



UK COLLABORATORIUM
FOR RESEARCH ON
INFRASTRUCTURE & CITIES

Influencing research, policy and practice

Annual Review 2023-24



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UKCRIC...our story so far

Established in 2015 as the UK's interdisciplinary infrastructure and urban systems hub, UKCRIC was launched to establish the national-scale, regionally-led, collaborative research needed to transform the UK's infrastructure and urban systems for net zero, safe, healthy, resilient and sustainable living; to generate economic opportunities for the UK; and to drive economic growth through improving skills provision.

The 2015 budget saw the UK government announce a £138m investment in UKCRIC to build [research and test facilities](#) at universities across the country that deliver research to ensure the UK's infrastructure is resilient and responsive to environmental and economic impacts. Matched funding from the host universities brought the total capital investment to £250m, enabling UKCRIC to deliver a suite of nationally-significant research capabilities across the engineering sciences.

Deliberately rejecting the idea of a single geographical centre, UKCRIC Phase 1 completed in April 2022 and built a new, world-class national network of 11 engineering laboratories; 6 full-scale urban observatories; and computer modelling, simulation and visualisation capabilities (the Data and Analytics Facility for National Infrastructure, or DAFNI). Phase 1 also established a regional approach to research and skills development in infrastructure and cities and created [Scientific Missions](#) focusing on sustainability, resilience, equity and governance.

September 2019 saw the opening of the National Research Facility for [Infrastructure Sensing \(NRFIS\)](#) at Cambridge (by the then President of the Institution of Civil Engineers, Andrew Wyllie CBE) and the [National Infrastructure Laboratory \(NIL\)](#) at Southampton (by the Chief Executive of Network Rail, Andrew Haines OBE). The Urban Observatories were formally launched in November. Also in 2019, UKCRIC extended its

reach into Scotland with the University of Edinburgh and Heriot-Watt University joining UKCRIC in October.

In May 2021 construction completed on UKCRIC's [Person Environment Activity Research Laboratory \(PEARL\)](#), housing full scale facilities that test the impact of environmental conditions such as space, colour, lighting and sound on people's behaviour and perception. In July 2021 UKCRIC's [Data and Analytics Facility for National Infrastructure \(DAFNI\)](#) received a further £1.2m of EPSRC investment, providing researchers and practitioners with an unparalleled collaborative computational facility and quality data services to design and test future infrastructure innovations.

In February 2022 the University of Bristol launched the new [UKCRIC Soil-Foundation Structure Interaction \(SoFSI\)](#) facility, which is capable of full-scale testing of how buildings and infrastructure interact with the ground when subjected to dynamic loads. In April 2022 the last of UKCRIC's new-build facilities opened at the University of Birmingham. The [National Buried Infrastructure Facility \(NBIF\)](#) enables researchers to study at scale the interactions between buried infrastructure and the ground.

As well as providing access to unrivalled research capacity and capability, UKCRIC is passionate about nurturing the highly skilled workforce required to manage and deliver nationally significant infrastructure projects. In 2021 The Centre for Postdoctoral Development [in Infrastructure, Cities and Energy \(C-DICE\)](#) launched to advance the skills base required to create a pipeline of world-class talent for the Infrastructure, Cities and Energy (IC&E) sectors, and to accelerate progress towards a net zero society by 2050. C-DICE brings together the collective expertise of UKCRIC's universities with the partners of

the Energy Research Accelerator (ERA), working alongside research associations, institutes, and leading industrial partners.

UKCRIC phase 2 pushed forward its vision to transform from a research community into a sustainable research entity to realise the multi-dimensional potential of infrastructure and urban systems. In January 2022 UKCIRC launched its [Doctoral Skills Network](#), which combines the collective expertise and capabilities of its university members to deliver skills and training and to support career development, helping create the engineers of the future. In March 2022 UKCRIC established a trading company, UKCRIC Limited, which gives collaborators access to engineering-related scientific and technical consulting services across UKCRIC member institutions.

Published in 2023, [UKCRIC's Transition Roadmap Project](#) provides the framework for UKCRIC's operations for the next five years. It sets out UKCRIC's vision to be established as an influential, independent, global, and interdisciplinary expert source in infrastructure and urban systems.

UKCRIC is poised and ready to respond to emerging challenges by pushing boundaries, by delivering world-leading research, and by influencing practice and policy. If you are interested in becoming a member, download the [membership prospectus](#).

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Foreword from the Chair of the International Advisory Board

UKCRIC is a remarkable network of expertise and facilities. There is no other multi-disciplinary infrastructure network that exists in the UK on this scale and, collectively, UKCRIC offers unrivalled potential to address global challenges in infrastructure and urban systems. This is where the International Advisory Board has an important role to play: guiding UKCRIC towards opportunities, drawing on international perspectives and achieving global impact. I am pleased to see UKCRIC's ambition matches its potential.

