

GC0183: Generator and Interconnector Availability During a Severe Space Weather Event

Workgroup 1, 05 August 2025

Online Meeting via Teams

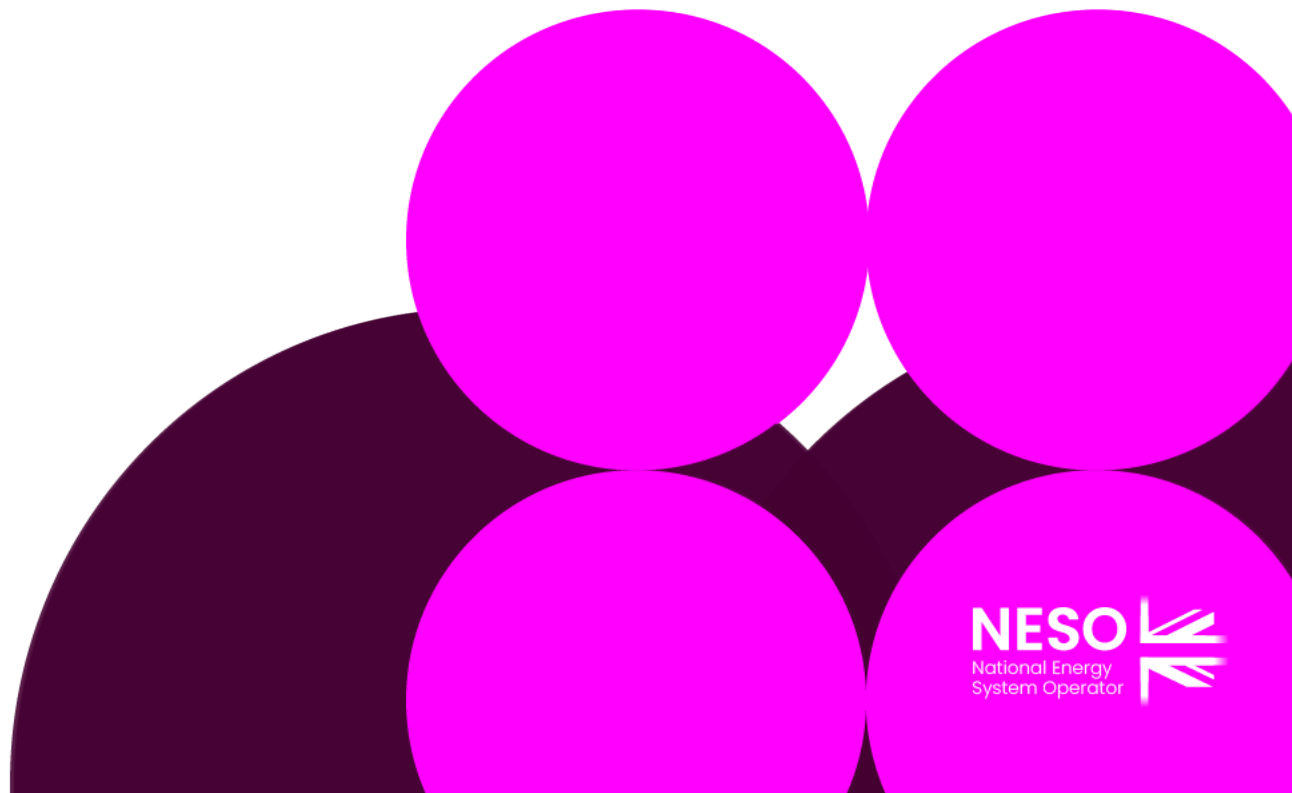
WELCOME

Agenda

Topics to be discussed	Lead
Introductions	Chair
Code Modification Process Overview <ul style="list-style-type: none"> • Workgroup Responsibilities • Workgroup Alternatives and Workgroup Vote 	Chair
Objectives and Timeline <ul style="list-style-type: none"> • Walk-through of the timeline for the modification 	Chair
Review Terms of Reference	All
Proposer's presentation	Proposer
Generator & Interconnector Briefing	Garth Graham
Questions from Workgroup Members	All
Draft Legal Text Discussion	All
Agree Terms of Reference	All
Cross Code Impacts	All
Any Other Business	Chair
Next Steps	Chair

Modification Process

Claire Goult– NESO Code Administrator



Code Modification Process Overview



Refine Solution Workgroups



- If the proposed solution requires further input from industry in order to develop the solution, a Workgroup will be set up.
- The Workgroup will:
 - further refine the solution, in their discussions and by holding a **Workgroup Consultation**;
 - Consider other solutions, and may raise **Alternative Modifications** to be considered alongside the Original Modification;
 - Have a **Workgroup Vote** so views of the Workgroup members can be expressed in the Workgroup Report which is presented to Panel.

Consult Code Administrator Consultation

- The Code Administrator runs a consultation on the **final solution(s)**, to gather final views from industry before a decision is made on the modification.
- After this, the modification report is voted on by Panel who also give their views on the solution.



