UKCRIC Roadmap

a vision for the future

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UKCRIC™

UK COLLABORATORIUM FOR RESEARCH ON INFRASTRUCTURE & CITIES

The UKCRIC Roadmap is the primary output arising from a twelve-month programme of work and was reliant on the contributions of multiple partners and stakeholders. The project was led by the UKCRIC investigators Prof Gordon Masterton, Prof Liz Varga, and Prof Sergio Cavalaro and supported by the dedicated researcher Seraphine Appel.

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Who we are

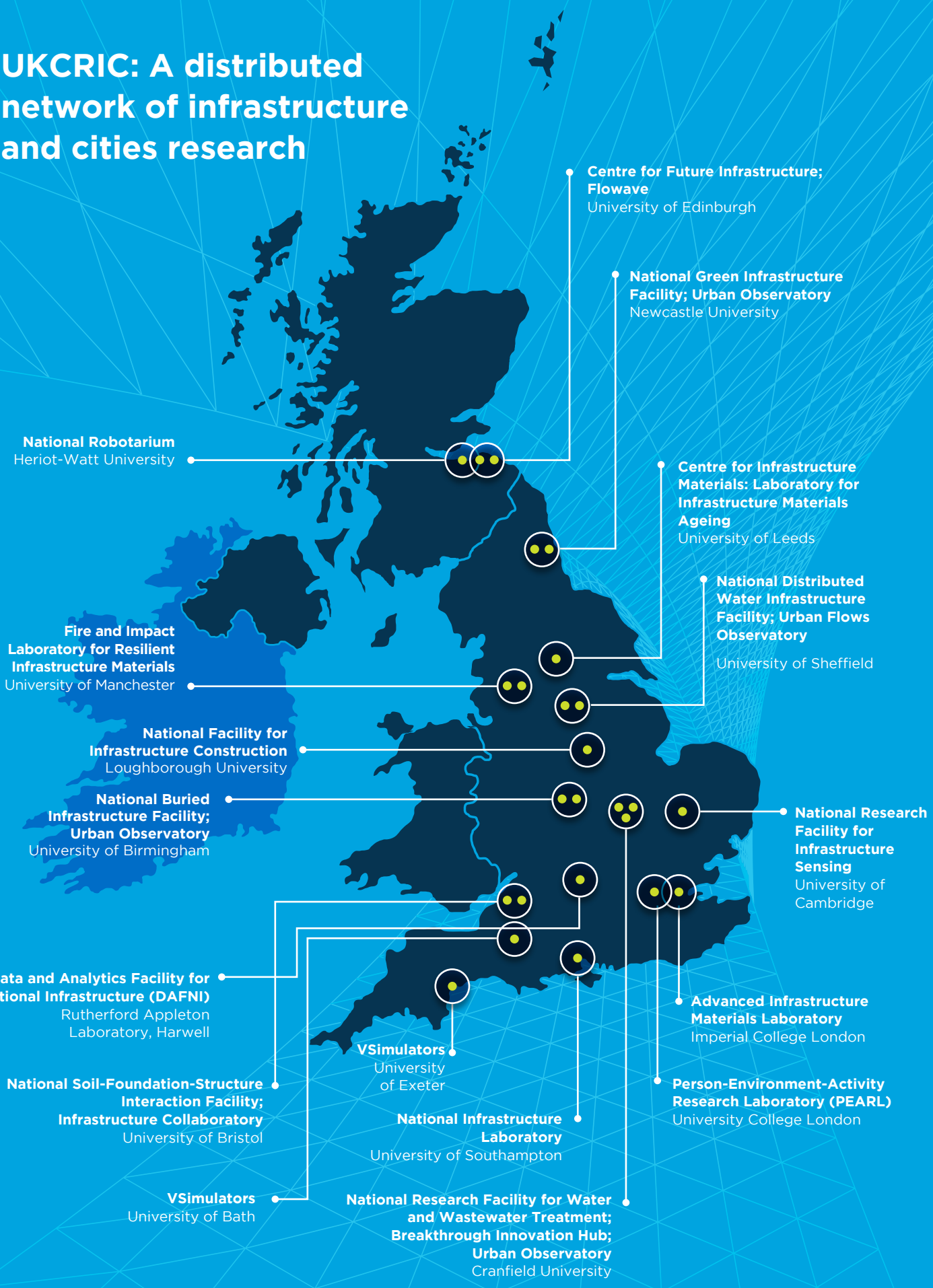
The UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC) is a consortium of expertise with an unrivalled scale of facilities and experts that spans the UK and brings together its leading universities in infrastructure and urban systems research. UKCRIC is leveraging improvements to infrastructure and urban environments to transform productivity, sustainability, and resilience outcomes. Its central capability is developing mechanisms, underpinned by a Theory of Change, to connect integrated transdisciplinary research to policy and practice. Already delivering substantial impact, UKCRIC's complementary Laboratory Facilities[1] enable testing at or near full scale, its Urban Observatories[2] collect real-time data, and the Data and Analytics Facility for National Infrastructure (DAFNI)[3] houses data modelling and simulation capabilities. Together they provide a world-class foundation for research and trialling new developments. UKCRIC's aim is to unlock the globally significant potential of infrastructure and cities to catalyse progress towards vibrant and liveable futures, which is becoming ever more relevant given the substantial and urgent challenges now faced by the UK and the international community. Commitment to a systems-based approach means working across disciplines and sectors to enable a deeper understanding of the consequences of any given intervention to de-risk investment, build resilience, and respond to current and future challenges.

