Association of University Engineers

Newcastle University

THE MODERN UNIVERSITY ESTATE

ENGINEERING AND ENVIRONMENTAL COMPLIANCE

ANNUAL CONFERENCE 2025 | 3 - 5 SEPTEMBER

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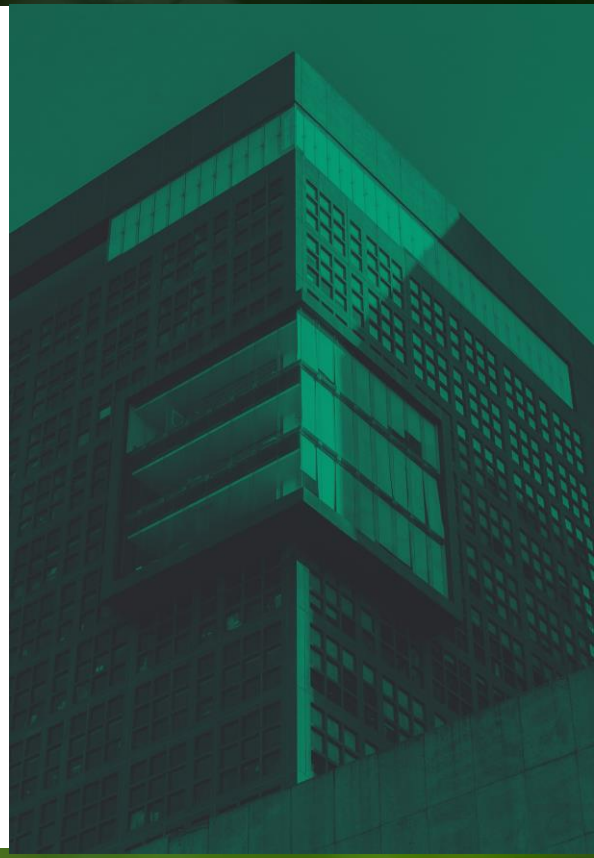
Where buildings come alive

// Common Power Challenges for University Estates Aiming for Net Zero Carbon

Mr N. Mistry
Dr S.J. Ball

// INTRODUCTION

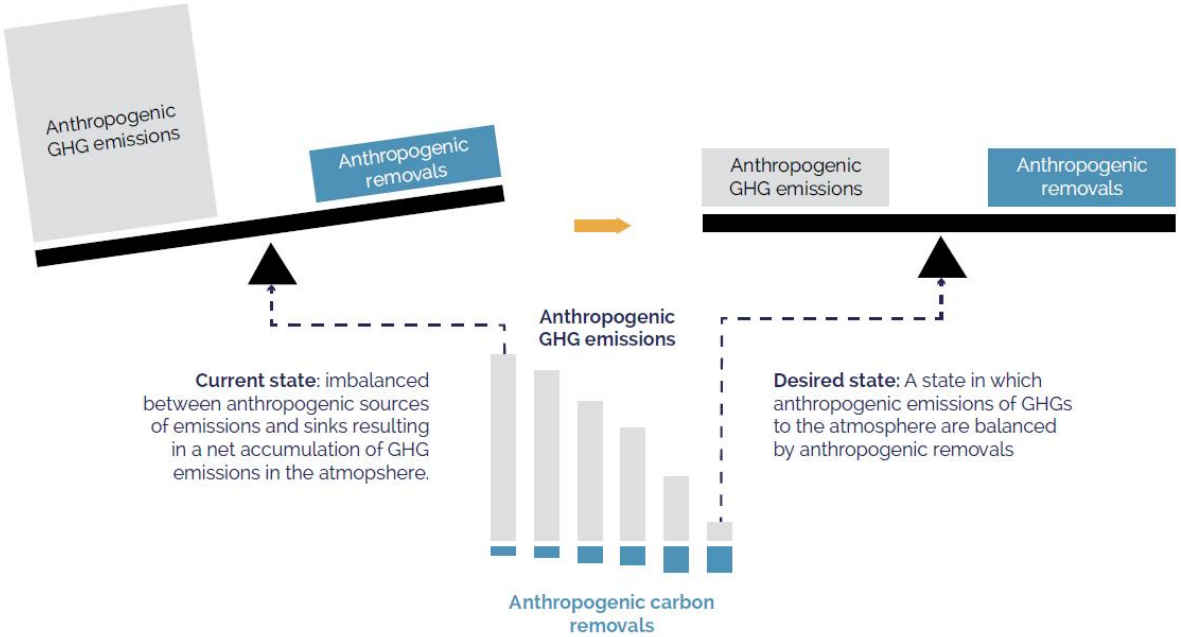
- Net Zero Carbon – Background
- UK Net Zero Carbon Buildings Standard
- Grid Decarbonisation
- National Electricity Grid
- Grid Connection Challenges
- HV Solutions – Case Studies



// Net Zero Carbon – Background

// NET-ZERO EMISSIONS AT THE PLANETARY LEVEL

To reach a state in which human activity no longer contributes to global warming means achieving a state in which anthropogenic Greenhouse Gas (GHG) emissions no longer accumulate in the atmosphere: a state known as **Net-zero Emissions**



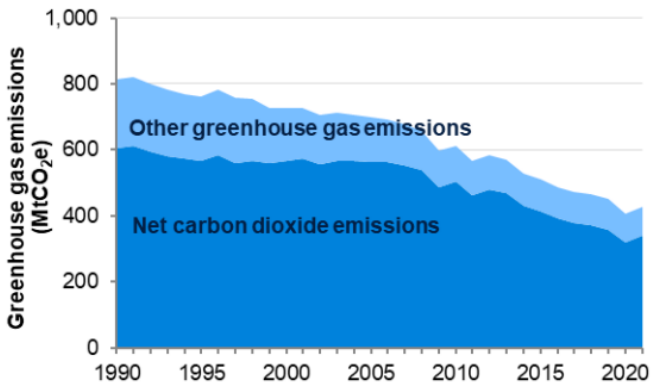
Anthropogenic: originating in human activity