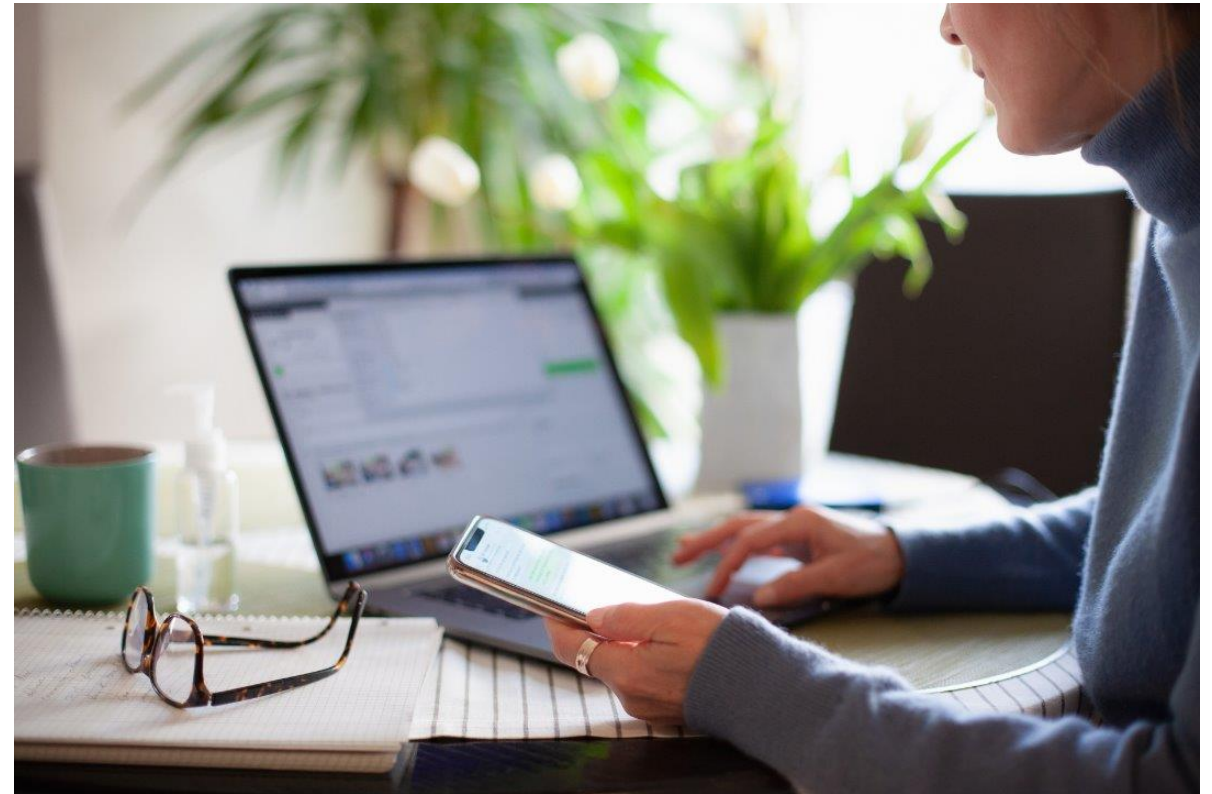
Decision



- Dependent on the Governance Route that was decided by Panel when the modification was raised.
- **Standard Governance:** Ofgem makes the decision on whether or not the modification is implemented.
- **Self-Governance:** Panel makes the decision on whether or not the modification is implemented.
 - An appeals window is opened for 15 days following the Final Self Governance Modification Report being published.

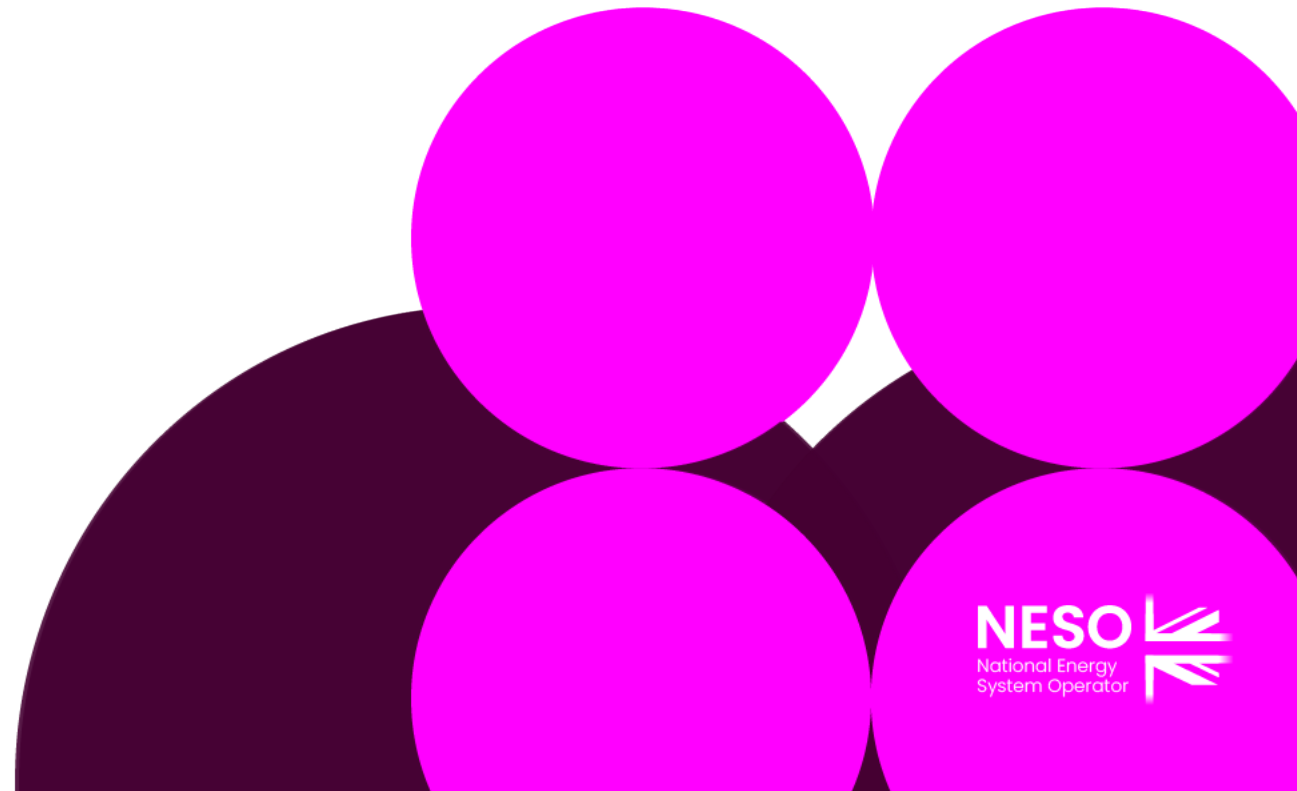
Implement

- The Code Administrator implements the final change which was decided by the Panel / Ofgem on the agreed date.



Workgroup Responsibilities and Membership

Claire Goult – NESO Code Administrator



Expectations of a Workgroup Member

Contribute to the discussion

Be respectful of each other's opinions

Language and Conduct to be consistent with the values of equality and diversity

Do not share commercially sensitive information

Be prepared – Review Papers and Reports ahead of meetings

Complete actions in a timely manner

Keep to agreed scope

Email communications to/cc'ing the .box email

Your Roles

Help refine/develop the solution(s)

