Electricity Storage Network

Battery Energy Storage Systems Explained

REGEN

Overview

The Electricity Storage Network (ESN) is the industry group and voice for grid-scale electricity storage in Great Britain, managed by Regen since 2018.

Battery energy storage systems (BESS) are large grid-scale battery storage projects that charge and discharge electricity to help provide flexibility and support renewable energy integration. BESS plays a crucial role in keeping the lights on and maintaining power quality in GB.

This document aims to set out the facts on common misunderstandings about BESS. We refer to BESS as battery storage throughout this report.

Membership

The ESN has 100 members and 600 professionals developing, operating and supplying grid-scale storage in the GB market. This includes representation from publicly listed specialist investment funds focusing on storage and independent developers that have raised several billion pounds to invest in this technology.

How much battery storage do we need?

The UK government has outlined an ambition for 23 GW to 27 GW of grid-scale battery storage in 2030.[1] The National Energy System Operator estimates 39 GW is needed by 2050 under their Holistic Transition pathway.[2]

1. DESNZ, 2024. Clean Power 2030 action plan
2. NESO, 2025. Future Energy Scenarios 2025: Pathways to Net Zero

Contents

The benefits of battery storage

Reducing bills

Battery storage is already saving consumers millions of pounds on bills through lower balancing costs.[3] It enables more homegrown wind and solar power to be harnessed, replaces expensive high-carbon options, shifts power to when it's needed and provides critical services that support a cleaner and cheaper energy system.

Unsubsidised

The GB battery storage market is already world-leading in terms of scale and maturity, having developed without direct subsidy since 2016. Costs have fallen rapidly as technology has improved, making it one of the few technology types that can deliver at scale ahead of 2030 without requiring direct government support or additional costs on bills.[4]

Improving energy security

Battery storage is uniquely placed to help stabilise the electricity network, making it more reliable and affordable. Power cuts are much less likely thanks to our existing fleet of battery storage in GB that can respond in less than a second to disturbances on the grid.[5]

