary fuel of the unit running continuously at rated capacity on its primary fuel.

The CRU receives regular updates on the availability of generators on secondary fuel; it has recently been the case that at any given time, one or more generators may not be available to run on secondary fuel, typically due to technical failures. There is work ongoing to monitor and improve this situation.

Table 3 Secondary fuel requirements for each generator type

Primary Fuel Type of the Generating Unit	Requirement to be capable of running on a secondary fuel	Requirement to hold stocks of that fuel

[24] https://www.cru.ie/wp-content/uploads/2009/07/cer09001.pdf

Gas units and CHP units of more than 10MW	Yes	Requirement to hold secondary fuel
Non-gas units such as oil and coal (excluding renewable and peat units)	No requirement	Requirement to hold primary fuel
Renewable units	No requirement	No requirement
CHP units of 10MW and less	No requirement	No requirement
Peat units	No requirement	No requirement

Wind power

The portion of electricity generated from renewable sources in Ireland in 2020 was around 42%. Wind produced around 36% of the total alone, up from 4% in 2005, thus representing a major contributor to generation [25]. The current record for the maximum wind output for Ireland is 3,591MW. The record for the maximum system demand is 5,357MW.

Two forecast vendors are used to provide daily 5-day forecasts, and wind is not currently included in generation outage planning, which minimises the potential impact of forecast errors.

The increasing addition of batteries and interconnection to the system offers options to mitigate shortfalls relating the coincidence of short-term calm conditions with a demand peak.

Progress is currently being made on enhancing the representation of renewables and other aspects of the system in capacity adequacy studies – for example, the current model, AdCal, is being replaced by a more sophisticated unit commitment model, Plexos.

(vii) Human factor

Accidental errors

There is a certification and re-certification program for all roles in the EirGrid control room. This program assesses and tests the grid controllers every two years in their competence to do remote

[25] https://www.seai.ie/publications/Energy-in-Ireland-2021_Final.pdf Table 12

switching on the power system. A review of safety documentation was completed by EirGrid in 2020, covering a number of aspects of the existing safety systems. The outcomes of this report will be actioned in 2021.

It is ESBN policy that only competent persons shall carry out electrical operations on the system. The process of issuing a competency approval for operations on the system includes successful completion of the appropriate training course, followed by mentoring with a competent person for a number of switching programmes as detailed in the procedure. Following completion of these two stages, an assessment process (technical & practical) is in place to confirm that the required competency is in place prior to the authorisation of an approval.

Pandemic and Strike

ESBN has business continuity plans in place which cover a range of potential scenarios including pandemics and industrial disputes. EirGrid has a Group Crisis Management Plan in place (updated Oct 2020) which will be invoked in the event of major incidents. This plan supported by Major Incident Response Plans which are revised from time to time.

(viii) Market failure

The scenario presented in section 1 under 'market failure' relates to unexpected flows occurring between SEM and BETTA via the Moyle or EWIC interconnectors. The operation of the system is such that in the event of a market failure, the EMS (Energy Monitoring System) would indicate any off-schedule flows. The control room can act to put the interconnector back on schedule or if necessary, take mitigating actions such as trading.

Table 4 below summarises the preventative and preparatory measures in place for each scenario type.

(ix) Infrastructure Delivery Deficit

To be included in TSO system planning, and by extension inform future supply/demand margins, non-generation infrastructure projects such as interconnectors must be sufficiently advanced in their development process; for example, have reached financial close and are in a position to start construction. For new generation plants, projects must have been successful in a Capacity Auction.

New capacity in Ireland is procured via the Capacity Remuneration Mechanism. Capacity Auctions are normally held by the TSO four years (T-4 Auctions) before a Capacity Year with additional Auctions for incremental capacity held closer to the Capacity Year, e.g. in the year prior to the Capacity Year start (T-1 Auctions). T-4 Auctions provide for the delivery of new capacity, which is capacity that is yet to be commissioned. New capacity is required to meet a series of milestones after achieving success in a Capacity Auction. This includes a requirement to achieve Substantial Financial Completion (SFC) within 18 months of the Capacity Auction Results Date. To achieve SFC the project must hold, amongst other items, all necessary consents, licences, authorisations and permits in respect of the construction, commissioning, repowering or refurbishment works for the planned capacity. The final date for delivery of the planned capacity is 18 months beyond the start of the Capacity Year.