Bring forward alternatives as early as possible

Vote on whether or not to proceed with requests for Alternatives

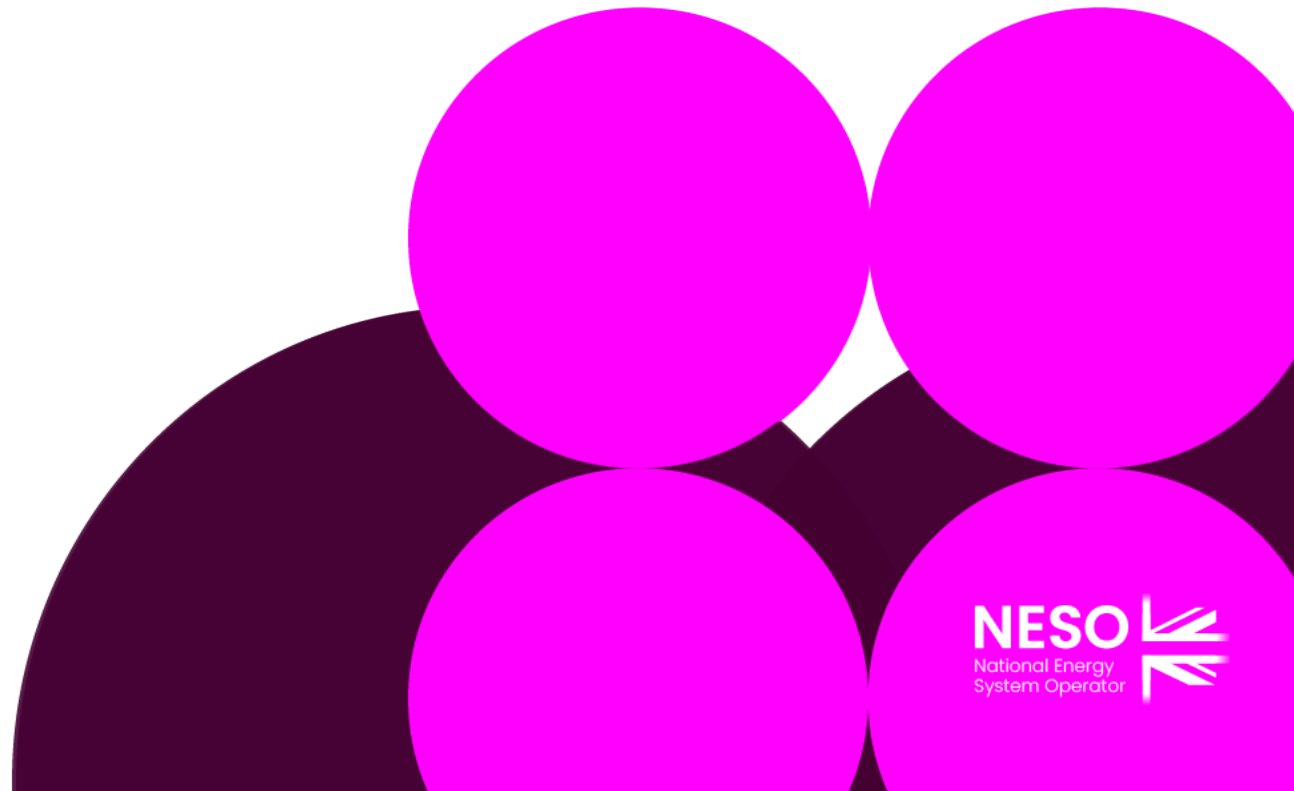
Vote on whether the solution(s) better facilitate the Code Objectives

Workgroup Membership

Role	Name	Alternate	Company
Proposer	Helen Newman		NESO
Workgroup Member	Garth Graham	Andrew Urquhart	SSE Generation
Workgroup Member	Patrick Murphy	Kevin Anaafi-Brown	Eleclink Limited
Workgroup Member	Allan Holton	Graeme Vincent	SP Energy Networks
Workgroup Member	Ross McFarlane		Northern Powergrid
Workgroup Member	Tim Ellingham	Andrew Allan	RWE
Workgroup Member	Charles Dolan		EDF Energy - Hinkley Point C
Workgroup Member	Kevin Cowan	Ali Gill John Reilly	EDF (Existing Nuclear Generation)
Observer	Andrew Larkins		Sygensys
Observer	Calum Beckwith	James Porter	VPI
Observer	Maria Lopez		NESO
NESO SME	Graham Lear	Antony Johnson	NESO
NESO SME	John Zammit-Haber		NESO
Authority Representative	Alice Siri		Ofgem

Workgroup Alternatives and Workgroup Vote

Claire Goult – NESO Code Administrator



What is an Alternative Request?

What is an Alternative Request? The formal starting point for a Workgroup Alternative Modification to be developed which can be raised up until the Workgroup Vote.

What do I need to include in my Alternative Request form? The requirements are the same for a Modification Proposal you need to articulate in writing:

- a description (in reasonable but not excessive detail) of the issue or defect which the proposal seeks to address compared to the current proposed solution(s);
- the reasons why you believe that the proposed alternative request would better facilitate the Applicable Objectives compared with the current proposed solution(s) together with background information;
- where possible, an indication of those parts of the Code which would need amending in order to give effect to (and/or would otherwise be affected by) the proposed alternative request and an indication of the impacts of those amendments or effects; and
- where possible, an indication of the impact of the proposed alternative request on relevant computer systems and processes.

How do Alternative Requests become formal Workgroup Alternative Modifications? The Workgroup will carry out a Vote on Alternatives Requests. If the majority of the Workgroup members or the Workgroup Chair believe the Alternative Request will better facilitate the Applicable Objectives than the current proposed solution(s), the Workgroup will develop it as a Workgroup Alternative Modification.

Who develops the legal text for Workgroup Alternative Modifications? NESO will assist Proposers and Workgroups with the production of draft legal text once a clear solution has been developed to support discussion and understanding of the Workgroup Alternative Modifications.

Can I vote? And What is the Alternative Vote?

To participate in any votes, Workgroup members need to have attended at least 50% of meetings. The vote shall be decided by simple majority of those present at the meeting at which the vote takes place (whether in person or by teleconference)

Stage 1 – Alternative Vote

- Vote on whether Workgroup Alternative Requests should become Workgroup Alternative Grid Code Modifications.
- The Alternative vote is carried out to identify the level of Workgroup support there is for any potential alternative options that have been brought forward by either any member of the Workgroup OR an Industry Participant as part of the Workgroup Consultation.
- **Should the majority of the Workgroup OR the Chair believe that the potential alternative solution may better facilitate the Grid Code objectives than the Original then the potential alternative will be fully developed by the Workgroup with legal text to form a Workgroup Alternative Grid Code modification (WAGCM)** and submitted to the Panel and Authority alongside the Original solution for the Panel Recommendation vote and the Authority decision.

Can I vote? And What is the Workgroup Vote?

To participate in any votes, Workgroup members need to have attended at least 50% of meetings. The vote shall be decided by simple majority of those present at the meeting at which the vote takes place (whether in person or by teleconference).