The purpose of this roadmap

This roadmap was developed to inform decisions for transitioning UKCRIC into a viable venture by exploring normative futures and making recommendations for the transition from capital projects and coordination node creation to being established as an institute. The recommendations were developed through desk research, analysis of the vision and theory already developed, and engagement with UKCRIC partners and stakeholders. The purpose is to offer strategies and mechanisms to achieve the objectives of UKCRIC and its partners through consensus-building and imagining possible futures. This roadmap identifies strategic risks, offers strategies for viability and recommended enablers, and suggests short-, medium-, and long-term steps to achieving UKCRIC's objectives.

1. https://www.ukcric.com/facilities/
2. https://urbanobservatory.ac.uk/explore/ukcric
3. https://dafni.ac.uk/

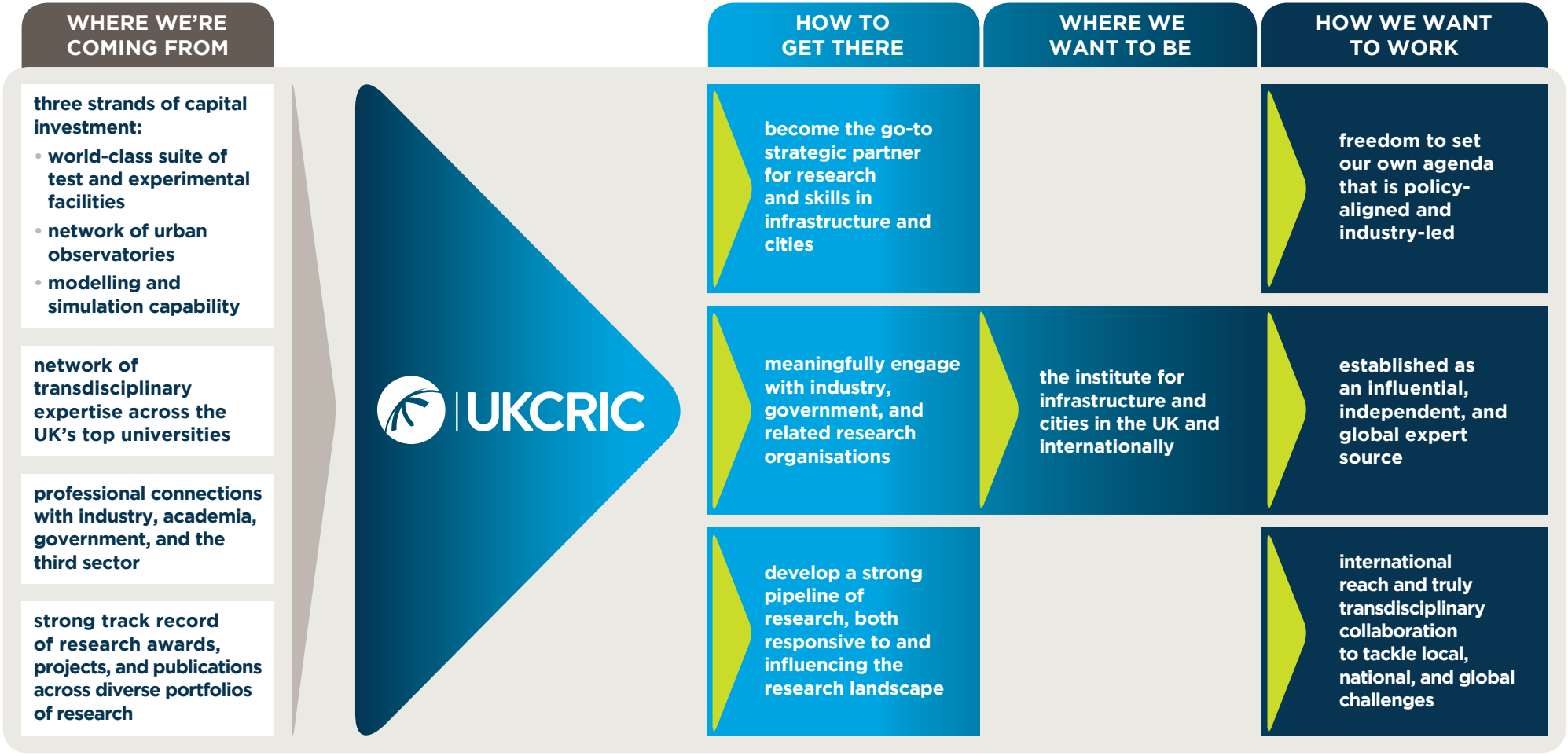
UKCRIC: A distributed network of infrastructure and cities research