The viability of proposed new capacity projects is evaluated as part of the Auction process by the System Operators, who additionally have the option to bring in an independent party for further verification of project status. Where projects are deemed unlikely to meet the Auction requirements, including a timely delivery, they can be rejected from the process.

Where Awarded Capacity is terminated by a successful bidder, a termination penalty is applied, which increases proportionally as the Capacity Year in question approaches.

Table 4 Summary of preventative and preparatory measures per scenario category

Scenario category	**Preventative measures**	**Preparatory measures**
Extreme weather	TSO Winter readiness report	TSO Winter Outlook report
		TSO Severe weather plan
		TSO solar storm policy
Malicious	TSO and DSO cybersecurity policies	
	NIS-D regulation	
	Control Centre security	
Primary equipment failure	TSO and DSO technical standards and specifications	
	TSO Outage planning	
	Transmission Asset Maintenance Policy	

	Transmission Protection Maintenance Policy	
	DSO Maintenance & Inspection Procedures	
	DSO Risk Register	
	DSO Capital & Maintenance work programmes	
Technical failure	Training and Certification programme for TSO Control Centre Staff	
		OPTEL back-up telephony system
		IT fail-over servers
		EMS software backup system
		Emergency Control Centre (incl. shift-based training)
Natural disaster	DSO Standard – Vegetation Management and Timber Cutting near transmission and DSO 110kV overhead lines	
Primary energy shortage	Greenlink/Celtic/batteries	
	Ireland-GB Pipeline twinning (2018)	Gas emergency test exercises
		Secondary Fuel Obligation
		TSO Winter Outlook report
		Adequacy studies
		High quality forecasting

Human Factor	Training and Certification programme for TSO Control Centre Staff DSO competency approval for operators	DSO and TSO business continuity plans
Market-related		EMS (Energy Monitoring System)
Infrastructure delivery deficit	Generation Capacity Statement TSO system planning input requirements CRM assessment of viability of timely delivery – proposed new capacity Binding Capacity Auction contracts with termination clauses TSO infrastructure delivery incentivisation under electricity networks regulatory price reviews	Capacity Auctions (T-1, T-2, T-3)

3.1 (c) Demand- and supply-side measures to mitigate an electricity crisis

(i) Criteria and process for activation of demand-side response

Several Demand Side Units currently provide under-frequency response. While disconnection of load is the largest proportion of demand-side response, other sites achieve their response through a combination of fast wind down of processes, dynamic load reduction or displacement of net import from the grid using secondary energy sources such as batteries or fast starting generation.

The response characteristics vary unit by unit; Frequency Restoration Reserve (FRR) will be a system defence measure if a significant deviation remains below 49.50Hz for a minimum of one minute (emergency state). Additionally, demand side units providing static response will have thresholds of between 49.80Hz and 49.30Hz and may also be categorised as a defence measure, depending on the system state active at the time of initiation.

(i) Non-market-based measures

Non-market-based measures shall be activated in an electricity crisis only as a last resort if all market-based measures have been exhausted or where it is evident that market-based measures alone are not sufficient to prevent a further deterioration of the electricity supply situation.

In the above situation, the TSO can call on Temporary Emergency Generation. Temporary Emergency Generation will be dispatched in an Emergency State where it is likely/ imminent that in the period immediately ahead there is a high risk of failing to meet System Demand. In order to ensure that this generation is available at short notice, it may be called upon to synchronise by the TSO during the alert state. Similar measures may be implemented in future to mitigate against the taking of demand control measures.

Demand control (load shedding) has a separate procedure which involves liaison with the Distribution System Operator (see Section 3.1(d)), and which may be utilised if the system is in an Emergency State. Options to disconnect demand would be deployed only after market-based solutions had already been exhausted or where it is evident that market-based measures alone are not sufficient to prevent a further deterioration of the electricity supply situation. This is true for system-wide issues and more localised issues whereby there may be fewer market-based solutions or options available.