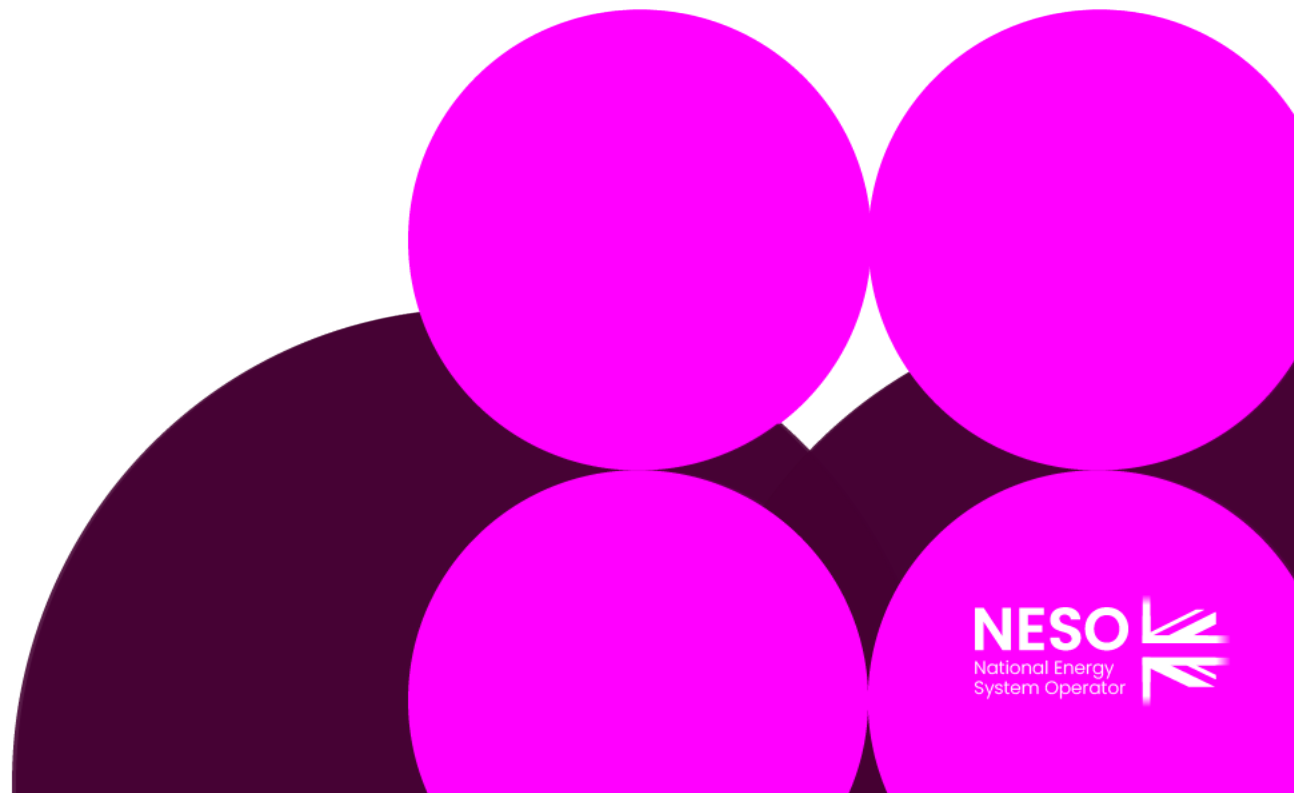
Stage 2 – Workgroup Vote

- 2a) Assess the original and Workgroup Alternative (if there are any) against the relevant Applicable Objectives compared to the baseline (the current code).
- 2b) Vote on which of the options is best.

Alternate Requests cannot be raised after the Stage 2 – Workgroup Vote

Objectives and Timeline

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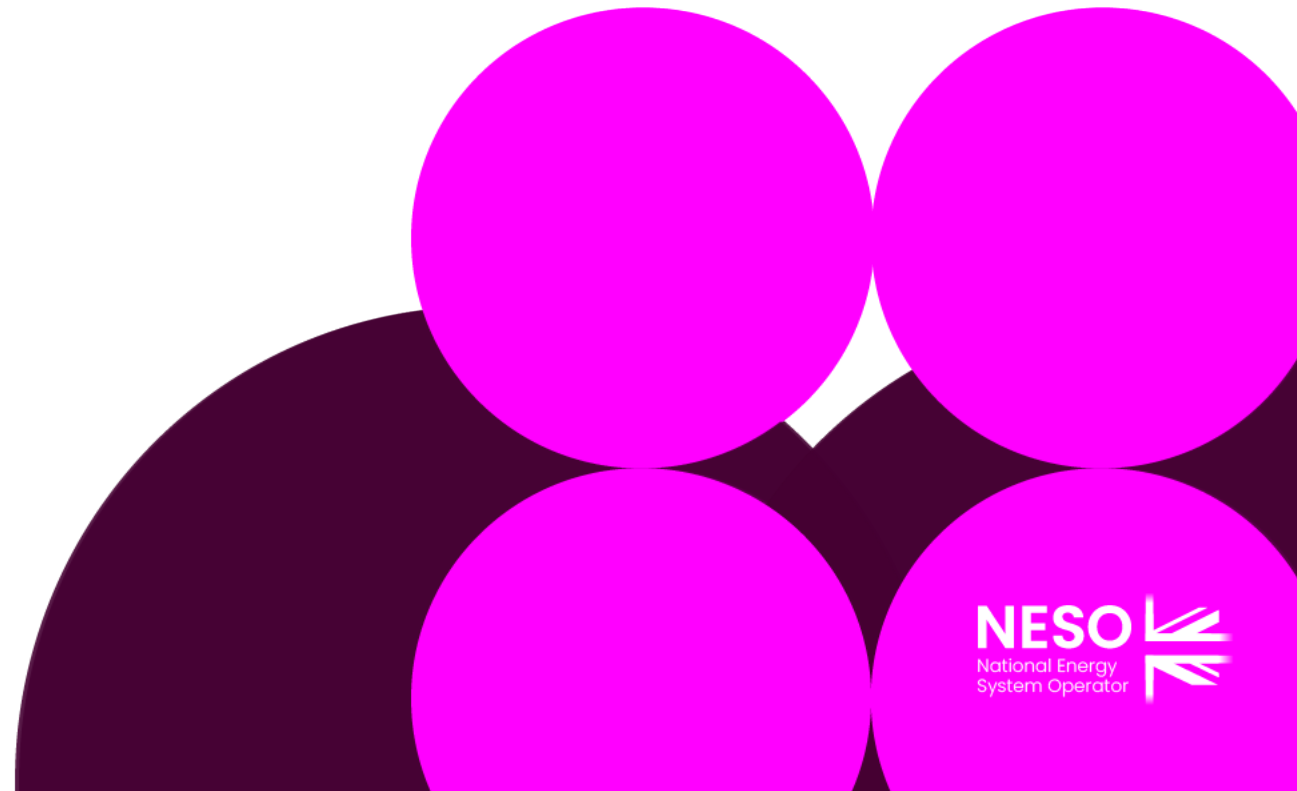