Where we want to go

Following the initial capital investment phase of building the Facilities and implementing the Coordination Node, UKCRIC has entered a transition period in which it will transform to its fully operational phase and sustain the collaboration. The long-term goal is to be an institution with the objective of becoming an influential, independent, and global expert source in the fields of infrastructure and cities.

Figure 1: UKCRIC's foundation and main goals for the future



Enabling the future of UKCRIC

Members of the UKCRIC International Advisory Board, Governing Board, Executive Board, and other critical colleagues were invited to imagine different future funding scenarios and how they would affect UKCRIC's impact, governance, research priorities, ability to act/responsiveness, and influence/ stakeholder engagement. This allowed investigation of mitigation and adaptation possibilities in a variety of possible futures. Table 1 shows the identified strategic risks and their corresponding mitigation strategies that could be successful in any funding scenario.

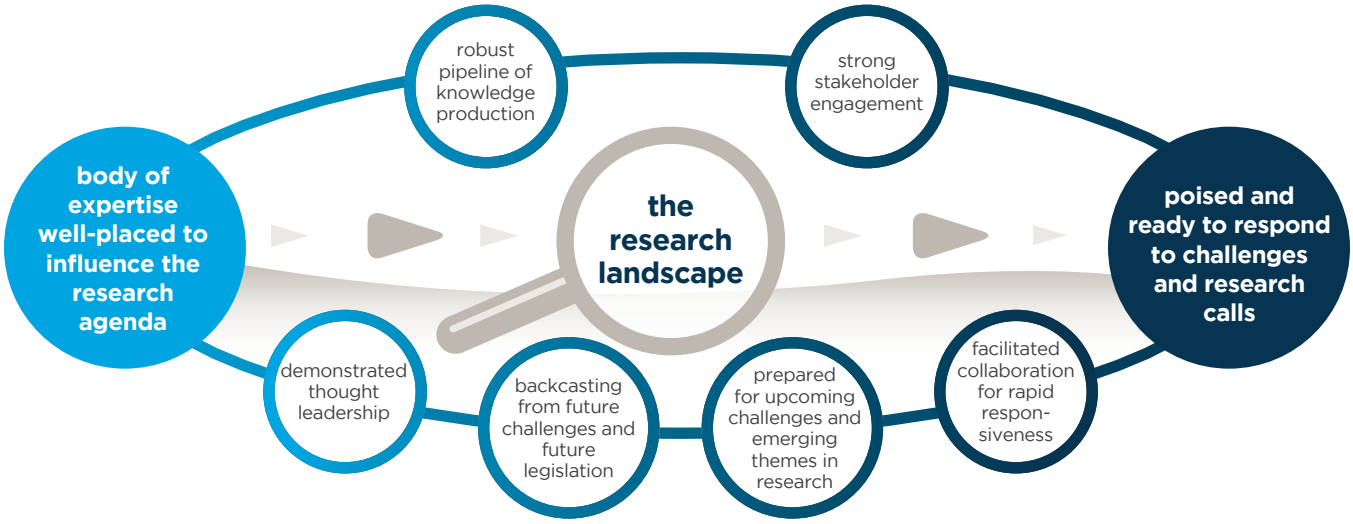
Table 1: Enablers designed to respond to identified strategic risks and strategies for viability