3.1 (d) Framework for manual load-shedding

Demand control is concerned with the reduction of demand (load-shedding) in the event of insufficient generation to meet demand, or in the event of breakdown or operating problems relating to frequency, voltage or thermal limits. The all-island approach to demand control is set out in a SEM Business Process[26]. The technical detail on demand control is contained in the EirGrid Grid Code, the EirGrid Demand Control Policy (internal document), and the ESB Distribution System Operator Load Shedding Plan approved by the CRU[27].

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[26] https://www.sem-o.com/documents/general-publications/BP_SO_09.1-Demand-Control-Process.pdf

[27] https://www.esbnetworks.ie/docs/default-source/publications/approved-dso-load-shedding-plan-01.10.2021.pdf?sfvrsn=35e8784a_8

The Grid Code states that demand control or load shedding may occur in the following ways:

- Automatic Load Shedding / Low Frequency Demand Disconnection
- Planned or Emergency Manual Disconnection

Grid Code section OC5 is concerned with the actions of the DSO and TSO in any case where available supply cannot meet demand, through insufficient generation, breakdown or operational issues. Manual Demand Control is specifically covered by Grid Code OC5.4, 'Procedure for the implementation of Demand Control on the Instructions of the TSO', and a description is also included in the SDP.

In the EirGrid Demand Control Policy, Operational Procedures, and ESB Load Shedding Plan there are three types of manual Demand Control available to the TSO and DSO:

- Emergency Load Shedding (Urgent). This type of Demand Control is implemented where demand reduction is required at short notice (less than 1 hour). The DSO will disconnect DSO customers as outlined in its Load Shedding Plan. Large Energy Users connected at 110 kV and above may be instructed to reduce demand should the emergency be sustained for several hours.
- Emergency Load Shedding (Planned). This type of Demand Control is implemented where notice of at least 1 hour can be provided to affected customers. The TSO and DSO will instruct Large Energy Users connected at 110 kV and above to curtail demand. Should a further demand reduction be required, the DSO will disconnect DSO customers as outlined in its Load Shedding Plan.
- Rota Load Shedding. This type of Demand Control is implemented where notice of at least 12 hours can be provided. The DSO will disconnect DSO customers on a rota basis as outlined in its Load Shedding Plan. The TSO and DSO may also instruct Large Energy Users connected at 110 kV and above to curtail demand on a rota basis.

The Emergency Load Shedding procedures are deployed rapidly when the system enters a System Emergency state. The Rota Load Shedding procedure is to be followed where at least 12 hours' notice is available of a protracted generation deficit. The procedures are reviewed and updated periodically.

Special protection against disconnection

As set out in the Distribution Code section OC5.1.4[28], the process of demand control, "*in so far as reasonably practicable does not discriminate against any Customer or Supplier and shall use reasonable endeavours to ensure that the burden is shared fairly among Customers"*. There are two categories of customers, at the time of writing, which are exempted from demand disconnection:

- Customers who are not shed because of the risk either to life or to national security, i.e., hospitals, prisons, airports etc., and
- Larger industrial customers where there is risk of severe consequential loss to production or plant, or where the standard rota shedding system could have severe consequences for employment and the economy.

Some aspects of these criteria and processes for selection of exempt customers are the subject of on-going review by ESBN and may be subject to change following future engagements with CRU. In all of these situations it will be made clear to customers that exemptions are determined by available resources and the need to prevent a total system collapse. Exemption cannot be guaranteed.in all cases.

3.1 (e) Mechanisms to inform the public

The Power System Emergency Communications Plan and Blackstart Emergency Communications Protocol (introduced in section 3.1 (a) (i)) provides for the requirements to inform key stakeholders in the event of a system emergency or blackout state arising on the system. The protocol requires that EirGrid inform the **Energy Press Officers Network (EPON)**, and that meetings are held at a set frequency with this group until the crisis has been resolved.

The EPON consists of communication experts from DECC, CRU, EirGrid, GNI and ESBN, as required, and is chaired by EirGrid's Head of Public Relations. The purpose of the EPON is to ensure the delivery of a consistent national media response in the event of an energy emergency. This is supported by a joint media crisis messaging plan.