Timeline for GC0183 as of 31 July 2025

Milestone	Date	Milestone	Date
Modification presented to Panel	17 July 2025	Code Administrator Consultation (1 calendar month due to likely impact to Regulated Sections)	19 September 2025 to 20 October 2025
Workgroup Nominations (8 Business Days)	17 July 2025 to 29 July 2025	Draft Final Modification Report (DFMR) issued to Panel (2 Business Days)	27 October 2025
Ofgem grant Urgency	29 July 2025 (5pm)	Panel undertake DFMR recommendation vote	30 October 2025
Workgroup 1 Workgroup 2 Workgroup 3	05 August 2025 11 August 2025 18 August 2025	Final Modification Report issued to Panel to check votes recorded correctly	30 October 2025
Workgroup Consultation (7 Business Days)	19 August 2025 to 29 August 2025	Final Modification Report issued to Ofgem	30 October 2025
Workgroup 4 Workgroup 5	04 September 2025 10 September 2025	Ofgem decision	TBC – requested as soon as possible
Workgroup report issued to Panel (2 Business Days)	15 September 2025	Implementation Date	10 Business Days after implementation
Panel sign off that Workgroup Report has met its Terms of Reference	18 September 2025 (Special Panel required)		

Proposer's Presentation

Helen Newman – NESO



Background – Risk and Mitigation

- The Sun experiences 11-year cycles of solar activity; the peak of this is called Solar Maximum. The Solar Maximum of the current cycle was reached in 2025.
- During Solar Maximum and the following 2–3 years, solar storms that lead to GICs* are statistically more likely.
- GICs can potentially lead to damage to some assets across the electricity system, depending on location, geology and asset design.
- A Space Weather Industry Protocol (SWIP) is currently being drafted by NESO and stakeholders.
- The SWIP workgroup has recognised a risk that some Generators and Interconnectors may potentially alter the operational status of some assets. For example, some assets may cease operations whilst others might reduce output or flow.
- This change in operational status could lead to a shortfall in electricity supply or instability of the GB electricity system.
- To mitigate this risk, NESO will need to understand the intended positions of Interconnectors and Generators in the event of a severe space weather event to ensure the system can be effectively managed in real-time.



***Geomagnetically induced currents (GICs)** are electrical currents induced at the Earth's surface by rapid changes in the geomagnetic field caused by space weather events.

The Proposal

Following initial discussions with industry at the SWIP workgroup, we identified that there are 2 possible routes:

Physical Notification (PN)

Area of code: [BC1.4.2 (a) (2) Day Ahead Submissions]

Purpose: To obligate generators and interconnectors to notify NESO of their position within X number of hours of a space weather Notification being received.



Outage Declaration

Area of code: TBC

Purpose: In the event of a space weather Notification being issued by NESO, Generators and Interconnectors will issue an Outage Declaration to NESO setting out their anticipated availability during and after a severe space weather event.



The Proposal

We now believe that the following option may be more suitable, and we have therefore based the Proposal on this option only.

Output Useable Declaration

Make an amendment to the Grid Code to obligate Generators and Interconnectors to issue a 'Space Weather Outage Declaration' to NESO (and advise the market, via their REMIT (Regulation for Energy Markets Integrity and Transparency) / information submissions), setting out their anticipated availability during and after a severe space weather event, following a space weather Notification being issued by NESO.

NESO issues a **Space Weather Prepare Notification** to control centres and ESIOs and posts the Notification on the BMRS

Generators and Interconnectors issue a **Space Weather Output Useable Declaration** to NESO within 3 hours of receiving the Space Weather Prepare Notification

NESO has visibility of the operational status of key assets in the event of severe space weather, allowing for effective operation of the electricity system

Space Weather Generator & Interconnector Briefing for GC0183

Garth Graham, Workgroup Member

Agenda

- What is it
- Putting the Risk in Context
- Wider Impacts
- Examples of impacts
- Solar cycles
- Typical timescales
- Met Office

What is it

- Space weather refers to the environmental conditions in space, within our solar system, which are influenced by the Sun and the solar wind
- It includes phenomena such as solar flares, coronal mass ejections (CMEs) and high-energy particles
- These phenomena can have a significant effect on the functionality of satellites, power grids and more
- Rapid fluctuations in the Earth's magnetic field, particularly during geomagnetic storms, induce an electric field in the Earth's surface
- This electric field then drives electrical currents to flow through conductive structures; this is known as geomagnetically induced currents (GICs)

[5 minute video]

- [Bing Videos](#)

Putting the Risk in context

- UK Government's latest assessment (page 16):
- [National Risk Register - 2025 edition](#)
- Severe Space Weather: as likely as a pandemic, less likely than a national power outage
- Less impactful than either of those (but might possibly lead to national power outage if assets / capabilities affected by space weather?)

Wider impacts (NRR 2025)

- Impacts may include regional power disruptions, loss or disruption of Global Navigation Satellite Systems (for example Global Positioning System (GPS)) and some telecommunications (for example satellite communications and high frequency radio), disruption to aviation, an increase in background radiation doses at high altitudes and in space, and possible disruption to ground-based digital components
- In the event of electricity transformers needing to be replaced in remote coastal areas, recovery could take several months based upon current replacement transformer availability

Examples of impacts (i)

- Severe space weather events impacting national electricity systems have been experienced in various countries including the UK, New Zealand, South Africa, United States of America, Canada and Sweden
- UK in 1989 had damage to T connected transformers at Indian Queens and Norwich Main

Examples of impacts (ii)

- Coronal Mass Ejections (CMEs) can cause Geomagnetic Storms on Earth and induce extra currents in the ground that can degrade (and in rare cases destroy) transformers
- [Electric Power Transmission | NOAA / NWS Space Weather Prediction Center](#)