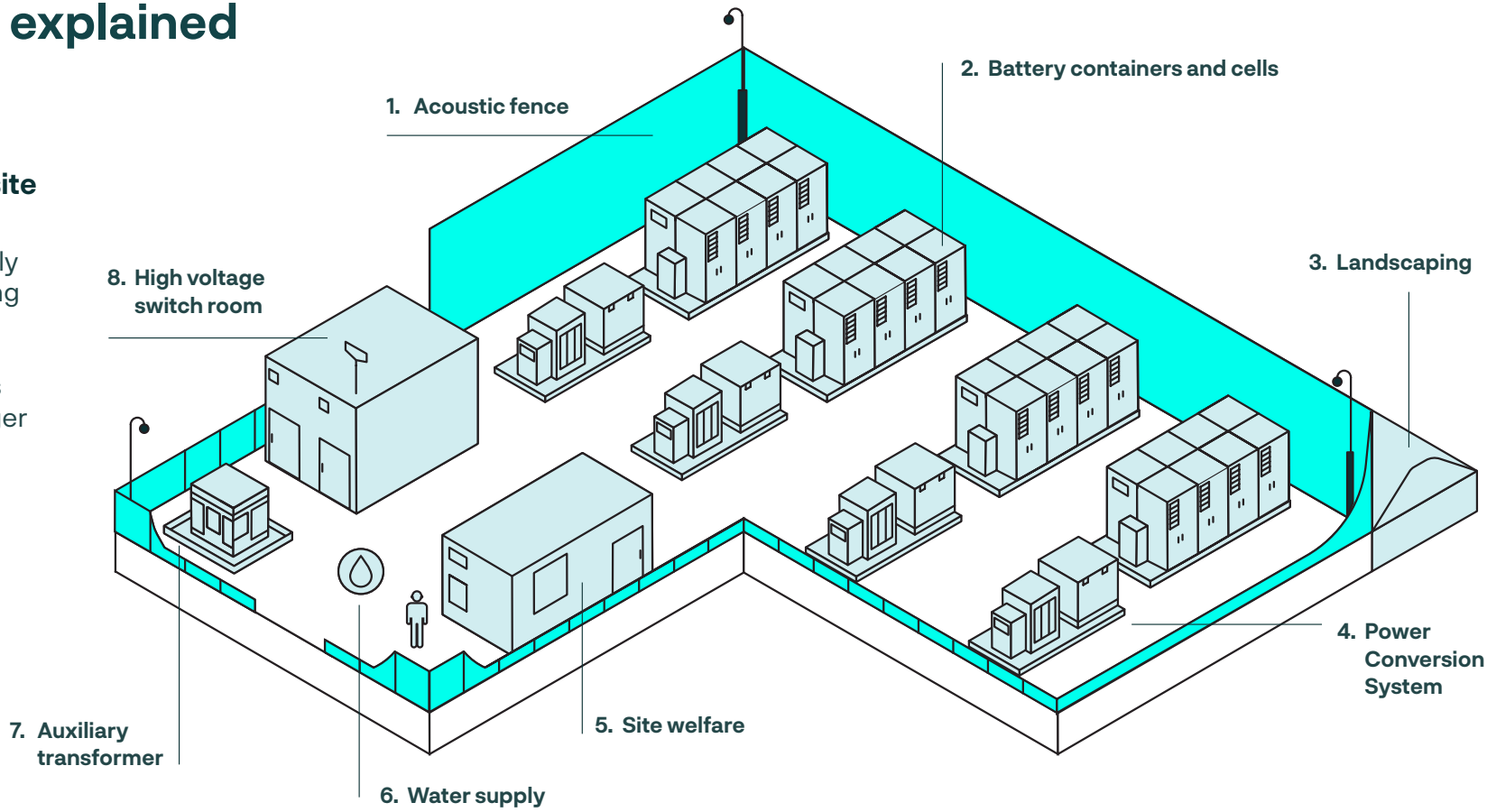
3. Modo Energy, 2025. Do batteries save consumer costs in Great Britain?
4. BloombergNEF, 2025. Lithium-Ion Battery Pack Prices Fall to $108 Per Kilowatt-Hour, Despite Rising Metal Prices
5. Ofgem, 2025. Frequency Risk and Control Report 2025 Consultation

Image: Harmony Energy

Battery storage explained

A typical battery storage site

Most sites contain the same types of components, with only quantities changing depending on the desired power (MW) and duration (hours). Larger transmission-connected sites will comprise significantly larger switchgear and transformer equipment suitable for 132 kV - 400 kV connections.



This drawing of a typical battery storage site is for illustrative purposes only. Site layout will vary depending on size, hardware, location, etc.

1. **Acoustic fence**
   Depending on the site, this may be required to reduce noise.
2. **Battery cells**
   The Li-Ion battery cells are collated into modules and arranged in racks, housed within a container. This can be a shipping container or other cabinet depending on the manufacturer and site. Monitoring and safety systems are integrated into these containers.
3. **Landscaping**
   Depending on the site, trees and hedging may be used to enhance biodiversity and visual screening, with a buffer from the perimeter to help reduce fire risk.
4. **Power Conversion System**
   The Power Conversion System uses inverters to convert the electricity from DC to AC and transforms to step up or step down voltages to allow it to connect to the network.
5. **Site welfare**
   Typically a site office and toilets.
6. **Water supply**
   From storage tanks, mains or other sources.
7. **Auxiliary transformer**
   Supplies low-voltage power to other systems on the site (e.g. monitoring).
8. **High voltage switch room**
   Contains switchgear and other equipment that controls and protects the flow of electricity.

Industry action to improve safety

Safety improvements

In the UK, developers follow robust safety protocols guided by Health and Safety Executive and National Fire Chiefs Council (NFCC) guidance.