Additionally, in the case of any outages resulting in loss of customer electricity supply (including minor network faults and maintenance), ESBN provide a service to the public via their PowerCheck

[28] https://www.esbnetworks.ie/docs/default-source/default-document-library/distribution-code-version-7.pdf?sfvrsn=bbfb01f0_0

website[29], which offers real-time information on the cause for the outage and expected reconnection times. ESBN also provide social media updates.

3.2 Regional and bilateral procedures and measures

A synchronous system and single electricity market (SEM[30]) are in operation over two jurisdictions within the island of Ireland – Ireland and Northern Ireland (NI). The transmission system in Ireland is operated by EirGrid, whilst SONI is the TSO for Northern Ireland. Following Brexit, Article 9 and Annexe 4 of the Northern Ireland Protocol ensure the continued operation of the SEM and the continuing application of EU energy market rules in NI concerning generation, transmission, distribution and supply of electricity, trading in wholesale electricity or cross-border exchanges in electricity.

Two interconnectors are currently in operation between the island of Ireland and Great Britain (GB). The EU-UK Trade and Cooperation Agreement provides for the development of electricity trading arrangements across the interconnectors.

It is anticipated that following the development of the proposed Celtic Interconnector (expected to connect in 2026[31]), Ireland will likely join the Central region[32].

3.2 (a) Mechanisms for cooperation and coordination within the region

3.2 (b) Regional and bilateral technical, legal and financial arrangements

3.2 (c) Mechanisms for cooperation with 3rd countries within the relevant synchronous area

This section considers those mechanisms relevant to cooperation/coordination between NI and Ireland, and between the SEM and GB.

Regulation (EU) 2017/2196, Network Code on Electricity Emergency and Restoration (NCER)

The System Defence Plan (SDP) and the Power System Restoration Plan (PSRP) described in Section 3.1 were developed by EirGrid in accordance with the NCER. In accordance with the principles of the NCER Article 5 (Consultation and Coordination) and Article 6 (Regional Coordination), the measures set out in the SDP and PSRP have been developed such that they

[29] https://www.esb.ie/esb-networks/powercheck/index.html
[30] https://www.semcommittee.com/about-us
[31] http://www.eirgridgroup.com/the-grid/projects/celtic-interconnector/the-project/
[32] ACER definition of System Operation Regions (29th june 2021)

are consistent with those contained within the SDP and PSRP for NI, as developed by SONI. The measures included in the SDP shall not lead the TSO's transmission system or the interconnected transmission systems into Emergency or Blackout states.

NCER Article 14 (Inter-TSO assistance and coordination in emergency state) obliges the TSOs to provide assistance to interconnected TSOs, including specific actions in the case of DC-connected systems, provided this would not cause an emergency or blackout state to occur on their own system.

Regulation (EU) 2017/1485 establishing a guideline on electricity transmission system operation (System Operation Guideline or SOGL)

Part IV of the SOGL, entitled Load Frequency Control (LFC) & Reserves, recognises that relatively small synchronous areas such as in IE/NI require operational flexibility when compared with larger synchronous areas such as continental Europe as well as specific time varying influence of network connectivity and technology in the energy mix in determining how system operators' processes and reserve services meet the system quality criteria. This flexibility is achieved through the development of agreements and methodologies.

In accordance with Articles 118, 119 and 120 of SOGL, EirGrid and SONI jointly developed a Synchronous Area operational agreement (SAOA) [33], an LFC Block operational agreement (LFCBOA)[34], and an LFC Area operational agreement[35], allocating responsibilities for operating the frequency restoration process. The methodologies contained in the LFC Area operational agreement for Ireland and Northern Ireland ensure application of the principles of proportionality and non-discrimination; transparency; optimisation between the highest overall efficiency and lowest total costs for all industry stakeholders and consumers; and use of market-based mechanisms as far as possible, to promote frequency quality and operational security.

Regulation (EU) 2016/1388 Network Code on Demand Connection

Regulation (EU) 2016/1447 Network Code on High voltage direct current connections.