Strategic risks	Strategies for viability	Recommended enablers
Failing to utilise our collaborative strengths	Aligned research agendas Coordinated activities and facilitated collaboration	- Explicitly align research projects, activities, and groups with UKCRIC's Scientific Missions, maintaining targeted research priorities for different scales while aligning with the shared vision - Facilitate connections between UKCRIC partners to develop collaborative proposals through internal events and workshops; facilitate new membership and their integration into the research community - Make connections to other disciplines and apply research to other sectors; foster cross-disciplinarity
Poor external engagement and communication	Prioritise internal and external communication and stakeholder engagement	- Schedule regular reviews of government, industry, and international research priorities with recommendations from the International Advisory Board and the Stakeholder Advisory Group to maintain a research agenda that is aligned with local, national, and international priorities - Prioritise maintaining funding for a Communications, Marketing and Events Manager position to develop capabilities that align internal and external communications
Failing to develop robust mechanisms	Stay active and monitor activities Strategic planning for adaptability	- Establish strong, balanced KPIs and monitoring mechanisms to track across different projects systematically for effective reporting, adaptability, prioritising, and impact creation - Embed strategic planning that slims research activity to prioritise activities in moments of restricted funding - Conduct translational research into multiple sectors and industries to strengthen adaptability to changing research priorities
Poor governance	Strong leadership and resilient governance structure	- Establish central coordinated governance with leadership rotation or succession strategy that utilises in-kind contributions from members, ensuring workload is shared across the community and governance is not dependent on external funding
Loss of capacity, talent, and collaboration	Collaboration and shared vision	- Maintain strong internal communication with robust EDI principles, engagement with all partners from doctoral students to HEI leadership - Build internal collaboration and foster bottom-up organising of research agendas, events, etc.

What we can do now

During this transition period, it is necessary to strengthen both the responsiveness of UKCRIC research and the ability to influence the research landscape.

Figure 2: Engaging with the research landscape by developing the responsive mode of research production in parallel with influencing the research agenda



To be better poised and ready to respond to emerging challenges and research bids, UKCRIC should develop the capacity to effectively horizon scan and support collaborative responsive research by:

- Strengthening its coordinated activities and facilitated collaboration across universities, disciplines, and career stages through All Hands meetings and other targeted mechanisms; accumulating evidence for a full business case for a future Institute for Infrastructure and Cities
- Bidding for and delivering research aligned with local, national, and international priorities by (a) horizon scanning and preparing for emerging themes in research; and (b) mapping capabilities across the Collaboratorium and developing a shared resource to support rapid collaborative response to research calls and cross-pollination of UKCRIC Facilities
- Sharing knowledge and news of collaborations and undertakings of UKCRIC members through strengthened internal communications
- Securing medium-term funding for the Operations Team to support the collaboration efforts

In parallel, with a view on the long-term, UKCRIC should be pushing the boundaries and raising its profile to influence the research landscape by:

- Demonstrating thought leadership in areas of expertise by widening engagement to a broader set of stakeholders in infrastructure and cities
- Building and maintaining strong stakeholder engagement with industry and government partners and diversifying sources of advice, steering, and collaboration to include other research organisations, universities, disciplines, community organisations, and the third sector
- Developing and producing foundational content that is useful internally and to others by creating a pipeline of knowledge production and directing it to the right places

Figure 3: Timeline of recommendations

Funding scenarios:

Basic functions maintained and Operations Team continues to support collaboration, communications, events, coordinated activities, etc.