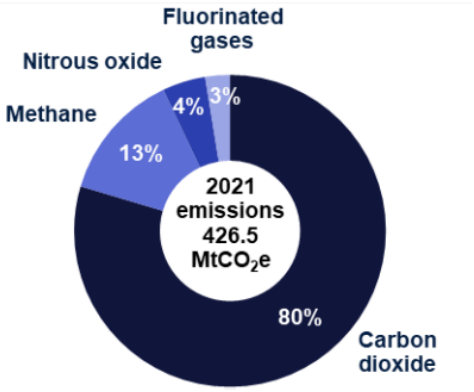
// GREENHOUSE GASES

Greenhouse Gases (GHGs) – (Often referred to as 'Carbon Emissions' in general usage): Gases (both natural and anthropogenic) which absorb and re-emit infrared radiation, thereby trapping it in the Earth's atmosphere. Includes – as defined by the Intergovernmental Panel on Climate Change (IPCC):

Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur Hexafluoride (SF_6)

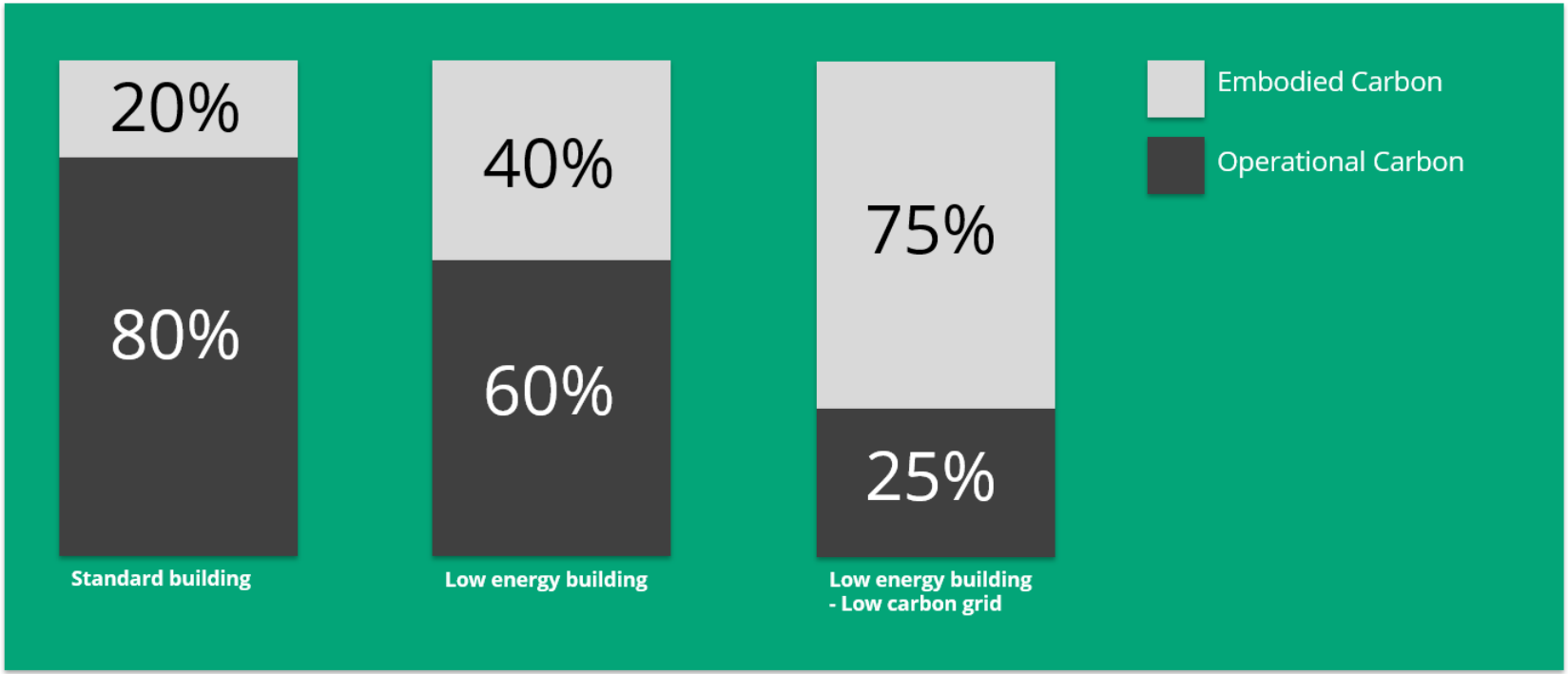
UK territorial greenhouse gas emissions, 1990-2021