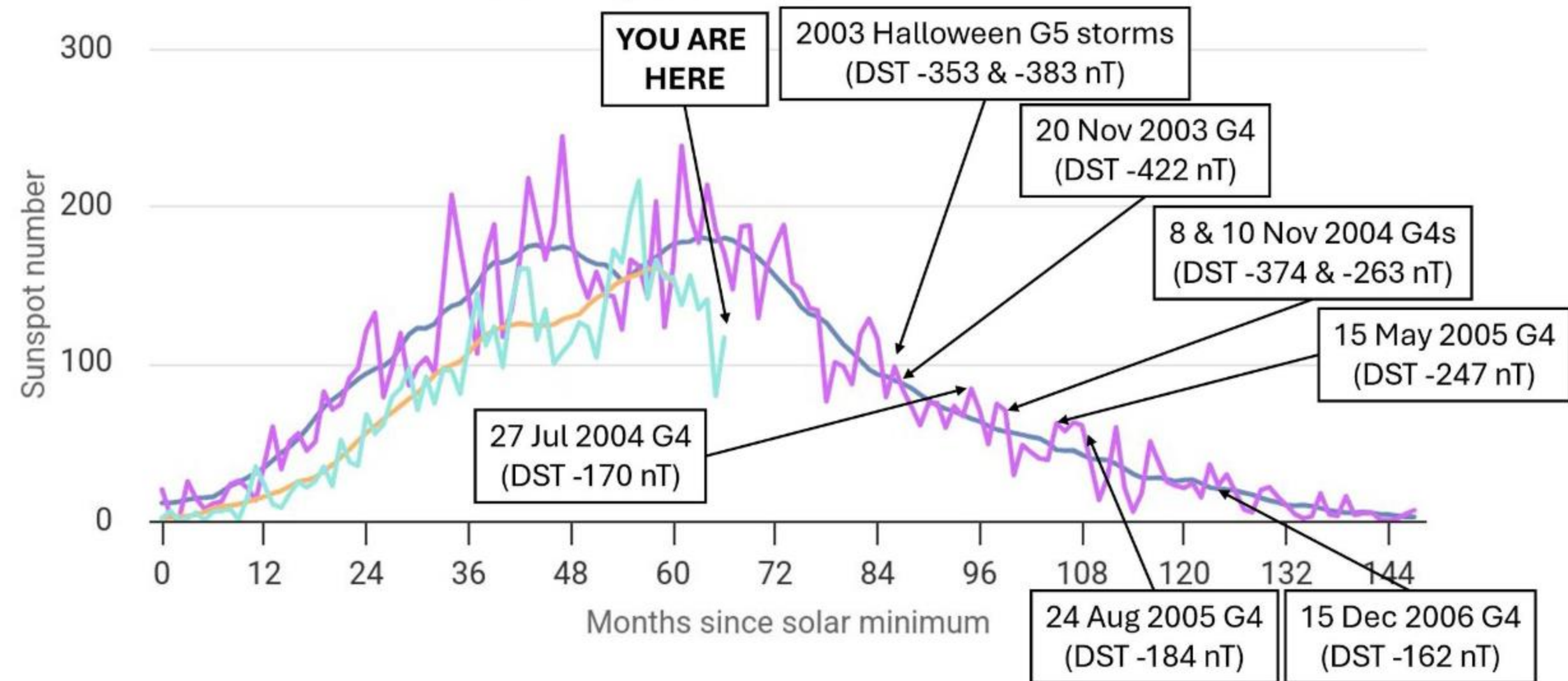
Risk factors

- **Latitude** (countries with a latitude between 40° and 70° , such as the UK, are most likely to experience geomagnetic activity)
- **Geology** (the resistivity of the rock strata the asset sits on)
- **Proximity to the coast** (nearer to / located at the coast, more at risk)
- **Electricity network configuration** (east/west circuits more at risk)
- **Transformer characteristics** (design and earthing/winding resistances, plus those which are single phase or three phase with five-limb are more at risk of damage from GIC effects, especially if they are operated close to their design loading)
- **Connection** (transformer connected to a vulnerable node on the transmission network are at higher risk)

Solar Cycles

- The Sun experiences 11-year cycles of solar activity. The peak of this solar cycle is known as the *Solar Maximum*.
- During the *Solar Maximum*, the number of sunspots on the surface of the Sun increases, this causes an increase in solar activity.
- The most recent *Solar Maximum* was reached in late 2024.
- Solar storms that lead to high levels of GICs are statistically more likely during periods close to the *Solar Maximum* and in the descending phase of the solar cycle (which can last 2-3 years, so from late 2024 to late 2027 after the *Solar Maximum*), but they can also occur at all other times in the solar activity cycle.

Solar cycle comparison



— SC1	— SC2	— SC3	— SC4	— SC5	— SC6	— SC7	— SC8
— SC9	— SC10	— SC11	— SC12	— SC13	— SC14	— SC15	— SC16
— SC17	— SC18	— SC19	— SC20	— SC21	— SC22	— SC23	— SC24

Typical timescales (NRR 2025)

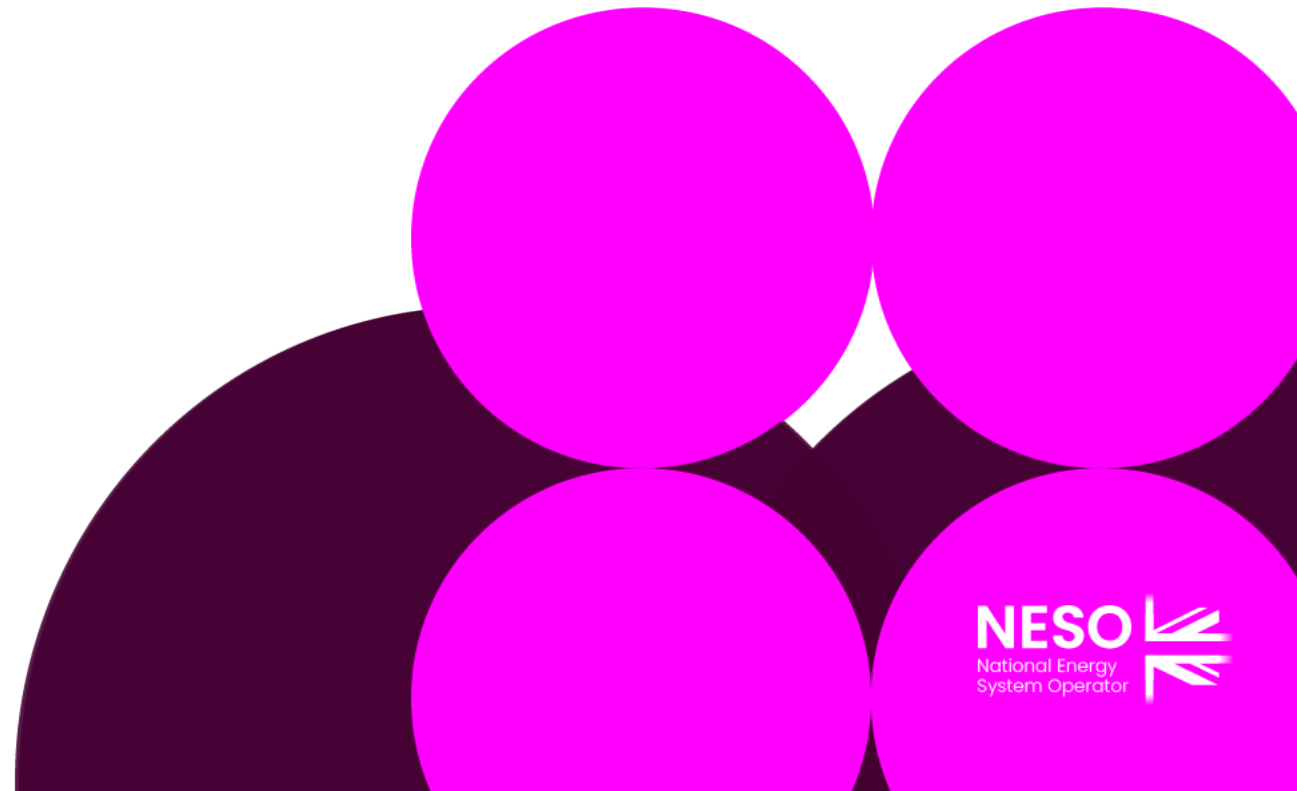
- Reasonable worst-case scenario (based on a severe space weather event, approximately the same scale and magnitude as the Carrington Storm of 1859) lasting for 1-2 weeks.
- Includes a number of different solar phenomena including coronal mass ejections, solar flares, solar radiation storms and solar radio bursts.
- Each phenomenon would likely occur several times during a 2-week period, with each varying in magnitude, temporal and spatial extent.