Infrastructure has a critical role to play in all aspects of life. The world has witnessed devastating events like the Israel-Hamas war, the Russian invasion of Ukraine and, of course, the impacts of climate change, which has in the last year seen catastrophic wildfires in Greece, the USA and Canada. Advances in infrastructure drive economic growth, facilitate sustainable environments and underpin our health, wellbeing and human development. Infrastructure advances societies and, perhaps most importantly in our current global climate, it aids recovery.

Amongst UKCRIC's five-year plan for growth is the ambition to become an influential, independent, and global expert source in the fields of infrastructure and cities. I am pleased to see that this past year has seen UKCRIC increase its engagements abroad as well as joining international platforms to contribute

expertise on global challenges. One highlight for me has been the delivery of the UKRI and the US National Science Foundation (NSF) transatlantic workshop on underground infrastructure in partnership with George Mason University in the USA. The report that followed is a fascinating read and I look forward to hearing about further developments as a result.

March 2024 saw the world's first comprehensive legal and regulatory framework for artificial intelligence, passed by the European Union. We are seeing more investment from governments across the world in this area. One thing I am looking out for in the future, as I am sure many of you are too, is the increased role of artificial intelligence in infrastructure – both in terms of training the next generation of engineers and in applied technologies. This is why I was so pleased that UKCRIC Limited won one of the inaugural Manchester Prize finalist awards to explore the use of AI in managing potable water system leaks. At the time of writing, UKCRIC Limited is waiting to hear whether it has won the £1m Manchester Prize. I wish them luck!



Lord Robert Mair
Emeritus Professor of Civil Engineering, University of Cambridge, and Chair, UKCRIC International Advisory Board

Letter from the Convenor

On 1 April 2022 UKCRIC ceased to receive UK Research and Innovation (UKRI) grant funding and moved to a [membership model](#). It's a strategy that will enable UKCRIC to grow, as well as giving existing and new partners access to an unparalleled network of academic experts in infrastructure and urban systems. This new business model also provides our members with a platform on which to engage, inform and influence key stakeholders from research, policy and practice.

UKCRIC's success is wholly the success of our members and its value results from its impact locally, nationally and internationally. We wish to thank our members for their commitment to what is a unique collaborative undertaking.

UKCRIC Limited has been trading since April 2022 and continues to grow along with our ambitions. We welcomed a Director of Business Development and a Project Manager in early 2024 to nurture its pipeline of projects and ensure clients receive a professional service. 2023 and 2024 have seen the number of UKCRIC Limited projects increase markedly and the forecast for 2025 is excellent, including repeat business.

Our [framework agreement with HS2](#) is soon to enter its fifth year. Despite the challenges faced by HS2 this year, the project continues to invest

in research-led innovation and continues to value its relationship with UKCRIC. You can read about some of the projects with HS2 in this report.

We have always valued collaboration, building partnerships both domestically and internationally. At the beginning of this financial year we were delighted to have signed an MOU with the [Digital Task Force for Planning](#), which then secured two placements via C-DICE's placement and secondment funding scheme for evaluating and assessing various decarbonisation toolkits that might enable the preparation of better local plans. Placements and secondments are a great way to support practice with research and UKCRIC is proud to be a C-DICE partner, extending C-DICE's opportunities to our members.

We know that dissemination is just as important as delivery so we embarked on a campaign of activity to engage stakeholders; sharing knowledge, influencing debates and providing thought leadership on key issues across the infrastructure landscape nationally and internationally. In 2023 we launched our thought leadership publication series, 'Connected'. These publications are authored by UKCRIC experts and invited external partners and provide insight and evidence on wide ranging infrastructure challenges in an accessible and easily digestible way.

Our Doctoral Skills Network hosted webinars and training workshops, introducing doctoral students to the research taking place at UKCRIC facilities and covering topics from green infrastructure to low-cost innovations in earthquake engineering for smart and resilient infrastructure. We hosted three research discovery days in UKCRIC facilities at the Universities of Manchester, Sheffield and Southampton, and spoke at a number of national and international Conferences including Futurbuild 2023 in the UK and the City Development Forum in Poland.

UKCRIC's research continues to be relevant, timely and important. When a breaking news story about school closures due to unsafe RAAC concrete hit the headlines in September 2023, UKCRIC member experts at Loughborough University were consulted by the UK government's Cabinet Office. Through media channels such as PoliticsHome we continue to increase our visibility with government, providing deeper insight into the challenges of the UK's ageing infrastructure as well as other topical infrastructure challenges such as [shaping the nation's transport future](#).