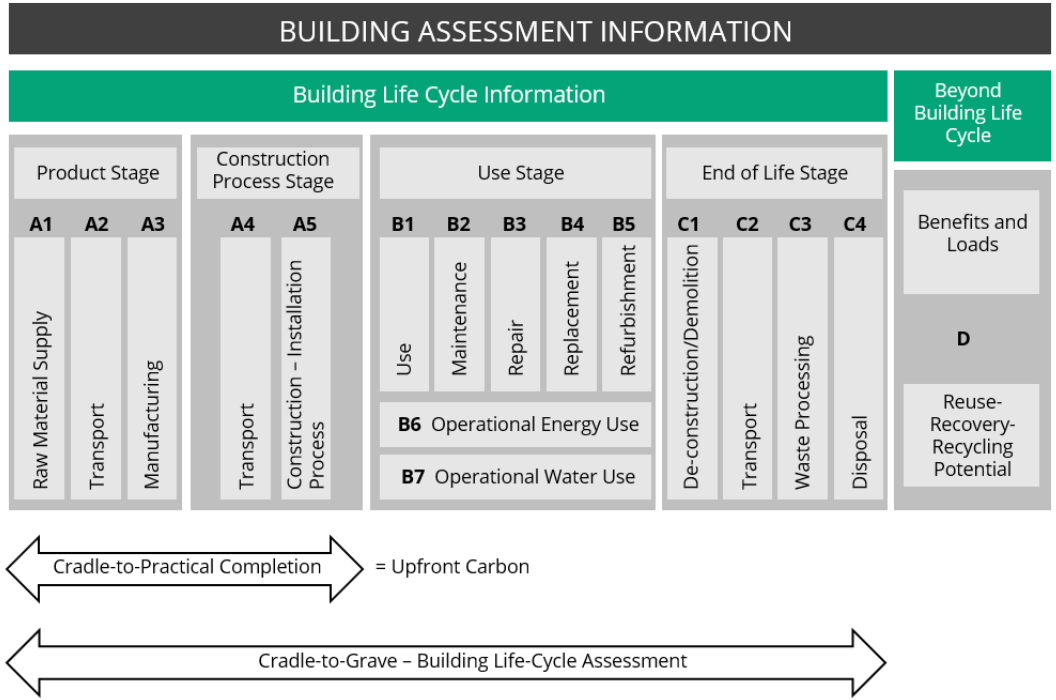


// NET-ZERO CARBON AT A BUILDING/ESTATE LEVEL

// OPERATIONAL vs EMBODIED CARBON



// LIFE-CYCLE MODULES BS EN 15978



// UK Net Zero Carbon Buildings Standard

// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

- Pilot Version Published in September 2024
- 3-years to get to this point
- Version 1 due December 2025

Creates a unified definition for:

- **‘Net Zero Carbon Aligned Buildings’** or
- **‘Net Zero Carbon Aligned Buildings (plus offsets)’**

in the UK to reduce spurious claims and accelerate the design, construction and use of buildings that deliver lower-carbon outcomes

// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

Key Technical Principles

- Informed by climate science (science-based)
- Adopts a whole life approach to net zero and includes both operational and embodied carbon
- Prioritises energy efficiency and elimination of the performance gap by using measured performance data
- Prioritises the reuse of existing buildings and assets
- Enhances renewable energy generation
- Encourages demand management, so that buildings can support electrification and grid decarbonisation

// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

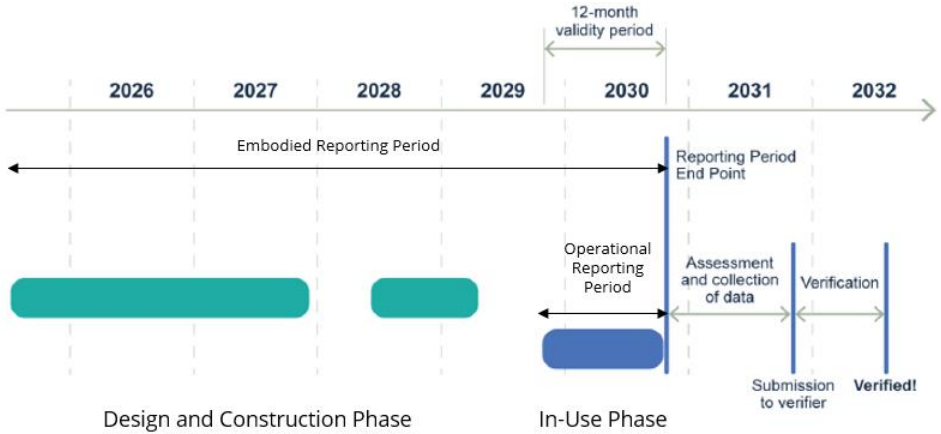
- Covers 13 sectors
- Separate Guidance for **New Builds** and **Refurbishments**

Homes	Sport and Leisure	Hotels
Offices	Retail	Commercial Residential
Schools	Culture and Entertainment	Storage and Distribution
Healthcare	Science and Technology	Datacentres
	Higher Education	

// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

In-Use Standard

Verification Process:



// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

Limits set for:

- **Upfront Carbon:** The carbon emissions generated during the initial stages of a building's life-cycle
- **Operational Energy**: Energy consumption during the use phase
- **Fossil Fuel Free:** Ensuring no fossil fuels are used on site
- **District Heating and Cooling Networks:** Reducing energy demand by using shared resources
- **Refrigerants:** Minimising harmful emissions from cooling systems
- **Space Heating Delivered:** Ensuring efficient heating systems

Targets set for:

- **On-site Renewable Energy Generation:** Encouraging renewable energy sources to meet building demands

// UK NET ZERO CARBON BUILDINGS STANDARD (UK NZCBS)

Reporting requirements for:

- **Life-Cycle Embodied Carbon:** Reporting the total carbon emissions associated with materials and construction processes across a building's entire life-cycle
- **Operational Water Use:** Monitoring and reporting water consumption during a building's use phase
- **Electricity Demand:** Tracking the building's total electricity consumption
- **Heating and Cooling Delivered:** Reporting the energy used for maintaining indoor temperatures