Working Closely with the Met Office

- Met Office lead for UK Government on space weather
- Met Office Space Weather Operations Centre (MOSWOC) issues notifications when a large, complex region of the sun has been observed, with the potential to lead to severe space weather
- NESO and industry has been working closely with Met Office for the past 15 years on understanding space weather and its effects
- This has included developing the proposed '*Space Weather Industry Protocol*' (which has resulted in GC0183 being raised)

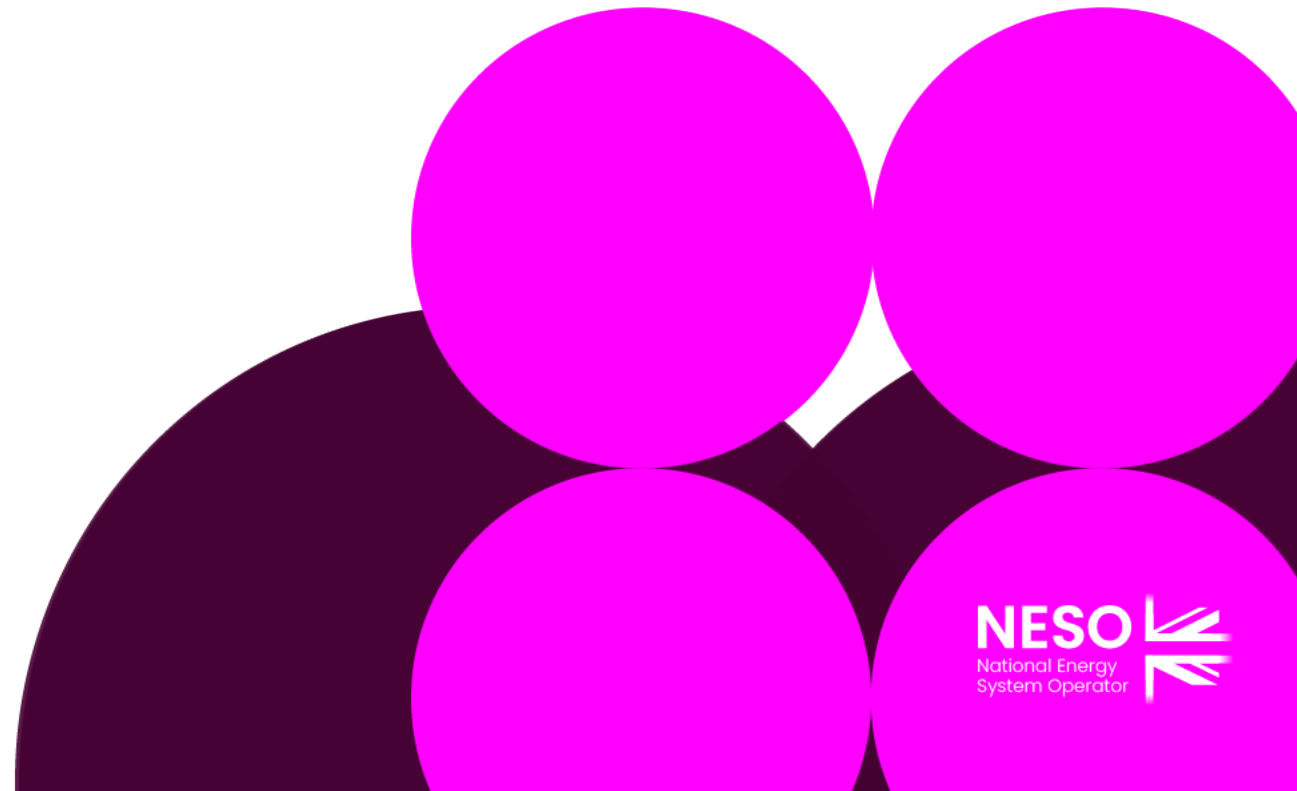
Questions

Draft Legal Text Discussion



Terms of Reference

Claire Goult – NESO Code Administrator



Terms of Reference

Workgroup Terms of Reference

a. Implementation and costs;

b. Review draft legal text should it have been provided. If legal text is not submitted within the Grid Code Modification Proposal the Workgroup should be instructed to assist in the developing of the legal text;

c. Consider whether any further Industry experts or stakeholders should be invited to participate within the Workgroup to ensure that all potentially affected stakeholders have the opportunity to be represented in the Workgroup. Demonstrate what has been done to cover this clearly in the report; and

d. Consider implications to sections linked to the Regulated Sections of the Grid Code