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Research, innovation, and strengthened collaboration is supported by UKCRIC seed funding for research projects; possibility to grow the Operations Team with identified need; funding available for fully networked CDT and UKCRIC post-doctoral, ECR, and CPD training schemes

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An institute with sufficient core funding for research and development to support the Facilities, Urban Observatories, and DAFNI's National Infrastructure Database, as well as allow for the creation of new centres of innovation across the whole of the UK

CURRENT FOCUS – consolidation

consolidating and expanding the UKCRIC network and articulating its research priorities

- **Diversify advice and collaboration:** Convene the Stakeholder Advisory Group to offer insight and steering alongside the International Advisory Board; create partnerships/relationships with other key research bodies and researchers in other disciplines
- **Align research activities:** Explicitly align research projects, activities, and groups with (though without being predetermined by) UKCRIC's Scientific Missions and Research Agendas and underpin activities with the methodologies developed in the UKCRIC Theory of Change; maintain targeted research priorities for different scales while aligning with the shared vision
- **Foster bottom-up organising:** Facilitate collaborative spaces and opportunities - e.g., All Hands meetings; horizon scan and prepare for emerging themes in research; strengthen internal communications; strengthen collaboration with the Doctoral Skills Network and the Centre for Postdoctoral Development in Infrastructure, Cities and Energy (C-DICE); map capabilities across the Collaboratorium and develop a shared resource to support rapid collaborative response to research calls and cross-pollination of UKCRIC Facilities
- **Horizon scan and backcast to identify research focus areas:** Identify knowledge gaps/research challenges that the UKCRIC community, government, and industry identify as research priorities, which are not only aligned with national and international priorities, but have a view on the long-term by prioritising areas for which backcasting from forecasted future legislation or future challenges is necessary

MEDIUM TERM – where we're headed

producing foundational content and growing the network

- **Establish UKCRIC areas of expertise:** Convene working groups to tackle key challenges and develop a series of briefing papers to address research priorities which have been identified as national/international priorities and fit with UKCRIC's research expertise, to develop foundational research outputs and demonstrate thought leadership
- **Produce useful foundational outputs:** Develop the briefing papers as well as toolkits and other knowledge resources which can be used to inform internal methodologies, for training, and to show what UKCRIC can deliver and in what areas it can lead
- **Support self-organised internal collaboration:** Connected to the simultaneous strengthening of the responsive mode of collaboratively applying for research funding, some working groups may continue to develop a research proposal, collaborative research paper, hold events and training/skills transfer activities, or generate other outputs (with continuing support from the Operations Team)
- **Engagement with multiple fields and audiences:** Foster multidisciplinary input and research activities by inviting researchers from other disciplines, encouraging translational research, and producing research outputs for a variety of audiences; strengthen engagement with the third sector as well as with educators, community groups, and the general public in order to involve civic society in interdisciplinary research
- **Develop a business case for the Institute for Infrastructure and Cities:** Communicate accumulated evidence for developing UKCRIC into an institute

LONG TERM – vision for the future

cementing national and international influence

- **UKCRIC is the Institute for Infrastructure and Cities:** Established as an influential, independent, and global expert source, and is the go-to strategic partner for other research organisations, industry, policymakers and government (e.g., Ministers, Chief Scientific Advisors, Departmental Science Advisory Council, Special Advisors, etc.), and society
- **Established pipeline of research:** Built and maintained pipeline of research directed to the right places (e.g., Chief Scientific Advisors)
- **Truly interdisciplinary:** Established network which includes other disciplines (e.g., social and political sciences, geography, psychology, business studies, economics, sociology, architecture, etc.)
- **Diverse research portfolio:** Demonstrated ability to tackle issues from lower TRL research connected to the Facilities through higher TRL projects and wicked problems to deliver consultant reports and policy recommendations
- **International involvement:** International profile engaged with global research challenges on a global scale and involved in international research initiatives
- **Influence and innovation:** Recognised influence over the national and international research landscapes, and influence on national policy for increased preparedness and resilience in the face of increasing global challenges (e.g., climate change, Sustainable Development Goals (SDGs), energy security)
- **Systems thinking becomes the standard:** Every major infrastructure and cities project embraces systems thinking and practices through interdisciplinary and cross-sector collaborations to deliver innovation and learning

Appendix 1: Research focus areas

UKCRIC research areas are being developed alongside this roadmap. Challenge-led research and development is ever-evolving and requires ongoing horizon scanning and backcasting, and research priorities to which UKCRIC is well-placed to respond will inform the proposed working groups and their outputs. Research focus areas will be viewed through the UKCRIC Scientific Missions and will align with and complement the previously identified Research Agendas and other work on research routemapping. Horizon scanning, backcasting from expected future challenges, input from UKCRIC members of all levels, and steering from the International Advisory Board, Stakeholder Advisory Group, and other critical colleagues will help inform the process of prioritising and setting the research focus areas and broader agenda.