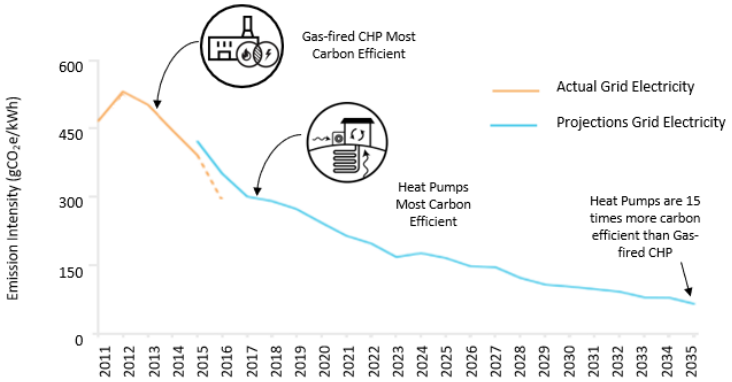
Optional reporting requirement for **Carbon Offsetting**, allowing projects to voluntarily disclose offset actions, although the focus remains on minimising direct emissions

// Grid Decarbonisation

// GRID DECARBONISATION – POWER

Over the past decade:

- Significant shift in the way electricity is generated in the UK
- Proliferation of Embedded Generation from Renewable Sources
- Managed decline in the use of coal-fired power stations
- Electricity Grid Emission Factors have reduced significantly
- **Part L 2013: 519gCO_2e/kWhr**
- **Part L 2021 (average): 136gCO_2e/kWhr**

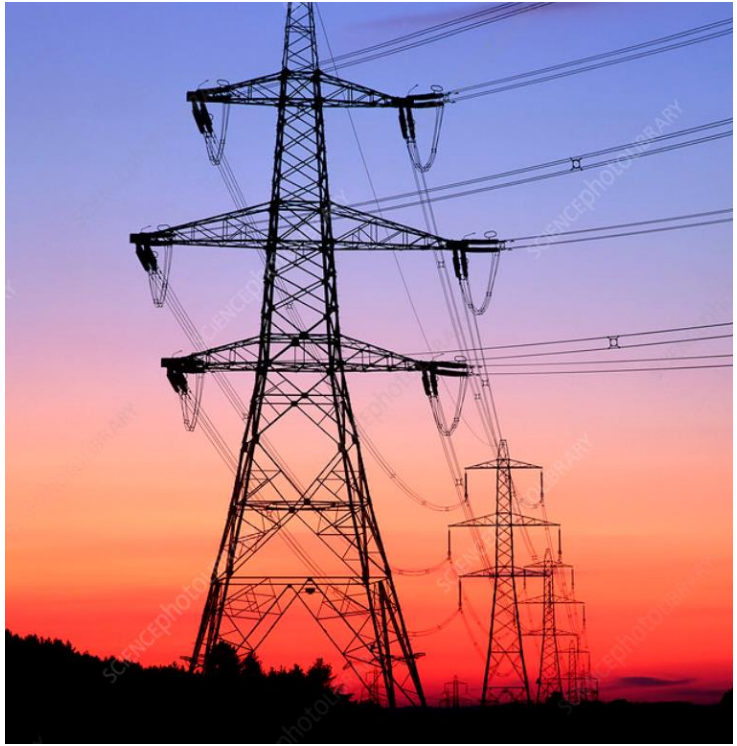


// GRID DECARBONISATION – POWER

Grid Connection **Delays** are Threatening **Net Zero Goals**

- Issues connecting embedded generation projects (PV/Wind)
- District Network Operators (DNOs) – Just say 'No'
- Major Reinforcement works are required: New Transmission Circuits and Grid Supply Points
- Delays of 10-15 years are not uncommon

Power is King



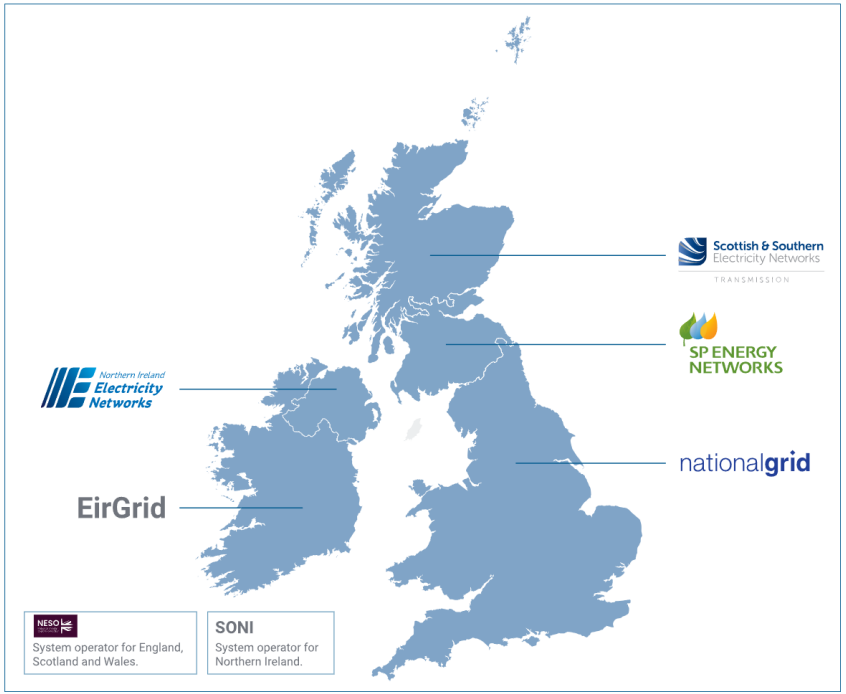
// National Electricity Grid

// GRID CONNECTION – GOVERNMENT RHETORIC

- UK faces one of its greatest engineering challenges as it seeks to combat climate change while keeping the lights on
- If it is to succeed the pace of delivery will be crucial
- Developers looking to connect renewable energy projects to the electricity grid are facing delays of more than 10-15 years threatening the UK's net zero ambitions
- Grid connection delays are putting both the climate targets and energy security at risk