UKCRIC is now firmly on its journey of delivery and our ambition has always been to drive innovation influence internationally, as well as in the UK. For example, in 2023 we joined the

previous government's Department for Trade 'Sustainable Smart City' delegation to Malaysia, designed to strengthen links between Malaysia and the UK's Midlands region. A delegation of UKCRIC colleagues was also invited to contribute to the Royal Society Conference and roundtable on *Ukraine's recovery: rebuilding with research*. In addition, colleagues from UCL provided their expertise to help design and develop the United Nations Disaster Risk Reduction (UNDRR) publication '[Principles for Resilient Infrastructure](#)'. These principles have since been recognised as a key area of action to support the implementation of the Sendai Framework, which was acknowledged in May 2023 at the UNDDR Midterm Review of the Sendai Framework.

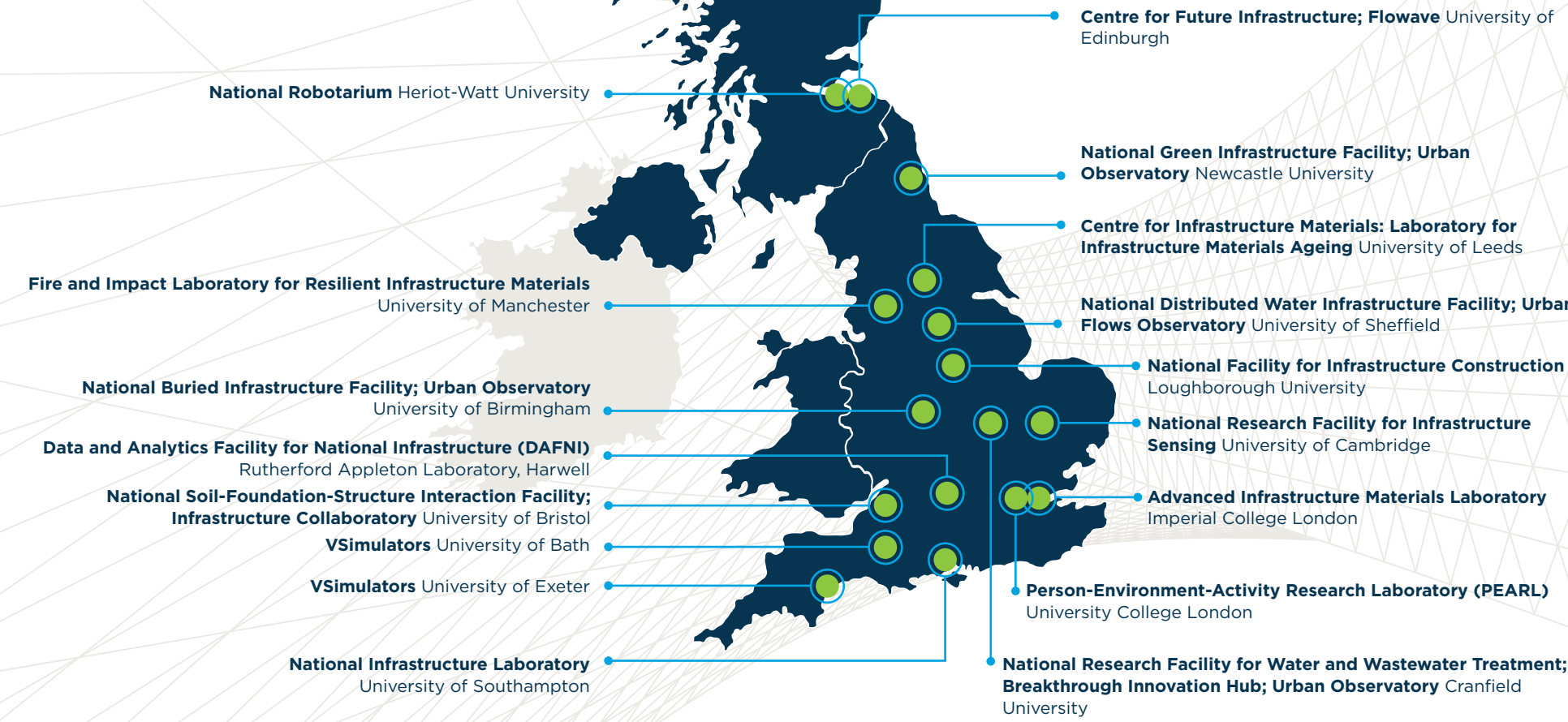
One of UKCRIC'S unique selling points is its convening power and in 2023 UKCRIC was commissioned by UKRI and the US National Science Foundation (NSF) to co-deliver a transatlantic workshop to explore the state of the art in urban underground infrastructure research. Facilitated and delivered by UKCRIC in the UK and by George Mason University in the US, the workshop brought together selected internationally-leading infrastructure scholars and experts to consider the big questions and define opportunities for transformation in urban underground infrastructure. A [landmark report](#) was published in July 2024 describing the workshop's outcomes and suggestions for next steps.