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[33] https://www.eirgridgroup.com/site-files/library/EirGrid/SAOA-for-the-Ireland-and-Northern-Ireland-Synchronous-area-V3.0-(post-co....pdf

[34] https://www.eirgridgroup.com/site-files/library/EirGrid/LFC-Block-Proposal-Submission-for-Ireland-and-Northern-Ireland-V2.0-(for-consultation-post-RfA).pdf

[35] https://www.eirgridgroup.com/site-files/library/EirGrid/S3-LFC-Area-Operational-Agreement-for-Ireland-and-Northern-Ireland-16.12.2019.pdf

Both the above regulations specifically refer to a requirement for harmonising frequency-related requirements across a synchronous system, and the latter particularly with regard to the connection of cross-border HVDC links.

TSO Licence conditions

The TSO Licence under which EirGrid operates contains multiple provisions for cooperation and coordination with its NI counterpart, SONI. These include terms relevant to an emergency situation, *inter alia*:

- the two transmission systems shall operate in a coordinated manner,
- the interests of consumers in both jurisdictions will be protected,
- planning and development will be consulted upon and carried out in a coordinated fashion,
- there will be cooperation in contracting of ancillary services,
- provision of information to interconnected system operators.

Interconnector Operating Protocols

There are two interconnector operating protocols in place for each HVDC link connecting the island of Ireland to Great Britain. The purpose of the protocols is to provide a common point of reference to cover issues associated with the operation of the links. They describe processes to be followed where there is an interface between the relevant system operators in the areas of outage planning, day ahead and intraday user data and transfer programme agreement, real-time operation including crisis scenarios/system warnings, and post-event review and general management. The protocols contain specific provisions relating to requests for emergency assistance and the responses to be provided.

3.2 (d) Technical, legal and financial arrangements

There are a number of arrangements in place under the SEM that cover the technical, legal and financial arrangements related to cooperation and coordination between the two jurisdictions, and with GB via the interconnectors.

System Operator Agreement

The System Operator Agreement (SOA) between EirGrid, SONI and the Single Electricity Market Operator (SEM-O) contains the technical, legal, financial and governance arrangements that are in place between the three entities.

Internal System Alerts Procedure Ireland and Northern Ireland

BP SO_9.2- Declaration of System Alerts is the SEM business process that contains the criteria for the establishment of an alert state in each jurisdiction and determines the processes and responsibilities for communicating the changes in alert state to relevant parties.

Demand Disconnection Procedure

BP_SO_9.1 Demand Control Process sets out the processes, responsibilities and information flows associated with a requirement for load-shedding under emergency conditions in either of the jurisdictions.

Trading and settlement code

The SEM Trading and Settlement Code (TSC) contains rules and procedures governing the sale and purchase of wholesale electricity in the SEM and includes specific procedures for the continuation of market activities during system restoration.

Interconnector operations and trading

A number of business processes cover operational and trading arrangements on the HVDC interconnectors with GB (National Grid Electricity Transmission, NGET). These include:

- BP_SO 11.2 Cross-border Trading between EirGrid/SONI and NGET[36] which relates to the exchange of energy across the Moyle and EWIC interconnectors in close to real-time
- BP_SO 11.4 Coordinated third party trading[37] details a mechanism available to alter the physical flows on the interconnectors in advance of the Cross Border Balancing timeframes
- BP_SO_11.3 Interconnector Emergency Actions identifies two interconnector actions that can be taken by the TSOS in a crisis, or potential crisis, situation:
    - **Emergency Assistance** is an increase or decrease in active energy into the requesting TSO transmission system. It is required in extreme cases when one of the parties foresees a difficulty in meeting the expected demand on its system or foresees a difficulty in maintaining security on its transmission system. Emergency Assistance will be assumed available for each TSO to instruct unless specifically withdrawn or a system warning has been issued.

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[36] https://www.sem-o.com/documents/general-publications/BP_SO_11.2_CBB_Trading_between_EirGrid_SONI_and_NGET.pdf
[37] https://www.sem-o.com/documents/general-publications/BP_SO_11.4_Coordinated_Third-Party_Trading.pdf

- **Emergency Instruction** is used for either safety, system security or demand control. If EirGrid have a shortfall in generation and EWIC transfer is export to GB, then EirGrid may reduce transfer to zero to maintain security of supply.

