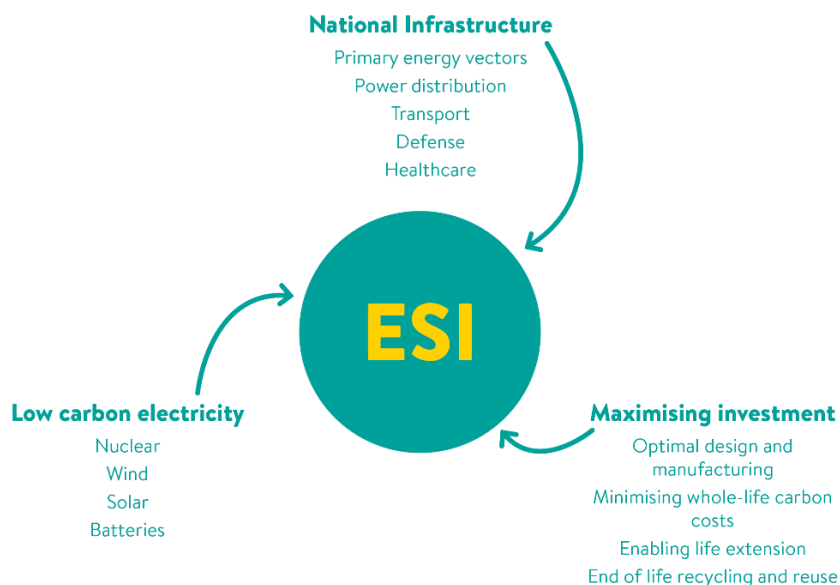


Position Paper: Executive Summary

Engineering Structural Integrity: A Key Enabler for Net-Zero

Introduction

The UK's economy, security, well-being and prosperity depend on safe, enduring and resilient infrastructure to deliver our energy, defence, transportation, and healthcare. The total value of critical UK infrastructure and the cost of replacement runs into trillions of pounds. Engineering structural integrity (ESI) is the integrated multi-disciplinary set of activities spanning science and engineering that ensures the operational integrity of that critical UK infrastructure; in parallel, it underwrites life extension of our major assets, providing the UK with huge economic and societal benefits and environmental protection.



This Position Paper, commissioned by the Henry Royce Institute for Advanced Materials (Royce) and prepared with the UK Forum for Engineering Structural Integrity (FESI), summarises the criticality of ESI to the UK economy and the opportunities afforded through a nationally co-ordinated approach to ESI technology, research, and training. It is allied to the [National Materials Innovation Strategy](#), which has identified structural integrity and the performance of materials in service as a key cross-cutting theme.

The Opportunity

ESI is a key underpinning UK resource that is central to the UK economy. The UK's journey to Net-zero depends on ESI skills, methods and activities for reducing whole-life carbon costs and maintaining a sovereign capability for safe operations and readiness. ESI activities seek to minimise the impacts of ageing and maximise the life of our vital existing infrastructure to increase the return on investment.



Structural integrity innovation has enabled the UK's nuclear reactor fleet to generate twice as much green electricity than their original design, delivering major reductions in CO₂ emissions and economic benefits. The ability to extend the operation at one Power station at Hartlepool provides 3% of the UK's electricity needs! The Advanced Gas-cooled Reactor (AGR) and Sizewell B Power Stations have saved 1.4 billion tonnes of CO₂ emissions, and their operation is underwritten by robust structural integrity.

Significant investment in future infrastructure for the UK to achieve Net-zero highlighted by the National Infrastructure Commission – modular nuclear reactors, floating offshore wind turbines, a hydrogen storage and distribution network, and carbon dioxide sequestration – will require innovation to advance ESI methods before any new infrastructure can be deployed and gain regulatory consent. Data mining and machine learning for design, probabilistic prediction of in-service performance, and real-time data reduction from extensive monitoring and diagnostics all represent major opportunities for greater efficiency and economies and which could be deployed at pace to huge benefit.