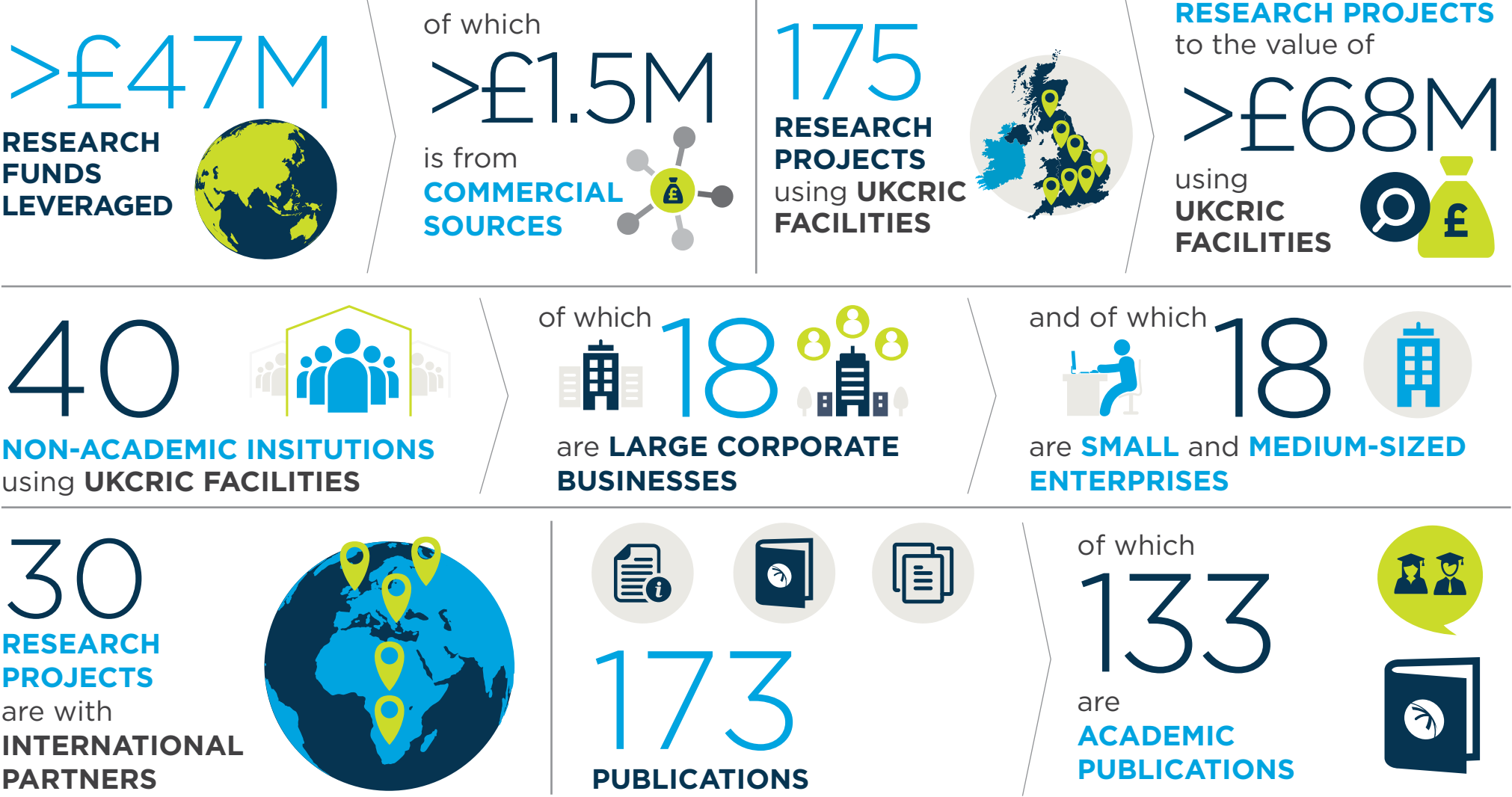
I continue to be inspired by the breadth of activities in which UKCRIC collectively engages. It is my hope that the examples in this report will inspire you too – and to join us, if you are not already a member.

Professor William Powrie,
UKCRIC Convenor

Facilities map



Impact 2023- 2024



DEVELOPING TALENT, NURTURING CAREERS

Doctoral Skills Network

The UKCRIC Doctoral Skills Network offers an opportunity for postgraduate researchers from UKCRIC institutions to meet and exchange ideas, support each other and gain skills to develop their careers as engineers of the future. Officially launched in January 2022 as part of UKCRIC's coordinated training activities, the aims of the Doctoral Skills Network are to:

-  Offer developmental opportunities to doctoral researchers based in UKCRIC institutions focusing on research in infrastructure and cities
-  Create a vibrant doctoral community and promote collaborations and idea exchanges
-  Combine the collective expertise and capabilities of the UKCRIC universities and partners in support of the activities of the doctoral network
-  Support the development of research-minded leaders that can address national and international priorities