4. Crisis co-ordinator

The Crisis Coordinator will be the Chief Operating Officer from the TSO, EirGrid. The role of the Crisis Coordinator is to chair the Electricity Emergency Response Team (EERT) (see section 4.1).

4.1 Committees and networks

Electricity Emergency Response Team (EERT)

In the event of an electricity emergency, the EirGrid Chief Operating Officer will chair a group known as the **Electricity Emergency Response Team (EERT)**. This group is comprised of key personnel from the DECC, CRU, GNI, EirGrid and ESB Networks. The forum is used to discuss the electricity situation nationally and in individual regions, to provide outlooks for the power system in 1, 4 and 8 hours' time, to review comms arrangements (e.g. frequency, method, etc) and consider media holding statements and news releases.

National Emergency Co-ordination Group (NECG)

The **National Emergency Coordination Group (NECG)** is a national group, chaired by the relevant government department, and which is convened to manage the planning and delivery of a response to the following emergency situations:

- An emergency that poses a threat to public safety or health, social and economic functioning, damage to infrastructure, property or the environment, and which is on a scale that requires a co-ordinated multi-Agency national level response.
- An emergency requiring that inter-Departmental co-ordination facilities be activated in accordance with provisions of the Framework for Major Emergency Management[38].
- Where the public interest demands national-level co-ordination of a response effort
- Where the Government believes that there is an imperative to raise the response to the national level.

In the context of an energy supply emergency that meets one of the criteria above, DECC will assume the role of Lead Government Department and will convene and chair the NECG, which consists of all Government Departments and the relevant agencies. During an electricity crisis, DECC will facilitate linkage between the EERT and the NECG, and the NECG will manage the national media response via the EPON.

[38] http://mem.ie/wp-content/uploads/2015/05/A-Framework-For-Major-Emergency-Management.pdf

5. Stakeholder consultations

5.1 Consultation on the National Electricity Crisis Scenarios

In collaboration with the TSO, the CRU developed a set of proposed electricity crisis scenarios for Ireland and conducted a risk assessment for these scenarios. A 4-week public consultation was held in November/December 2020 by way of a published consultation paper, and responses invited under the following headings:

- Does the list of scenarios cover the range of events and outcomes that might be expected to cause an electricity crisis in Ireland?
    - If not, please define the potential electricity crisis scenario that you believe to be missing, including where possible a basis for the associated likelihood and impact ratings.
- For any specific scenario, are the overall risk assessment ratings reasonable?
    - If you disagree, please explain the reasoning and provide evidence and/or data to support your argument.

Post-publication of the paper, CRU held meetings with ESBN and GNI as the relevant system operators to provide them with an overview of the consultation topic.

The CRU received 4 responses to the consultation paper, from Bord Gáis Energy, the Irish Energy Storage Association, ESB Generation & Trading and the DSO, ESBN. The key comments made by respondents are summarised below alongside the CRU's response and any consequent changes made to the proposed scenarios and risk assessment (see Section 2).

Q1. Responses	Comments	Action
Proposed additional scenario: a generation shortfall due to plant ageing and narrowing supply margins	Comment has been reflected in the addition of new scenarios	Scenarios added: Primary energy shortage, Primary equipment failure, and Infrastructure delivery deficit
Proposed additional scenario: a situation where different scenarios might be likely to happen simultaneously, e.g. a heatwave/dry spell and a forest fire	The national scenarios were created in a parallel process to the development of regional scenarios by ENTSO-E, in order to have some consistency across EU Member States. The ENTSO-E approach at this time did not cover simultaneous occurrences and this approach has been mirrored with the national scenarios. However, CRU has updated the final version of the Plan in section 1.1 to highlight the potential impact of simultaneous occurrences	None
Proposed additional scenario: a trip of a major generator on the system causing a rapid drop in frequency at a time of high SNSP	The policies, tools and performance monitoring systems established under the EirGrid DS3 Programme aim to ensure that a single unit trip, even during operation at high SNSP, would not be expected to cause a crisis scenario.	None