While battery storage is still an emerging sector, the industry has learned a great deal as the technology has matured, leading to significant advances in safety standards and best practice. Sites are designed to prevent fire incidents with different levels of monitoring and safety. If an incident does occur, sites are designed to minimise the environmental impact and ensure a rapid, effective emergency response.

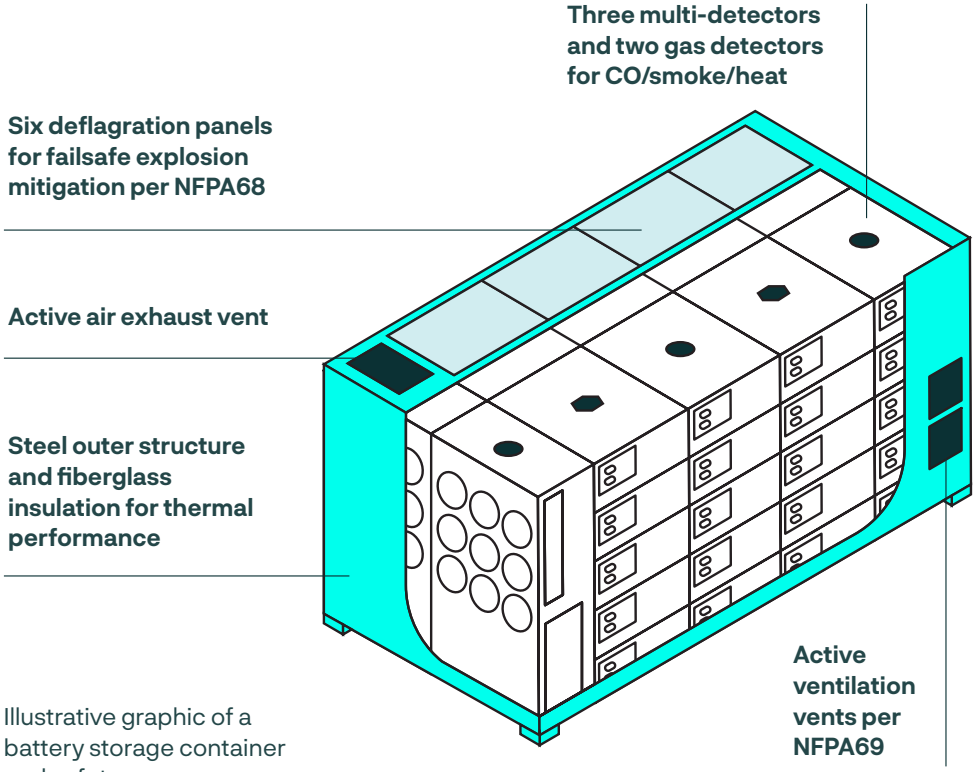
The insurance sector also plays an important role in enforcing safety standards, as all projects require cover to secure funding and operate. Insurers effectively enforce an additional layer of safety standards based on globally recognised standards, helping ensure sites remain safe for people, property and the environment.

Actual UK experience shows incidents are rare and contained, with only a handful documented.[6] In every case, the fire was contained to the affected battery container.

International data collected by the Electric Power Research Institute shows the rate of failure incidents has fallen sharply (around 97% globally between 2018 and 2023) as lessons from early failures have been incorporated into safer designs, detection systems and operational best practices.

Regulatory framework

UK battery storage facilities operate under a strong regulatory framework. The Health and Safety Executive oversees workplace safety and risk management, while planning approvals require detailed emergency response and safety management plans developed with local Fire and Rescue Services. Environmental safeguards are incorporated to protect soil and waterways and an additional environmental permitting process for battery storage is being developed.



Illustrative graphic of a battery storage container and safety measures

Design evolution

Battery storage design has evolved significantly, with newer systems using modular containers, improved detection and suppression technologies, and layouts that support targeted response by emergency services. Developers continually review and enhance safety measures so new projects adopt the latest technology, operational procedures and lessons learned. This ensures that UK battery storage remains safe, environmentally responsible and tightly regulated.