The Network has more than 200 members from across 15 universities. Between April 2023 and March 2024 four conferences and 16 webinars were hosted in collaboration with UKCRIC Centres for Doctoral Training (CDTs), the Energy Research Accelerator, C-DICE Network and other collaborative partners. These activities addressed contemporary themes such as energy resilience and the built environment, green infrastructure approaches, and innovation in earthquake engineering. A particular highlight is the Sustainable Infrastructure & Cities PGR conference hosted by the EPSRC Centre for Doctoral Training in Sustainable Infrastructure Systems, at the University of Southampton. UKCRIC hosted day three of the conference in partnership with the CDT and UKCRIC network postgraduate researchers presented their projects.

UKCRIC supports managers and investigators of Centres for Doctoral Training that are based in UKCRIC institutions through a dedicated LinkedIn group. The group encourages the sharing of experiences and of best practices for running successful CDT programmes, as well as sharing upcoming collaborative opportunities.

The three-day PGR Conference was a truly inspiring, multi-faceted event bringing together members of our 'research, development and Innovation future' to network, collaborate, share and refine emerging findings, and reflect on the interdependencies between the many infrastructure and urban systems. I had the privilege of presenting on How to Think and Act Systemically in a Complex World and receiving insightful multi-dimensional feedback. Our future is in safe hands!"

Chris Rogers, Professor of Geotechnical Engineering, University of Birmingham

ENHANCING DIGITAL RESILIENCE

The challenges posed by software vulnerabilities in critical national infrastructure

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The findings from the workshops and case studies establish key areas of future research and policy development while underscoring the need for comprehensive strategies that encompass secure design, robust data management, and effective stakeholder collaboration.

Professor Liz Varga, Principal Investigator of UKCRIC and a Director of UKCRIC Limited

UKCRIC Limited is the trading company of UKCRIC, giving collaborators the opportunity to work with UKCRIC member institutions through one organisation. Officially trading since April 2022, the work of UKCRIC Limited complements UKCRIC's Scientific Missions to underpin the renewal, sustainment and improvement of infrastructure and cities in the UK and elsewhere. From expert consultancy and collaborative research, to custom programmes and developing framework agreements, the combined expertise of UKCRIC Limited member institutions provides unmatched knowledge and capability able to deliver bespoke solutions for infrastructure and urban systems practitioners across industry, government, non-profit and public sector organisations.

UKCRIC Limited applied for a grant from the Business Continuity Institute (BCI) to carry out research to explore the challenges posed by software vulnerabilities in critical national infrastructure (CNI), examine their potential consequences, and outline strategies for enhancing digital resilience. The proposed project was ranked top in that round of BCI grant applications.

CNI encompasses essential services that are foundational for societal and economic stability, including sectors such as energy, water, transportation, communication, and public services. As digitalisation transforms these sectors through technologies like Internet of Things (IoT), big data analytics, and artificial intelligence, the efficiency and adaptability of infrastructure operations have significantly improved. However, the integration of digital systems within CNI has also introduced new complexities and vulnerabilities, particularly around cyber threats and software resilience.

The UK government classifies infrastructure as CNI based on the severity of disruption it would cause if compromised, with many systems increasingly

interconnected through expansive digital networks. The Parliamentary Office of Science and Technology (POST) highlighted the exponential rise in attempted cyber-attacks on UK infrastructure, emphasizing that market forces have not sufficiently driven proper risk management practices. The evolving threat landscape necessitates proactive and collaborative measures to strengthen the cyber and software resilience of CNI.

Relevant work at BCS, The Chartered Institute for IT and the IT Leaders Forum titled [Elephant in the Room \(2022\)](#) identified the need to prepare against disruptions caused by software failures and build national preparedness, hence its interest also to the [National Preparedness Commission \(NPC\)](#).

The UKCRIC Limited research combined an analysis of academic literature with other technical reports and case studies about software resilience and vulnerabilities in CNI, and stakeholder engagement through structured workshops. The workshops, designed and developed by the UCL research team, facilitated discussions about key vulnerabilities, emerging risks, and potential mitigation strategies. The workshops enabled cross-sector collaboration and ensured that diverse perspectives were incorporated, acknowledging the complexity of digital threats and the multifaceted nature of resilience-building efforts. Having validated the five key types of software failure (security and resilience, intrinsic software, data-driven, software-hardware interface, human-computer interface) workshop participants then underscored the severe societal and economic consequences of software failures in CNI and developed a set of possible strategies to enhance software resilience. A summary of the project findings appears on the UKCRIC website and a journal paper is underway.