Figure A4: UKCRIC Scientific Missions

1. INFRASTRUCTURE AND URBAN SYSTEMS FOR ONE PLANET LIVING

Accelerating sustainability through substantial advances in responsible consumption, resource efficiency and sustainable growth and helping the UK meet its carbon targets.

2. OWNERSHIP, GOVERNANCE AND BUSINESS MODELS FOR INFRASTRUCTURE AND URBAN SYSTEMS

Developing innovative models for coping with greater system interdependencies, changing patterns of use and new, disruptive technologies while at the same time delivering social justice and affordability.

3. TRANSFORMATIONAL INFRASTRUCTURE AND RESILIENT URBAN SYSTEMS FOR A CHANGING WORLD

Pioneering methods in infrastructure and urban systems design to meet the challenges of climate change, changing patterns of use, societal expectations and emergent technologies.

4. INFRASTRUCTURE AND URBAN SYSTEMS AS DRIVERS OF EQUITY, INCLUSION AND SOCIAL JUSTICE

Providing the underpinning, transdisciplinary research platforms for forging healthy, happy and productive lives for all through urban design, planning, policy and infrastructure.

Appendix 2: Mechanisms for monitoring and adapting the recommendations in this roadmap

Bottom-up and top-down steering

One of the main recommendations of this roadmap is to foster a diversity of sources of advice and directions of collaboration. This means engaging with multiple stakeholders, committing to transparency, embedding adaptability, and fostering opportunities for bottom-up as well as top-down steering of research activities through establishing processes of decision-making and agenda-setting that span all levels of involvement and interest.

Recommended enablers: (a) engage with various levels of UKCRIC (e.g., involving both the Governing Board and the Facilities Managers) during decision-making processes for determining research outputs (e.g., the proposed series of briefing papers); (b) develop mechanisms for engagement self-selection to occur (e.g., communications to the UKCRIC community that are easy to respond to).

Link outputs to measurable outcomes

Monitoring and reporting on activities and outputs are crucial to determining if they are delivering the desired outcomes and to ensure that UKCRIC has the right balance of focus between the short-term response to funding calls and the long-term pipeline of foundational research outputs. The importance of developing responsiveness is key and will be enabled by a strengthened capability to make coordinated research bids and to influence the research agenda. The effectiveness of developing capabilities and outputs should be continuously reviewed, keeping the long-term goals at the forefront.

Recommended enablers: regular reviews of (a) research priorities; (b) how the identified research priorities match the skills and knowledge within UKCRIC, and how those that do not can be strengthened; (c) efficacy of responsive research capabilities and methods; and (d) efficacy of influencing research capabilities and methods.

Appendix 3: The process of developing the roadmap

This roadmap is the culmination of a programme of work reliant on the contributions of stakeholders and led by Prof Gordon Masterton (Chair of Future Infrastructure, University of Edinburgh, and UKCRIC Deputy Convenor), Prof Liz Varga (Professor of Complex Systems, UCL, and Principle Investigator of the UKCRIC Coordination Node), and Prof Sergio Cavalaro (Chair of Infrastructure Systems, Loughborough University, and the UKCRIC Doctoral and Postdoctoral Training Lead), and supported by Seraphine Appel (Research Fellow, UCL, Researcher for the UKCRIC Roadmap project).

This project has explored options via consensus-building across multiple partners and stakeholders on various opportunities and potential normative futures. The findings are intended to inform the UKCRIC Governing Board's decisions required for transitioning UKCRIC into a viable venture. The methodology used a discursive approach rather than following a logic model, and purposefully focused on what is possible given the current dependencies, capabilities, and funding landscape.