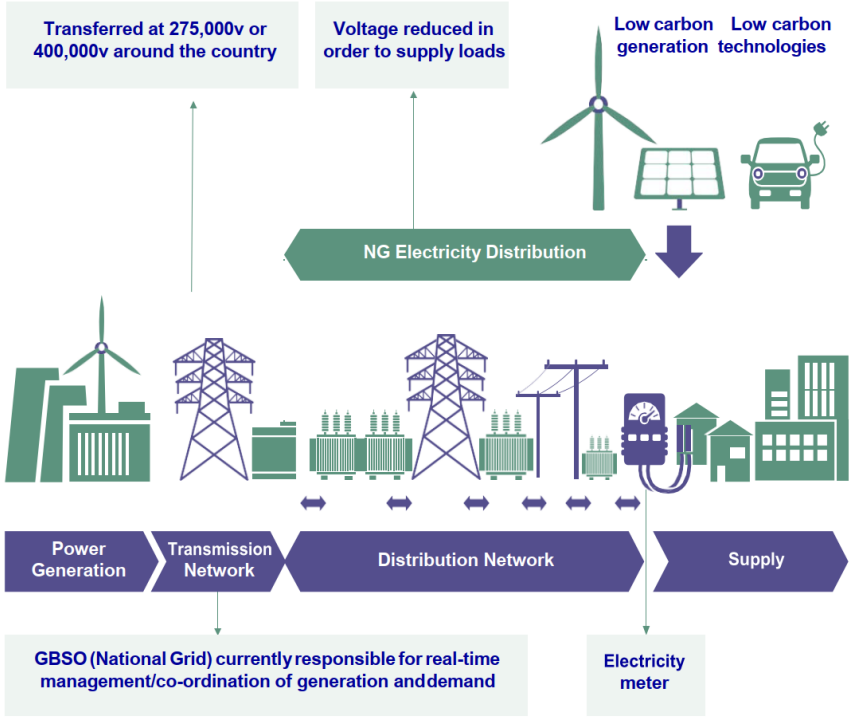
'You have the rhetoric from the government of wanting to be carbon-efficient, invest in PV, be efficient, be clean, but when you go to do it the DNO says no'

// GRID CONNECTION – ELECTRICITY TRANSMISSION & DISTRIBUTION OPERATORS

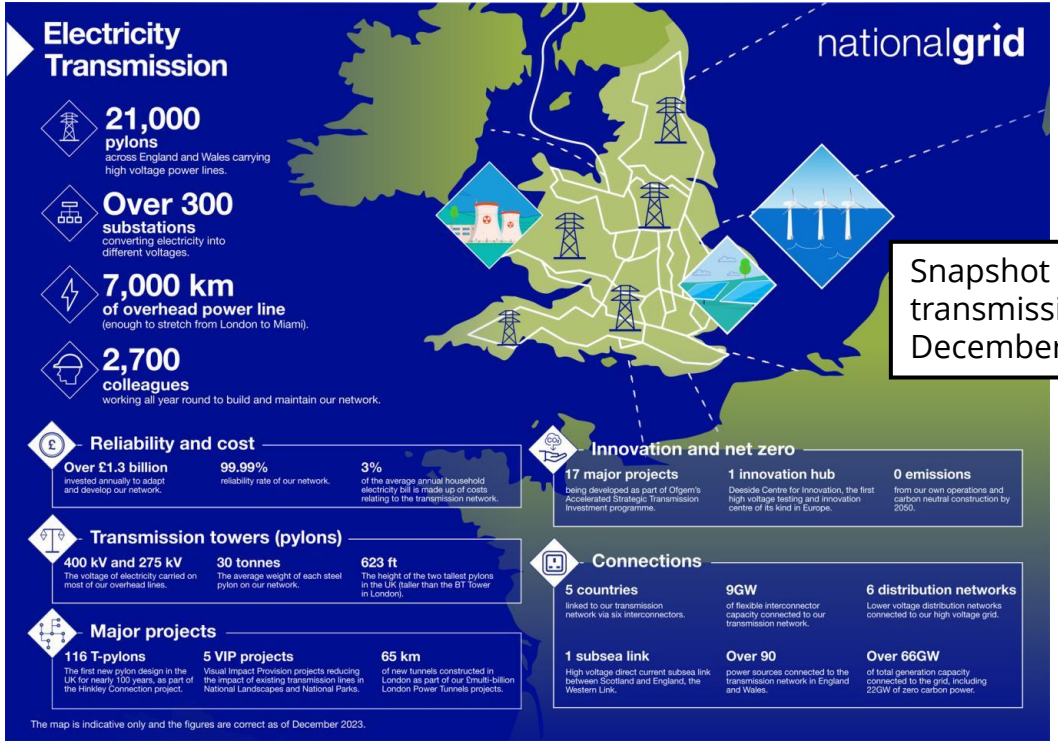


// GRID CONNECTION – NATIONAL GRID TRANSMISSION NETWORK TOPOLOGY

- Traditional top-down network topology from the 1940s
- Not designed for power flow in reverse in multiple locations
- Significant increase in the rise of large connected embedded generation projects and…
- Large capacity import demand connections associated with data centres



// GRID CONNECTION – NATIONAL GRID TRANSMISSION NETWORK



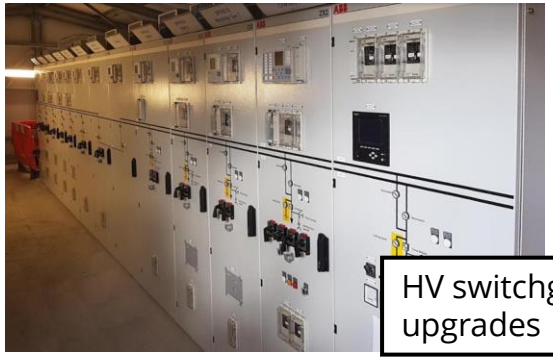
Snapshot of the National Grid transmission network from December 2023