DECARBONISING INFRASTRUCTURE

Investigating the potential for tunnels to provide a low carbon heating solution

The University of Leeds and HS2 Ltd collaborated to investigate the potential for tunnels that were, at the time, expected to be constructed as part of Phase 2b of HS2, to supply heating and cooling in addition to their primary function.

The project required mapping future infrastructure assets which could be used to access geothermal energy in the Manchester and Crewe areas, a desktop assessment of likely thermal energy available, an estimate of installation costs of a tunnel energy system, engagement with potential heat users along the route and other stakeholders to understand barriers to deployment, and a financial analysis to demonstrate economic viability.

Decarbonising heating and cooling will be subject to competing demands for low-carbon and environmental energy sources. Power-

to-heat technologies such as heat pumps will place demands on the electricity grid that will also need to supply sufficient green electricity to enable the shift to electrified transport. Meanwhile, civil engineers are ever more aware of the need to reduce environmental impacts from infrastructure and seize opportunities to support decarbonisation. Dual use of buried infrastructure by thermal activation, so called “energy geostructures”, is an attractive route to contribute to both these aims. However, attempts to incorporate heat transfer pipes for thermal activation of tunnel linings in the UK has previously not been successful due to a combination of economics and insufficient programme time to permit necessary stakeholder engagement, making it impossible to accommodate the design and construction changes required. HS2 Phase

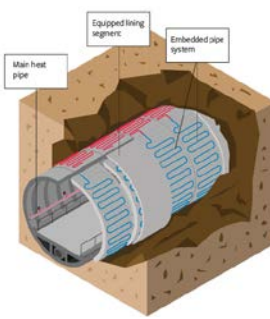
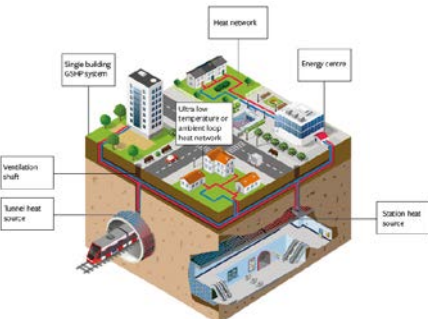
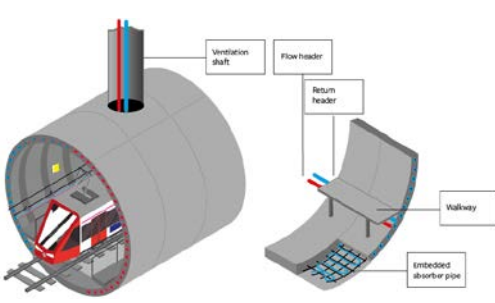
2b represented a significant opportunity for early engagement to encourage adoption of an energy tunnel solution. With development of heat network zoning policy in the UK, there was also a chance to develop a novel case study of energy geostructures used with district heating networks.

The University of Leeds’ engineering team’s assessment showed the geothermal activation of the tunnel linings had the potential to provide up to 13GWhr/year at each tunnel ventilation shaft where the heat could be accessed. This could heat the equivalent of 1200 homes. Engagement with external stakeholders including local authorities, heat network operators and large potential consumers found genuine enthusiasm for the use of tunnel heat. Costs and benefits for thermal activation of the tunnels to provide

heating and cooling for rail station buildings were compared with those for air source heat pumps demonstrating positive financial returns, subject to economic uncertainties such as interest rates, inflation and energy prices. However, capital funding being derived from the Department for Transport with benefits potentially accruing to other national and local government policy areas was highlighted as a significant barrier.

The positive financial analysis, support from internal and external stakeholders, and potential for reputational benefits to HS2 supported the case for further development. Unfortunately, before this could occur this part of the HS2 project was discontinued. Nonetheless, the approach has been shown to be viable and is applicable to other projects. Further work would be required to refine costs, progress aspects of the design, and further engage stakeholders. Key policy developments in terms of energy policy and capital project financing would also accelerate progress.

Zoë Edmonds, Senior Innovation Manager at HS2 said, “The team from the University of Leeds demonstrated the potential feasibility and desirability of using some of HS2’s proposed transport tunnels to simultaneously harness heat energy, generating a significant additional benefit for the neighbouring community, and highlighting the potential for a new contribution to the future energy security and net zero targets of the UK. Incorporating learning from HS2 Phase One, Crossrail and other international tunnelling schemes like Turin metro, Professor Loveridge and team worked with HS2 to investigate this potential early in the projects’ development, before detailed designs were fixed, which was essential for the affordability and viability of the concept. I hope that by sharing these findings it encourages others to use a multidisciplinary lens early in project development to seek to maximise the value from major infrastructure investment.”



“The team from the University of Leeds demonstrated the potential feasibility and desirability of using some of HS2’s proposed transport tunnels to simultaneously harness heat energy, generating a significant additional benefit for the neighbouring community, and highlighting the potential for a new contribution to the future energy security and net zero targets of the UK.”