6. House of Commons Library, 2025. Battery energy storage systems (BESS)

Key topics

The following pages explore 10 key topics relevant to battery storage project sites, setting out the latest industry thinking and good practice, with a focus on how these issues are being addressed across the sector today.

1. What is the risk of fires in large battery storage systems?

Battery storage fires are very rare and are carefully managed with strong safety measures, occurring less frequently than fires in other non-domestic buildings in England.

The risk of fire in battery storage systems comes from 'thermal runaway', where a damaged battery cell overheats and produces heat faster than it can be released. As large battery storage systems contain many individual cells, there is a small risk that one failing cell could affect neighbouring ones. However, cells are specifically engineered to prevent this.

Modern battery storage uses the same lithium-ion technology found in mobile phones and laptops, but with industrial-grade safety built in at every stage of design and operation. These include multiple layers of protection, such as smoke sensors, fire suppression systems, careful spacing between units and emergency procedures that are developed in collaboration with local fire services. International best-practice standards also guide safe design and operation.

With strong safety controls in place, battery fires are very rare. Current data shows that fire rates at these sites (0.7%) are lower than those for other non-domestic buildings in England (0.8%). Incidents are typically contained quickly, keeping the overall risk to the public very low.[7]

7. Department for Energy Security and Net Zero, 2025. Clean Flexibility Roadmap

2. What measures prevent firefighting water from harming the environment?

Water is carefully controlled during battery-storage fires and is primarily used to prevent fire from spreading to adjacent units, rather than to extinguish flames. This can reduce water use and environmental impacts.

The NFCC provides guidance on battery storage fires. In line with this guidance, if a fire does occur, water is applied strategically to protect adjacent containers and contain the incident, employing a controlled-burn approach to the affected container. Specialised battery technology and appropriate spacing prevent the fire from spreading.

Battery storage sites are designed with safety in mind, including plans for managing water in an emergency. Firefighting water can mix with battery electrolytes and other chemicals during a fire. To manage this, battery storage sites can be designed with containment measures, such as bunds, interceptors, lined drainage or storage areas, to prevent runoff from entering soil or waterways.

Following NFCC guidance, operators develop robust outline battery safety management and emergency response plans alongside local fire and rescue services, ensuring that water use, containment and fire response are managed in accordance with regulatory requirements. Lessons from rare incidents are shared across the industry and with fire and rescue services to support future responses.

Image: Zenobe

A controlled-burn approach for battery storage fires

The NFCC guidance acknowledges that battery storage fires are difficult to extinguish and that using large volumes of water can generate large volumes of contaminated firewater runoff, which could impact the environment. To address this, the NFCC describes a managed or “controlled-burn” approach as the prevailing firefighting tactic in many battery storage incidents. In practice, this means:

— Allowing the affected battery container to safely burn itself out under controlled conditions
— Using water defensively for boundary cooling to protect neighbouring containers and prevent fire spread
— Focusing on containing the fire, rather than aggressive extinguishment using water, to minimise runoff and environmental harm.

Image: Harmony Energy

3. What measures prevent fire plumes at battery sites from harming the environment?

Developers should follow the NFCC guidance to ensure suitable environmental protection measures are used.

The environmental consequences of battery storage fires have been studied through real-world incidents, experiments and monitoring, and show minimal long-term impact compared to other industrial fires.[8]

Airborne emissions, such as carbon dioxide and trace chemicals like hydrofluoric acid, are largely confined to the fire site and disperse rapidly into the atmosphere.[9] Developers are aware of the potential impact on neighbouring buildings and take this into account in emergency planning and response. Smoke plumes from a fire naturally rise above building heights, helping to minimise effects on nearby properties. Rapid dispersion also keeps concentrations below flammability or toxic limits.