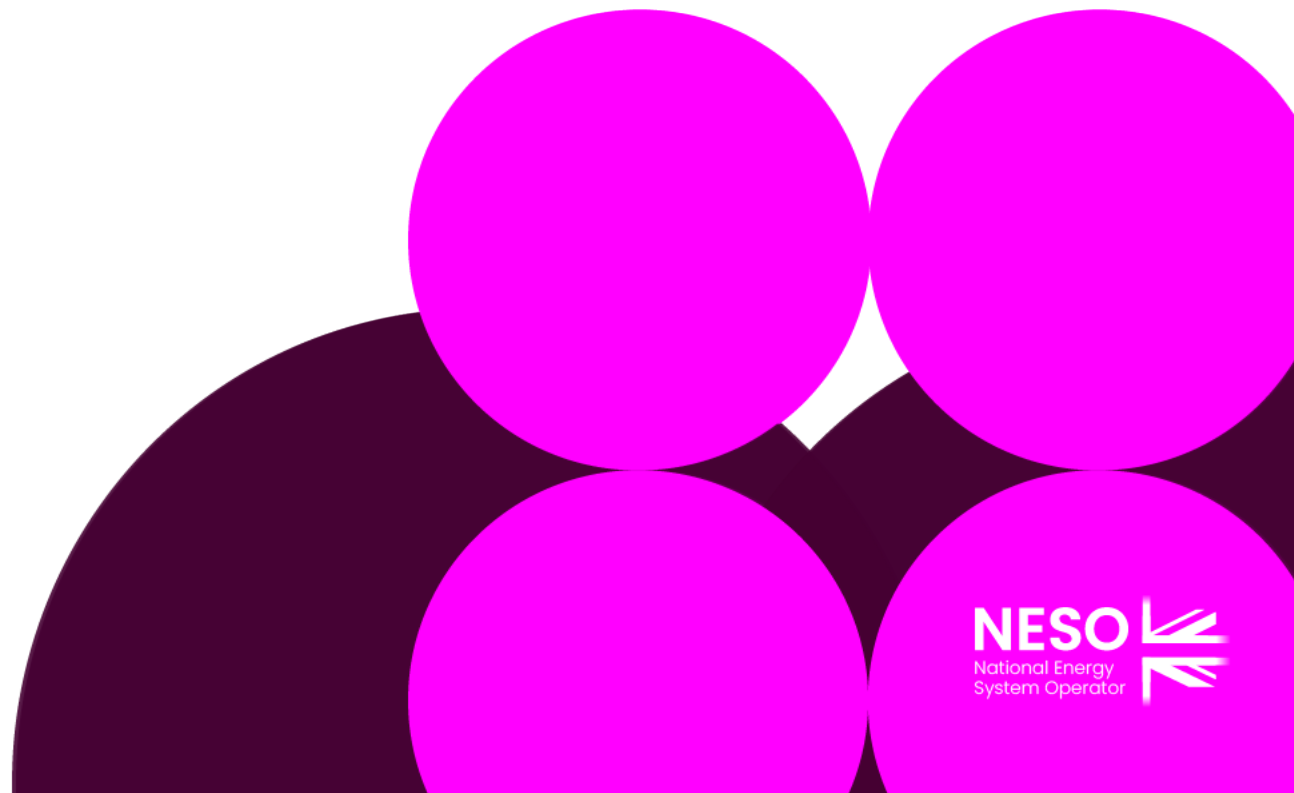
e. Consider the scope of work identified and whether this is achievable within the timeframe outlined in the Ofgem Urgency decision letter.

f. Identify interactions with other Industry related processes dealing with the issue and consider ways in which information should be incorporated. Where relevant suggest ways in which these might be taken forward.

g. Consider interaction with other obligations on stakeholders e.g. obligations relating to reporting of events under OC7.

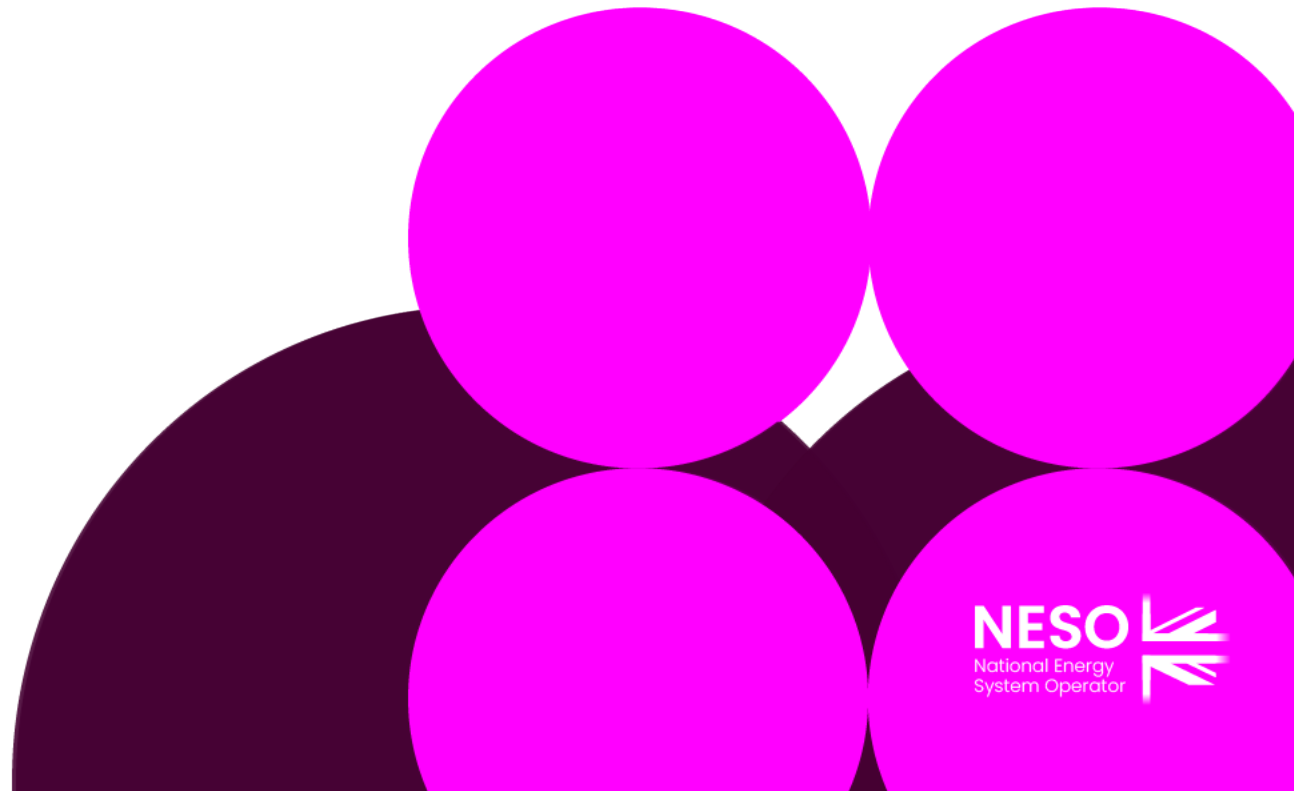
Cross Code Impacts

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Any Other Business

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Next Steps

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