Zoë Edmonds, Senior Innovation Manager, HS2

EMPOWERING LEADERS

Workshops for Network Rail asset managers

Network Rail asset managers are facing the challenges of maintaining an ageing network, carrying traffic of varying intensity and speed, and increasingly restricted funding. To tackle these challenges, Network Rail is developing an asset leadership programme to enhance peer-to-peer support, increase confidence and widen personal networks across regional boundaries, and has engaged UKCRIC members the Universities of Southampton and Birmingham to provide elements of the programme. This includes a series of residential workshops comprising structured, peer-to-peer learning away from the front line, to help senior asset managers get the most out of their existing expertise.

Asset managers have identified their key challenges as: management and mitigation of asset risk; working with codes and standards; setting an appropriate specification for work; delivery - cost, control and assurance; management across asset disciplines; influencing business and investment decisions; and attracting and retaining the next generation of asset managers.

There is a high level of engineering competence in the cohort but the depth of understanding that discipline-specific asset managers have of other and allied disciplines varies. There is also variable working across disciplines, which makes it difficult for asset managers to

“I feel empowered to be bold and control cost.”

“A superb range of speakers – all different, all engaging. Really inclusive, generous sharing of knowledge.”

a system view, as is the confidence of asset managers to make sometimes quite finely nuanced decisions concerning safety and performance consequences. They also find it difficult to challenge and control the cost of smaller and refurbishment works. They know what things cost but not always what they should cost and this makes it difficult to be confident about ways of meeting budgets other than by reducing outputs. It can also be challenging to assert an asset perspective in an organisation that is driven by service availability metrics.

The five-year programme empowers experienced staff to apply their expertise and professional judgement, supporting them to control their supply chain, apply or depart from standards appropriately, and properly influence business decisions.

The programme will strengthen links between staff across the regions, creating a network that supports a collegial approach to often common but sometimes unusual issues. This one-of-a-kind peer network will advise, encourage and support any of its number who need to challenge standards, specifications and target prices, backed by the latest knowledge in engineering science and assessing risk. It will enhance and encourage sound professional judgement.

The programme begins with small groups meeting for three- or four-day residential workshops of structured, peer-to-peer learning away from the front line. Workshops are based on facilitated discussions of case studies together with provocative presentations from academics, senior National Rail staff, and practitioners in related industries.

A long term objective of the network is to influence stakeholders’ and business leaders’ decisions and build trust between maintenance, capital delivery and asset management. A further objective is to improve organisational culture by enabling the delegates to identify their team’s current culture and providing them with the tools to make positive change.

Feedback from delegates has been overwhelmingly positive with a high likelihood of participants recommending it to colleagues (64% rating it between 9 and 10 out of 10). More workshops are being planned to expand the benefit across the organisation. Network Rail is developing on-line tools and a collaboration space to maintain the network after the initial workshops, and short refresher workshops are also planned.



National Infrastructure Laboratory (NIL), Southampton



“The training providers were internationally renowned and the F2F aspect with experienced peer cohort was very valuable.”



BUILDING RESILIENCE

Boosting UK infrastructure resilience against climate change

There is an urgent and increasing need to protect the UK's natural and built environments. From a surge in population growth, and severe weather events such as extreme floods and droughts caused by climate change, the UK's infrastructure resilience against these types of events must improve.

To help address the critical need to combat potential losses arising from the growing impacts of climate change and strengthen the UK's natural and built environments, in April 2023, UKRI funded a £4m investment for the Science and Technology Facilities Council (STFC) to establish a national 'Centre of Excellence for Resilient Infrastructure Analysis'. The virtual centre is an extension of the DAFNI platform (Data & Analytics Facility for National Infrastructure) and forms part of the UKRI 'Building a Secure and Resilient World' (BSRW) programme, a 5-year initiative which seeks to tap the research and innovation system to tackle large-scale, complex challenges.

The aim of this new Centre is to foster multi-disciplinary research and DAFNI, as the high performance platform, brings together research areas including engineering, data sciences, environmental science, health sciences and social sciences.

In August 2023, STFC Scientific Computing's Centre of Excellence for Resilient Infrastructure

Analysis announced an award of £1.4m across eight UK-based projects to boost infrastructure resilience against these types of events.

Using computational modelling on the DAFNI platform, these eight projects strive to strengthen the UK's resilience against severe weather events and other complex challenges, reducing the risks of road closures, energy failures, sewer overflow flooding, and water shortages, as well as helping underground infrastructure such as water pipes and electrical cables to withstand extreme weather-related events.

For example, a project led by Dr Anna Murgatroyd of the University of Oxford is addressing the concerns around England's water supply, as traditional water resource management is no longer sufficient to address such complex issues. Anna has now moved to University of Newcastle and is continuing the work there.