8. Fire & Risk Alliance, LLC, 2025. Assessment of Potential Impacts of Fires at BESS Facilities
9. American Clean Power, 2025. Assessment of Potential Impacts of Fires at BESS Facilities

4. How are locations for battery sites chosen?

Battery sites are usually located near substations or renewable projects to strengthen the grid.

Battery storage systems are needed across the electricity grid to balance supply and demand and support renewable energy integration. By storing electricity when supply exceeds demand and releasing it when needed, they can reduce the need for costly network upgrades.

Locations are chosen based on where storage will provide the most benefit, considering factors such as where the electricity is generated and consumed, the timeline for grid connection and whether substations have the capacity to accommodate new connections. Site-specific factors, including but not limited to, landscape, ecology, safety and flood risk are also assessed.

Battery systems must connect to existing grid infrastructure to import and export power as needed. Therefore, many projects are built next to existing substations or co-located with renewable developments such as solar farms, where the infrastructure can be shared. Close proximity avoids lengthy transmission cables, maximises grid stability and minimises environmental impact and cost.

5. How do battery storage projects mitigate impacts on farmland, wildlife and the environment?

Planning policies and environmental assessments ensure that high-quality farmland and ecologically sensitive areas are avoided where possible. Where farmland is used, developments are designed to minimise disruption.

Not all battery storage projects are built on agricultural land, but because they must be located near existing electricity infrastructure, many are. In GB, there are roughly 17 million hectares of farmland,[10] yet in 2025, the total area used for grid-scale battery storage is only about 125 hectares[11] – equivalent to just 0.0007% of agricultural land, or roughly 190 football pitches - representing a small percentage of farmland with minimal impact on overall agricultural productivity.

Developments avoid high-quality farmland and ecologically sensitive habitats where possible, and where farmland is used, battery storage sites are designed to minimise impact. Sites are often located next to substations or renewable energy developments, further reducing land-use pressures. Developers are also required to deliver a minimum 10% biodiversity net gain in England, offsetting ecological impacts through measures such as wildflower meadows, pollinator-friendly habitats, hedgerows, orchards and grasslands.[12]

10. Department for Environment, Food and Rural Affairs, 2025. Agricultural Land Use in United Kingdom at 1 June 2025
11. Based on the current 6.8 GW of operational battery storage capacity and assuming an average density of 22 MW per, as observed in recent projects – referencing the red line boundary
12. Department for Environment, Food and Rural Affairs, 2025. Understanding biodiversity net gain

6. How could a battery storage site affect local views and surrounding landscape?

Battery storage sites are designed to minimise visual impact on local communities where possible using profile layouts, hedgerows and screening.

During the planning process, a Landscape and Visual Assessment (LVA) is typically submitted to evaluate the potential direct and indirect effects of a proposed battery site on the surrounding landscape. This includes considering views from nearby homes, public rights of way and sensitive natural areas. The impact will depend on the scale of the site and local context. Larger battery storage sites are being deployed as the technology continues to mature, which can have increased landscape and visual impacts.

Where impacts are identified, mitigation measures are implemented, where possible. Common approaches include planting hedgerows and trees, installing earth mounds as screening, fencing, or adjusting the site's layout and orientation to reduce visibility. Battery storage units themselves are usually compact, low-rise and designed to minimise contrast with the surroundings. Combining these measures helps ensure that the overall visual impact is limited and considerate of the local environment.

Imagery: top Harmony Energy, below Eku Energy

7. Are battery storage sites noisy?

Battery storage sites are generally quiet. Most noise comes from fans and inverters and sites are designed to meet strict noise limits and minimise impact.

Batteries themselves are quiet, with most sound coming from fans, inverters, air conditioning and transformers. Systems are designed to operate efficiently and quietly to minimise noise. Key factors include the technology used and the existing background noise in the area (e.g. road noise).

Battery storage systems are designed to be considerate of nearby communities. Before a site is built, a Noise Acoustic Impact Assessment is carried out and approved by the local Environmental Health Officer, with the system designed to meet strict noise limits set by the local authority. Where needed, mitigation measures such as barriers or enclosures are used, ensuring that the noise from the site is minimal.