// GRID CONNECTION – NATIONAL GRID TRANSMISSION UPGRADES

Overhead lines being upgraded

Grid Supply Points (GSPs) being replaced/upgraded

Super Grid Transformers being upgraded or new added to GSPs



HV switchgear upgrades

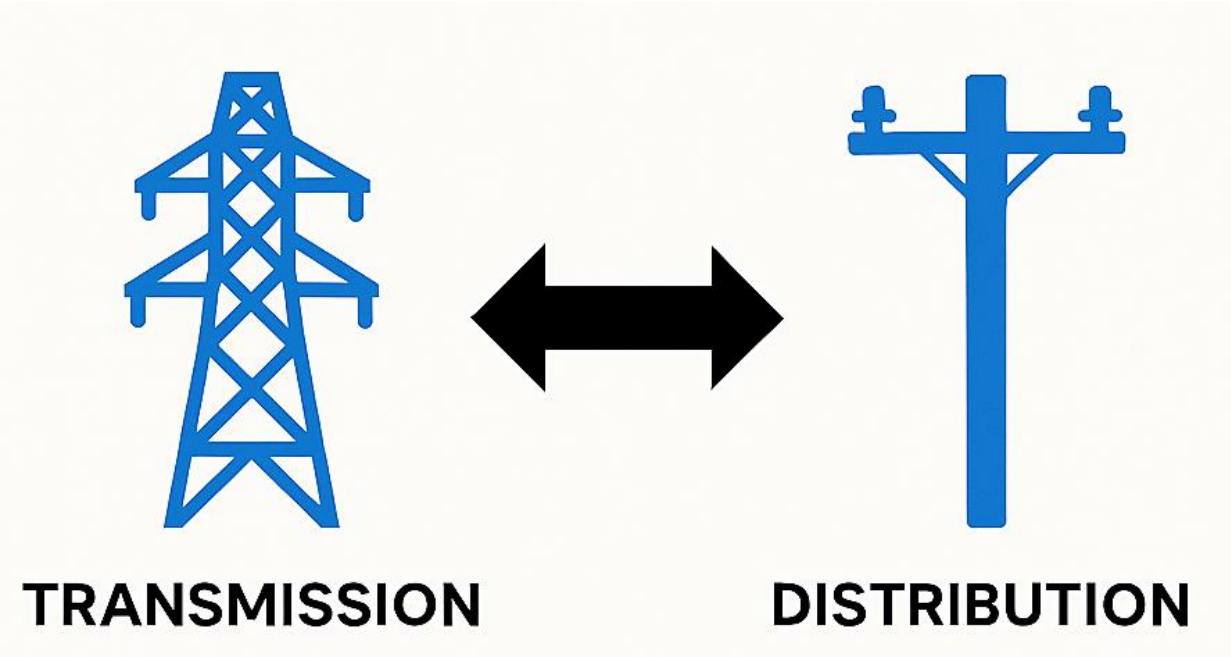
// Grid Connection Challenges

// GRID CONNECTION CHALLENGES – THE SCALE OF THE CHALLENGE

- Surge in renewable energy projects across the UK
- Grid connection bottlenecks due to outdated infrastructure
- Long connection queue times delaying clean energy deployment
- Reform needs highlighted by Ofgem, NESO introduced a new process in July 2025 to actively approve connections and identify 'zombie' projects

// GRID CONNECTION CHALLENGES – TRANSMISSION vs DISTRIBUTION COMPLEXITY

- Developers face uncertainty between transmission and distribution networks
- Different gateway criteria and planning hurdles slowing the connection process

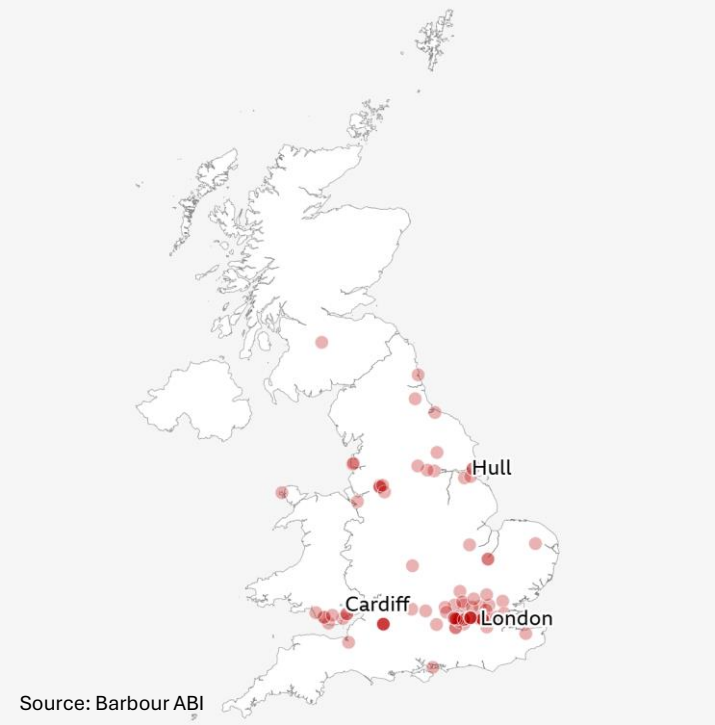


// GRID CONNECTION CHALLENGES – GRID STABILITY & RENEWABLE INTEGRATION

- **Intermittent Renewable's Challenge** – Shock Absorbers are needed
- **Green Inertia** – National Grid is investing in technologies such as grid-scale batteries and special turbines, to provide this stability service
- **Reactive Power Control** – helps maintain voltage levels and improve power factor of the grid
- **Voltage Regulation** – injects or absorbs reactive power to keep grid voltage stable and minimise fluctuations
- **System Strength** – high levels of fault level are needed for system strength and stability, especially during faults
- **Frequency Stability** – synchronous inertia, reducing oscillations and improving frequency stability in response to disturbances