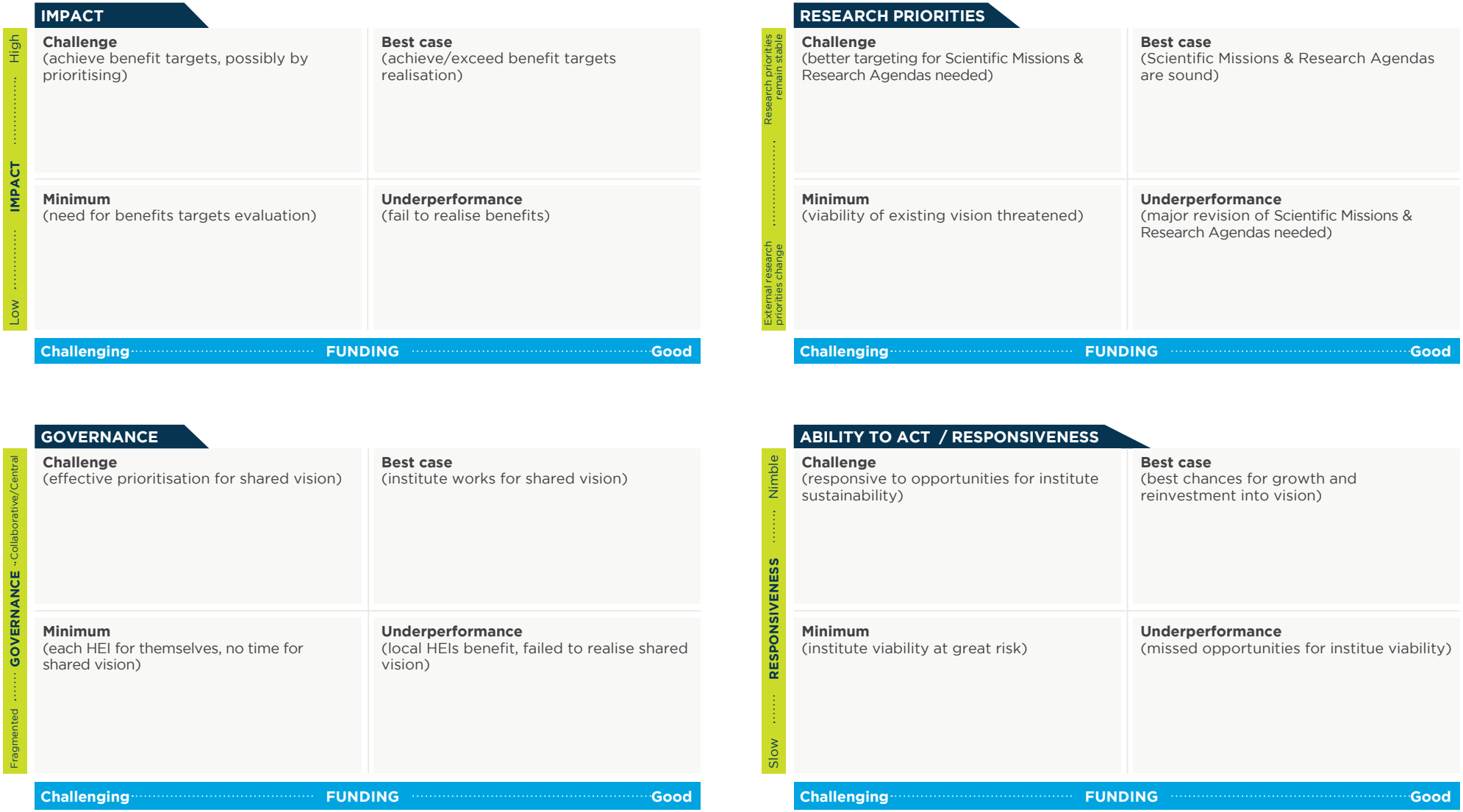
In December 2021, the authors held a Visioning Session as a first step in consensus building around mitigation and adaptation possibilities in a variety of possible futures. By using a series of possible-future matrices, we explored the consequences of funding scenarios combined with other variables. Four matrices were prepared for the session, and a fifth was left blank for participants to discuss and agree. Participants explored impact (high vs low), governance (collaborative/coordinated vs fragmented), research priorities (external research priorities remaining stable vs changing), and ability to act/responsiveness (nimble vs slow). Influence/stakeholder engagement (high vs low) was agreed for the final matrix. The common axis was funding (good vs challenging) as this is currently UKCRIC's most pressing challenge and is expected to continue to be so for the next several years. Participants from across UKCRIC and other critical colleagues contributed to each possible future in the form of consequences, potential scenarios, strategies for resilience/long-term sustainability, mitigation strategies, and possible routes by which UKCRIC might arrive in different positions. These responses were then analysed to identify the main strategic risks, strategies for mitigation and resilience, and enablers such as monitoring and adaptation strategies, and formed the foundation for subsequent research that produced the final recommendations for this roadmap.