	A more extreme version of this proposed scenario is captured by the existing scenario, "Simultaneous failure of power system primary elements". For this reason, this additional scenario will not be included here.	
Proposed additional scenario: an unexpected drop in wind speed followed by a failure in the ramp-up/start-up of a large conventional generator	This proposed scenario falls into a similar category as point (b), combining multiple situations. See also the new scenario under 1.2(f).	None
Q2. Responses	**Comments**	**Action**
Flood risk is perhaps underestimated based on recent experience (the last 5 years)	The NRA's assessment of a flood event as "Likely" straddles three of the ENTSO-E's methodology classifications – "Very Likely", "Likely" and "Possible". Whilst we agree that overall, the flood risk could be considered to be in the higher of these three bands, we also have to look at the historical impacts of flooding specifically on electricity supply.	The recent Electricity and Gas Networks Sector Climate Change Adaptation Plan39 indicates that in the coming decades, heavy precipitation events are projected to increase in frequency, and flooding is mentioned as the highest risk to the transmission system due to climate change.

[39] https://www.gov.ie/en/publication/7fcf4-electricity-and-gas-networks-sector-climate-change-adaptation-plan/

	Changing the assigned likelihood to the ENTSO-E 'Likely' category would increase the overall risk assessment rating of this scenario to 'Major', placing it in the same category as a storm event. This does not fit with recent evidence and experience, with storms causing more disruption and potential electricity crisis events (as relevant to this report) than floods. For this reason, we have chosen to keep the original assessment score for this scenario.	There is clearly a need for further data, and in particular, analysis of additional site-specific data which are currently not available, so this has been noted for inclusion in the next iteration of the regulation implementation.
Pandemic scenario – using the NRA rating misses the fact that we could encounter further episodes related to the current COVID pandemic in the near future	It is legitimate to point out that the very near future we may well expect further disruption due to the current pandemic. However, the current evolving pandemic situation would be classified as a slow onset risk. Recent experience has led to the development of related protocols, and further disruptions that would lead to a crisis scenario are not anticipated.	None
Possible overestimate of storm risk due to use of EENS – does not capture the detail of the restoration process	The use of EENS as a measure of impact does indeed fail to capture the specific detail of the evolution of this crisis. However, the use of the metric is as prescribed by the ENTSO-E methodology and is required for consistency.	There is a reasonable case to 'downgrade' the impact of a storm scenario to major, rather than critical; Table 1 has been amended accordingly.

	Taking the picture presented by this response into account does indicate that the initial assessment may have overstated the impact of a storm, particularly considering the national impacts in Ireland compared to the types of storm found in other regions of the EU which may be more significant (e.g., a tornado).	Additional work will be undertaken on this scenario in the next iteration to ensure the most relevant storm conditions for Ireland and their frequency are applied, and that the detail of the restoration process is sufficiently captured in the impact assessment.
Malicious infrastructure attack scenario not broad enough and should include key distribution infrastructure – perhaps with a new scenario	The current scenarios, based on the ENTSO-E regional list, do not differentiate or specify distribution or transmission level infrastructure, and so a new scenario is not considered to be necessary. We fully agree that a distribution-level view must, however, be taken into account when developing the preparedness plans.	Ensure distribution level view taken when developing plans: DSO included in development of draft plan. Footnote included in Section 1.2 to ensure it is clear that distribution level infrastructure is also relevant and will be considered in the RP Plan.
'Local technical failure with regional importance' could be underestimated – if a Bulk Supply Point on the distribution network went down, there's a case to upgrade to critical	The existing scenario description already rates the impact of this scenario as 'critical'. The overall rating is 'minor' as the scenario likelihood is 'unlikely'. Whilst we appreciate that in context, these events may be significant, the methodology is proscribed. It does not seem appropriate to change the likelihood, as to do so	None

	would be to expect a failure with a regularity of more than once in 10 years, which would be an overestimate. It is also considered that the regional relevance of a BSP failure (Inchicore or Finglas or Carrickmines or Poolbeg) is limited.	

5.2 Consultation on the Draft Risk Preparedness Plan

This draft Risk Preparedness Plan has been developed in consultation with the TSO, EirGrid, and the DSO and TAO, ESBN. As such, their feedback and contributions have been included throughout the draft.

The Department for the Economy – Northern Ireland (DfE-NI) and DECC have also been consulted regarding section 3.2, and their comments and feedback incorporated.