During construction, temporary noise from site activities and vehicles is managed through a Construction Environmental Management Plan, or similar.

Imagery: top Zenobe, below Eku Energy

Image: Gore Street Capital

8. Will building a battery storage site significantly disrupt local roads or traffic?

Building a battery storage site usually causes limited disruption. Most deliveries are standard-sized and any larger vehicles carefully managed with local authorities for safe traffic.

The latest battery storage systems are usually made up of 20ft or 40ft containers that do not interfere with normal traffic. The heaviest traffic occurs during groundworks and container installation, which can take longer for larger sites. Later stages involve fewer vehicles, with visits mainly for commissioning and operational checks.

For larger projects, delivery of heavy transformers may require one-off, abnormal load movements, and laying of grid cables may involve temporary road closures with stop/start traffic management, which must be approved by the local authority in compliance with the project's road opening license. Careful planning and coordination with local authorities ensure that any disruption to residents and traffic is minimised. A construction Transport Management Plan is typically included in battery storage planning applications and covers delivery routes, timing of abnormal loads, HGV numbers and hours, access arrangements, traffic management and liaison with traffic authorities, where required. Once operational, traffic to the site is very low and is limited to routine maintenance visits as sites are not permanently manned.

9. Could we be exposed to electromagnetic fields near battery storage sites?

The batteries themselves don't generate electromagnetic waves. Other electrical equipment on a site can emit electromagnetic fields and safe limits are informed by the UK Health and Security Agency.

All electrical equipment produces some level of electromagnetic fields. The battery storage cells do not emit electromagnetic fields, but the supporting electrical infrastructure does when active. The levels created at a battery storage site are typically low and do not travel far from the equipment. This is because magnetic fields quickly weaken as they move away from the source, so any effects are confined to the immediate areas around the batteries. Main contributors to a site include inverters, transformers and switchgear, which are well understood from other technologies and have limits and regulations set by government with input from the UK Health and Security Agency.[13]

10. Could a cyberattack on battery storage sites disrupt the power grid?

Battery storage systems have strong cybersecurity and safeguards. With advanced protections, failsafes and regulations.

As battery storage is integrated into the electricity grid, it could become a target for cyber threats. To prevent unauthorised access, these systems incorporate layers of cybersecurity, including encryption, authentication, intrusion detection and network segmentation.

Battery storage sites are designed for operational resilience. If a threat is detected, grid compliance requirements ensure that systems disconnect from the network, isolate themselves or operate autonomously, preventing disruption from spreading across the grid. Large-scale installations are managed under strict ownership and operational protocols, overseen by the UK National Cyber Security Centre, which sets standards and provides guidance for critical energy infrastructure. Cybersecurity regulations are being reviewed and the industry is working with the UK government and the energy regulator to update standards, regulations and best practice.

13. National Grid, 2026. EMFs.info

Additional resources

Learn more

To learn more about battery storage safety, technology and regulations, the following resources are available:

— NFCC Guidance on Battery Energy Storage Systems
— HSE Energy Storage Safety Guidance
— Assessing battery energy storage systems applications

Community engagement

Open conversations between developers and communities help inform decisions about new projects. Regen's best-practice guide in community engagement offers practical advice and examples to support conversations at every stage.

Developers value community input. Local consultation events, asking questions and sharing concerns help ensure projects are designed with both safety and community priorities in mind.

Membership

The Electricity Storage Network, managed by Regen, is the only industry body dedicated to grid-scale storage in GB.

Get in touch if you'd like to speak to us. Please reach out to ESN lead Olly Frankland - ofrankland@regen.co.uk

Regen provides independent, evidence-led insight and advice in support of our mission to transform the UK's energy system for a net zero future. We know that a transformation of this scale will require engaging the whole of society in a just transition.