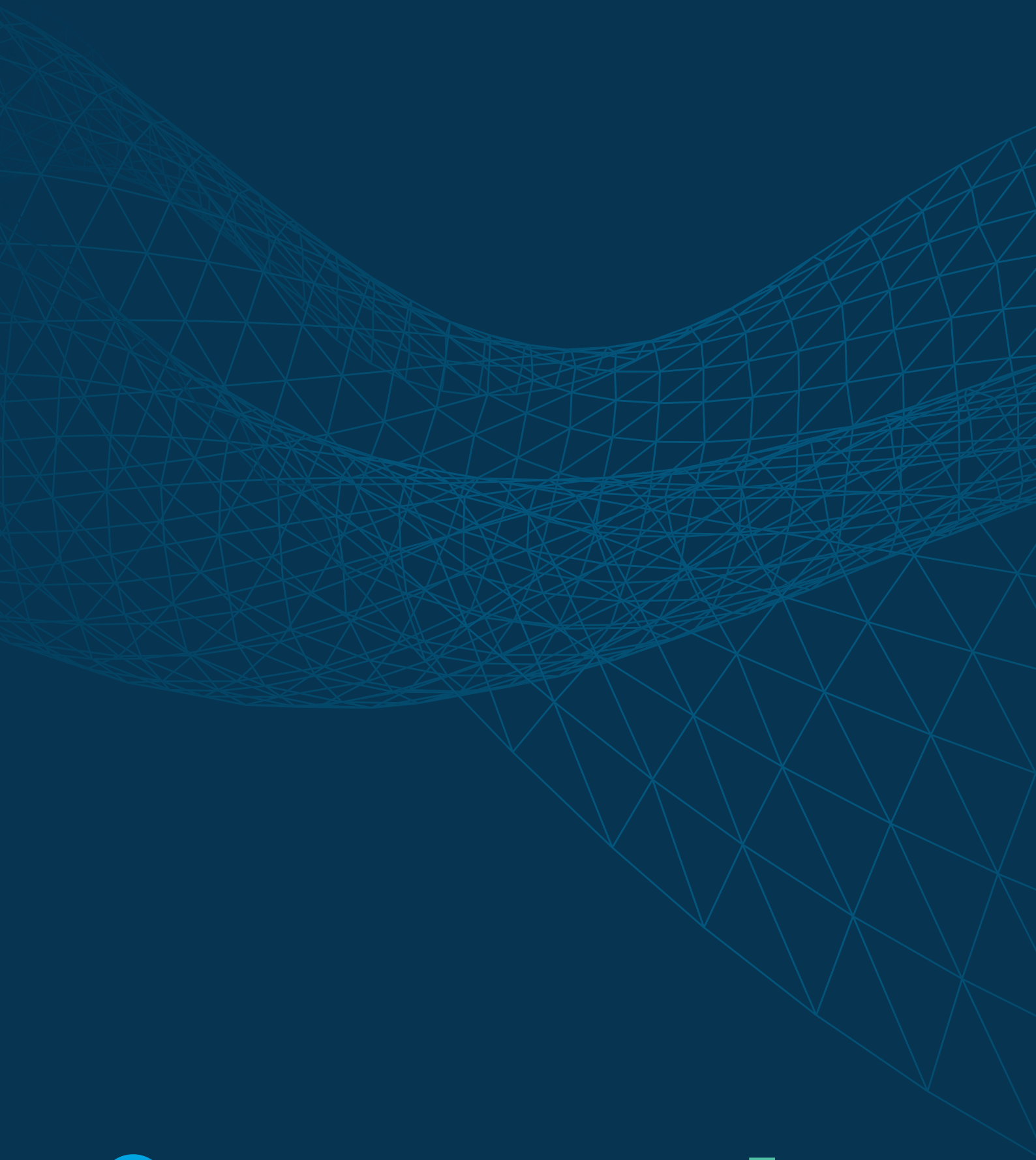
Several of the enablers identified were actioned during the process of developing the roadmap, such as the creation of the Industry Clusters ahead of the event "Working with UKCRIC to accelerate R&D in infrastructures and cities" in May 2022, the creation of the Stakeholder Advisory Group, and planning of the first working groups and their outputs.

Due to the nature of the project revolving around transparency, dialogue, and consensus-building, the recommendations within this document were shared and discussed across UKCRIC and beyond throughout the process, and the short-term recommendations are being piloted as the first draft of this roadmap is being circulated.

Figure A5: Timeline for developing the UKCRIC Roadmap

Figure A6: Four matrices from the Visioning Session





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