// GRID CONNECTION CHALLENGES – UK DATA CENTRES UNDER CONSTRUCTION/PLANNED

- Data centres in UK set to increase by almost a fifth
- There are currently an estimated 477 Data Centre's in the UK
- Growth in AI increases the need for more processing power



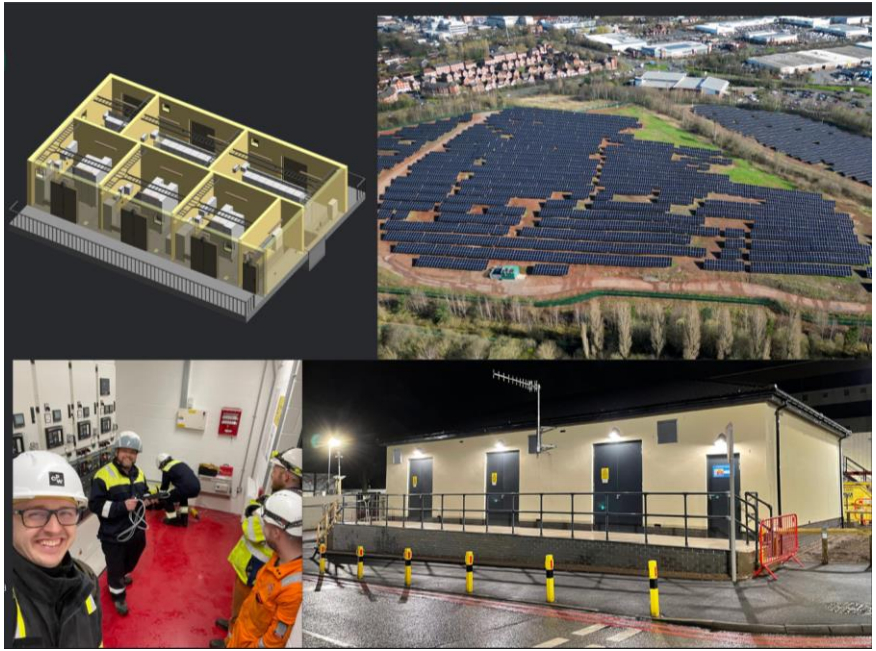
// GRID CONNECTION CHALLENGES – DELAYS THREATEN NET-ZERO GOALS

‘Upgrading the grid and revolutionising the UK's energy system is probably the biggest engineering challenge the UK has faced in a very long time. The aspiration is right but are we going at the right pace today?’

// HV Solutions – Case Studies

// HV SOLUTIONS – CASE STUDIES

- Existing hospital site in the West Midlands
- 3MVA site capacity
- Load growth circa. 4MVA (decarbonisation plans)
- EPC contract to deliver 7MWp solar PV farm on reclaimed land
- New 12MVA intake substation established
- 2.11MW export capacity agreed

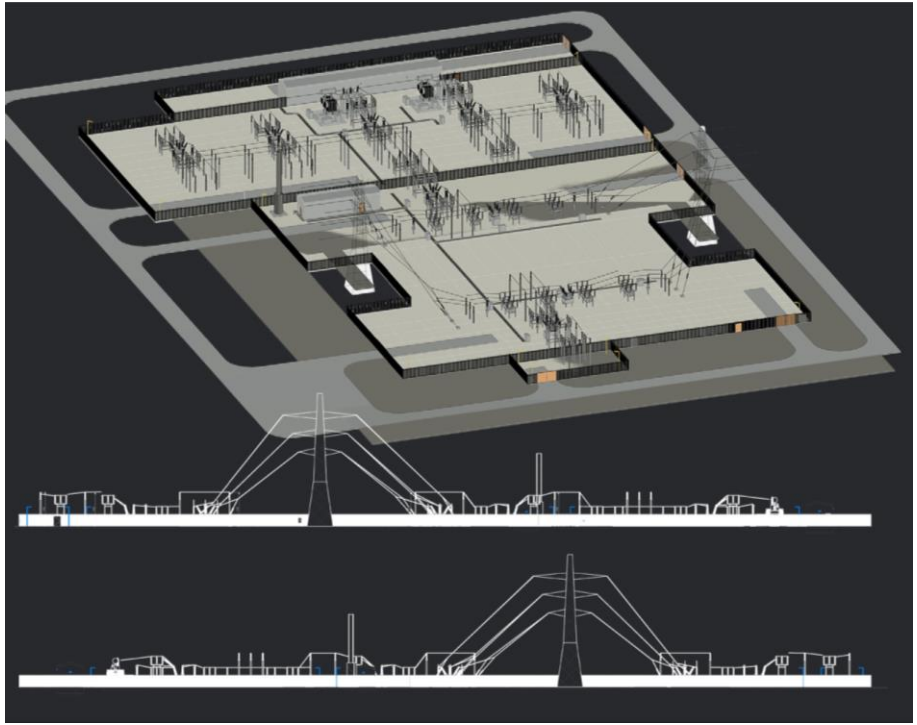


// HV SOLUTIONS – CASE STUDIES

- Existing university site in the East Midlands
- Site load growth associated with new building projects and decarbonisation plans
- New 4MVA intake substation established
- New switchgear installed equipped with G100 ELS interface ready for future embedded generation connection