Visit regen.co.uk to find out more about our work

Image: Pulse Clean Energy

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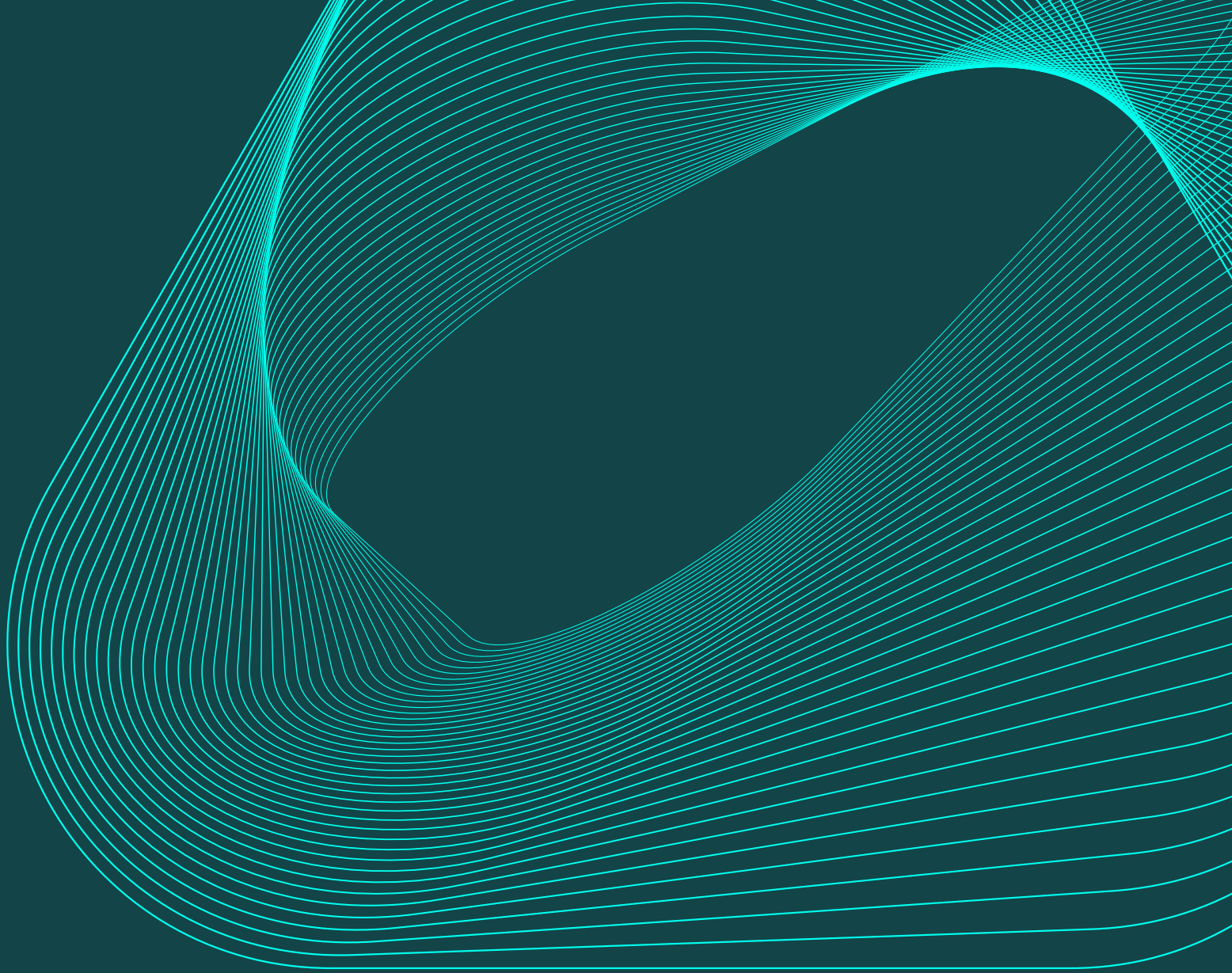

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