Another project, from University College London, has created a model that can be used by transport planners in the UK, allowing users to run "what-if" scenarios to predict the impact of infrastructure changes, such as the impact of the HS2 railway, on transport and land use.

The outputs from the Centre of Excellence will be instrumental in providing policymakers, local councils, and private companies with the essential

analysis and scenario-planning vital to ensure the UK is resilient against potential future risks.

Dr Brian Matthews, DAFNI Facility Lead and leader of the Open Data Systems Group at the STFC Scientific Computing Department said,

"The successful projects explore a range of research challenges in infrastructure resilience that will provide the momentum to deliver the Centre of Excellence for Resilient Infrastructure Analysis on DAFNI. These are exciting projects which will deliver essential research models for informed decision making."

The projects are all due to complete by spring 2025.

Kristine Zaidi, Associate Director for UKRI's Arts and Humanities Research Council, and lead for the Building a Secure and Resilient World theme added,

"To build a more secure and resilient world, we must put people at the heart of our research. The eight projects will help communities of all sizes improve their ability to prevent and respond to threats from extreme weather occurrences. By working across disciplines and improving access to robust evidence and information, we can strengthen the UK's resilience. I look forward to seeing the impact these projects will have on a wide range of sectors."

"To build a more secure and resilient world we must put people at the heart of our research. The eight projects will help communities of all sizes improve their ability to prevent and respond to threats from extreme weather occurrences."

Kristine Zaidi, Associate Director for Arts and Humanities Research Council and lead for the Building a Secure and Resilient World theme

CONVENING INTERNATIONAL EXPERTS

Transformation in urban underground infrastructure

Cities are major drivers of economic growth, technological innovation, and cultural vitality. However, their infrastructure systems are often patchworks of legacy and new components with incompatible standards, materials, and governance structures. The performance of such systems can be unpredictable under normal conditions and more so when subjected to extreme events. Mega projects are especially susceptible to cost overrun, delay, and public criticism. In the USA, for example, the Gateway Tunnel project to construct two new tunnels underneath New York's Hudson River and repair existing tunnels is currently three years behind schedule and is expected to cost US\$2 billion above original projected costs. In the UK, The London Underground's Elizabeth Line was repeatedly delayed and re-costed, coming in almost £4 billion over its 2013 estimate.

Without a paradigm shift in how infrastructure systems are engineered, constructed, and operated, significant cost overruns are likely to continue and the gap between the services these systems are designed to deliver and the population's requirements will continue to widen.

We require our infrastructure to operate seamlessly and continuously, supporting uninterrupted movement and commerce. This can be a challenge for underground infrastructures such as water and wastewater, transportation, telecommunications, and power systems, because of access difficulties and the harsh underground environment in which these systems reside. Smart city and digital twin concepts offer a promising direction to help reduce this challenge, especially given new breakthroughs in sensing and computation. However, key knowledge gaps remain.

As national governments invest into the trillions in infrastructure to combat climate change (e.g., US Inflation Reduction Act of 2022 and the UK Net Zero Strategy), there is a window of opportunity to mobilise scientific communities to create socially equitable, minimally disruptive and potentially transformative solutions for sub-surface infrastructure.

In September 2023 a pivotal two-day transatlantic workshop explored the state of the art in urban underground infrastructure research.

The workshop was funded by UK Research and Innovation (UKRI) and the US National Science Foundation (NSF), and brought together internationally-leading infrastructure scholars and experts from the UK and USA to consider the big questions and identify major gaps in knowledge and the enabling technology.

The transatlantic workshop brought together experts in civil engineering, urban planning, computer science, operations engineering, public policy, sensing, energy, waste and other fields to explore how underground infrastructure systems can better support a net zero future.

It became clear that we do not fully understand the subsurface, we do not work efficiently in the subsurface, and we do not use the subsurface to its full potential. Seven thematic areas were identified as offering enablers and potential solutions to these challenges and the resulting report published in July 2024 is an important milestone in defining the opportunities for transformation in urban underground infrastructure.



“Without a paradigm shift in how infrastructure systems are engineered, constructed, and operated, significant cost overruns are likely to continue”

Joanne Leach, UKCRIC Executive Manager

Partners





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 **WORK
WITH US**

We are actively seeking collaborative partners from the research community, industry, government, the third sector, finance, commerce and investment communities to work with us to solve the complex problems relating to infrastructure, cities and systems.

There are a number of ways of engaging with UKCRIC; through direct commissioning of a facility or facilities, professional training, sponsoring a research stream, and framework agreements. We also offer technical consulting services and welcome collaboration on higher TRL opportunities via the trading company of UKCRIC, UKCRIC Limited.

If our Scientific Missions complement your organisation's research and innovation priorities, we'd like to hear from you.

**Contact us to find out how
UKCRIC is able to help.**



Engineering and
Physical Sciences
Research Council