// HV SOLUTIONS – CASE STUDIES

- New industrial distribution park in the Midlands for a large global real estate developer
- 40MW import demand capacity and 65MWp solar PV (roof and ground mounted) connection secured
- No capacity to connect at 11/33kV therefore new 132/11kV primary substation proposed, designed in line with G81 local DNO standards
- Diversion of local overhead lines required to facilitate this connection



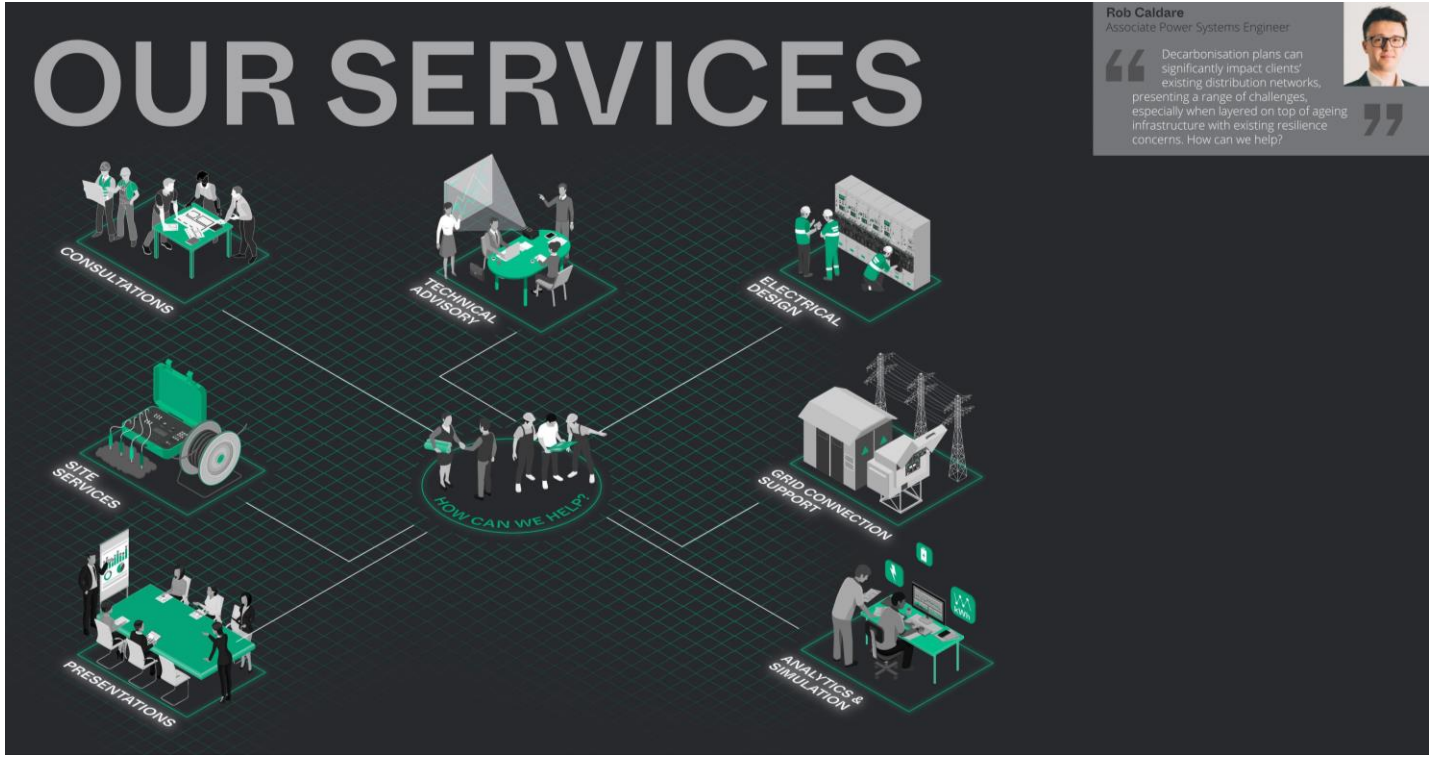
// HV SOLUTIONS – CASE STUDIES

- Existing large university estate in the West Midlands
- Supporting the sites rapid growth and capacity needs
- Bold decision for a new 132/11kV connection agreed
- Joint DNO/University primary substation established in 2002
- 17MVA import demand capacity made available

// How we can Help

// SPECIALIST HIGH VOLTAGE ENGINEERING

// OUR SERVICES



// NERS ACCREDITED ENGINEERS

NERS ACCREDITED ENGINEERS

OUR WORK IS CONTINUOUSLY REVIEWED BY THE LRQA'S NATIONAL ELECTRICITY REGISTRATION SCHEME (NERS) WHICH PROVIDES AN ACCREDITATION FOR UNDERTAKING DESIGNS OF DISTRIBUTION NETWORKS UP TO 132KV.

We are registered to undertake the design of connections to the public electricity network under the National Electrical Registration Scheme (NERS), using the Competition in Connections (CIC) process.

We are able to design the contestable element of any connection to the UK Distribution Network Operators' (DNO) standards allowing the customer to appoint an approved contractor to undertake the installation of the works.

This enables the client to have increased control in the design input on the contestable part of the installation and may offer reduced delivery times along with cost savings.

We can also provide design services to Contractors registered for the installation of contestable works, enabling the contractor to have access to full design services, as part of their offer.

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Director
If you think we can be of assistance with your project please get in touch, our team are always happy to help.
Where buildings come alive
Over the past 40 years and after a succession of growth periods, CPW has established a strong presence across the UK and internationally as an industry-leading mechanical engineering, electrical engineering and low carbon consultancy.
Global challenges require a global mindset, diverse perspective and joined-up thinking.