Following a public consultation on the draft Risk Preparedness Plan, one response was received from Bord Gáis Energy. The key comments and CRU's response are set out in Table 5.

Table 5 BGE Response and CRU comments

BGE response to consultation	CRU response
Re-iteration of the point made in the previous consultation on scenarios regarding the inclusion of simultaneously occurring crisis events (section 5.1, Q1.b)	See response given in section 5.1.
The plan should include some of the measures recently identified to address short-term security of supply risks in Ireland (see CRU 21115[40]). Some of these measures are likely to be deployed in response to short-term crises scenarios and so should be covered by the Risk Preparedness Plan.	See scenarios added: Primary energy shortage, Primary equipment failure, and Infrastructure delivery deficit. See also 3.1(c) Non-market measures and 3.1(d) where reference is made to recently updated demand control measures, which are now in place.
The provisions made for EirGrid to deviate from the System Alerts Procedure, as was previously understood to have occurred in September 2021	The procedures to be followed in an emergency situation are as set out in Section 3.1(a) of this Plan. The TSO is charged with protecting Security of Supply in a range of challenging operational circumstances. It is expected that procedures will be followed in all eventualities.

[40] https://www.cru.ie/wp-content/uploads/2021/09/CRU21115-Security-of-Electricity-Supply-%E2%80%93-Programme-of-Actions.pdf

Additional insight required on actions to be taken on interconnectors in emergency situations where such information is not commercially sensitive	BP_SO_11.3 Interconnector Emergency Actions referred to in this Plan in Section 3.2(d) is the current information provided to the SEM on the operation of Interconnectors in an emergency situation. A recent Information Paper on Scarcity Pricing and Demand Response in the SEM[41] indicates that there is ongoing work in the area of transparency and access to information within the SEM, which may help to address the respondent's concerns.
Increase frequency of updates to the Risk Preparedness Plan from 4 years to 1 year, given the current circumstances	Where an update is warranted sooner than the anticipated 4-year frequency, this will be undertaken.

[41] https://www.semcommittee.com/sites/semc/files/media-files/SEM-21-083%20Information%20Paper%20on%20Scarcity%20Pricing%20and%20Demand%20Response.pdf

6. Emergency tests

Test/Exercise	Actors (Led by in bold)	Procedures	Date/Cycle
Communications Plan Exercises	**TSO**, Government Department, the Regulatory Authority, Transmission Asset Owner and the Gas Transmission System Operator	Blackstart Emergency Communications Protocol (BECP) Power System Emergency Communications Plan (PSECP)	Annual, Autumn
Secondary Fuel Tests	**TSO**, Gas-fired Generators;	EirGrid Secondary Fuel Test Procedure[42]	Each unit annually if successful
Annual Certification Workshops	Control Room personnel	Training Program for the Certification of Control Staff	Biennial
Blackstart Simulations	**TSO**, Blackstart generators (may include DSO)	One or more Black Start Units in each Black Start Station is tested annually.	

[42] https://www.eirgridgroup.com/site-files/library/EirGrid/Operation-on-Primary_Secondary_Mix-Fuel-Test-Procedure-Template.docx

Appendix: Emergency Communications Register

	System Operations	Operations Charge Engineers	Executive Team	Public Relations	Customers & Connections	Engineering & Asset Mgt	Market Operations On-Call	CRU & DECC	UR &DfE
Alert State(AMBER)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emergency State (RED)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Death or Injury	✓		✓	✓	✓	✓		✓	✓
Security or quality of customer supplies affected[43]	✓	✓	✓	✓					
Customer supplies affected – major outage	✓	✓	✓	✓	✓			✓	✓
Market adversely affected (including NTC)	✓		✓	✓	✓		✓	✓	✓
Environmental incident	✓		✓			✓			
Damage to transmission assets[1]	✓		✓			✓			
Issues likely to attract media attention	✓		✓	✓	✓		✓	✓	✓

[43] *COO should also be informed for the following: (i) any under frequency load shedding of normal tariff customers, (ii) failure of the EMS. If damage to a key transmission station asset causes significant risk to customer supplies then other parties should be appropriately advised*