The Challenge

Since the turn of the millennium, ESI in the UK has become fragmented across diverse organisations and industrial sectors with decreasing innovation and connectivity. The UK's ESI skills base is under threat from a rapid reduction in the number of new graduates and professional engineers, scientists and technicians entering and active in the field. Failure to invest sufficiently in ESI can result in the high financial and human costs of over-engineering, catastrophic failures, breakdowns, lengthy and costly repairs and downtime.

In 2021 metal fatigue cracks found on a large percentage of our train services resulted in mass withdrawal of service for four weeks. Structural integrity assessment and non-destructive testing were essential to getting this fleet back up and running, delivering huge economic benefit, while ensuring passenger safety as repairs took place.



Proposed Key Interventions

ESI is a “hidden discipline”, as it is often only considered when things go wrong; however, it is critical for the efficient and safe design of new infrastructure, and also for in-service reliability of existing infrastructure. Therefore, for the UK to achieve its Net-zero objectives the UK must:

- **Grow its ESI community** and focus on ESI training and professional development with urgency to ensure a competent and skilled workforce.
- **Assess and rationalise access to appropriate ESI** testing and experimental capabilities
- **Boost its international presence** so it can benefit from knowledge exchange and technology transfer from other advanced economies.
- **Develop more efficient regulation of innovation in ESI** in order to enable faster introduction of novel approaches and the benefits they will bring.

Recommended Next Steps

To deliver on this, the ESI Community in the UK must establish clear leadership, direction, and integration to drive innovation, transfer technologies, develop skills and share knowledge and experience between industry sectors.

To meet the challenges outlined above requires the formation of a new *industry-led Umbrella Organisation for ESI*, with a government-convened public-private *Leadership Group* representing the whole ESI Community. The Group will set out the future requirements and drive the implementation of a coherent *UK National Strategy for ESI* with input and endorsement from key stakeholders in industry, government, universities, research and technology organisations and regulators. It will form part of the **National Materials Innovation Strategy**. Outputs will be:

- Production and dissemination of a *UK National Strategy for ESI*.
- Mechanisms and forums to *coordinate our distributed capabilities* around the UK, to make judicious investment decisions in high priority areas, and to ensure that we develop the necessary capabilities to support our industry/infrastructure.
- Development of an evolving *Roadmap for ESI* to focus and accelerate ESI innovation in areas such as data science, AI and advanced diagnostics.
- An audit of skills training and professional development across the range of ESI disciplines specifying the requirement for a *UK ESI Training and Skills Academy*.
- Assessment of needs for *capital investment in ESI testing facilities* for net zero infrastructure while ensuring that existing national facilities are utilised efficiently.
- *Improved communication and dissemination of knowledge and new methods* across disciplines and industry sectors, linking the many organisations whose activities relate to ESI.

The key recommendations are that the ESI Community should by the end of 2024 or soon after:

- **Establish an Umbrella Organisation and Leadership Group** that will implement an overarching UK National Strategy for ESI so that the UK can meet its Net-zero aims.
- **Engage with National Funders, including the Research Councils and Innovate UK** and with the key industry sectors, to ensure the financial sustainability of the underpinning facilities and skills delivery for ESI.
- **Establish the framework for a UK National ESI Training and Skills Academy** for different ESI disciplines in line with the ESI Roadmap.

Investment in engineering structural integrity is vital for the UK economy, generating the knowledge, skills and infrastructure to deliver the UK's commitment to net zero.

This report has been prepared by a small Project Team and received input from an Advisory Group representing the ESI community. It is now issued as a "Draft for Comment" by the wider ESI community before it is officially launched and disseminated to government and other bodies.

Key Industrial Sectors

Energy, defence, transport, space, civil infrastructure and the build environment, medical devices.

Key Stakeholders

Universities, Research and Technology Organisations, Consultancies, Aerospace Technology Institute, The British Institute of Non-Destructive Testing (BiNDT), UK Institutions of Structural Engineers, Civil Engineers; Mechanical Engineers, Institute of Materials, Minerals and Mining (IOM3).