

# UKCRIC and the Oxford-Cambridge Arc



**UKCRIC**

UK COLLABORATORIUM  
FOR RESEARCH ON  
INFRASTRUCTURE & CITIES

## Who we are and what we do

UKCRIC is an integrated research capability with a mission to underpin the renewal, sustainment and improvement of infrastructure and cities in the UK and elsewhere. We were founded by a collaboration of universities who recognised that governments struggle to think about infrastructure in a joined-up way, and want to address the impacts that siloed planning can have on current and future infrastructure.

**TWELVE**  
INFRASTRUCTURE  
LABORATORIES



**SIX**  
URBAN  
OBSERVATORIES



**FIFTEEN**  
PARTNER  
UNIVERSITIES

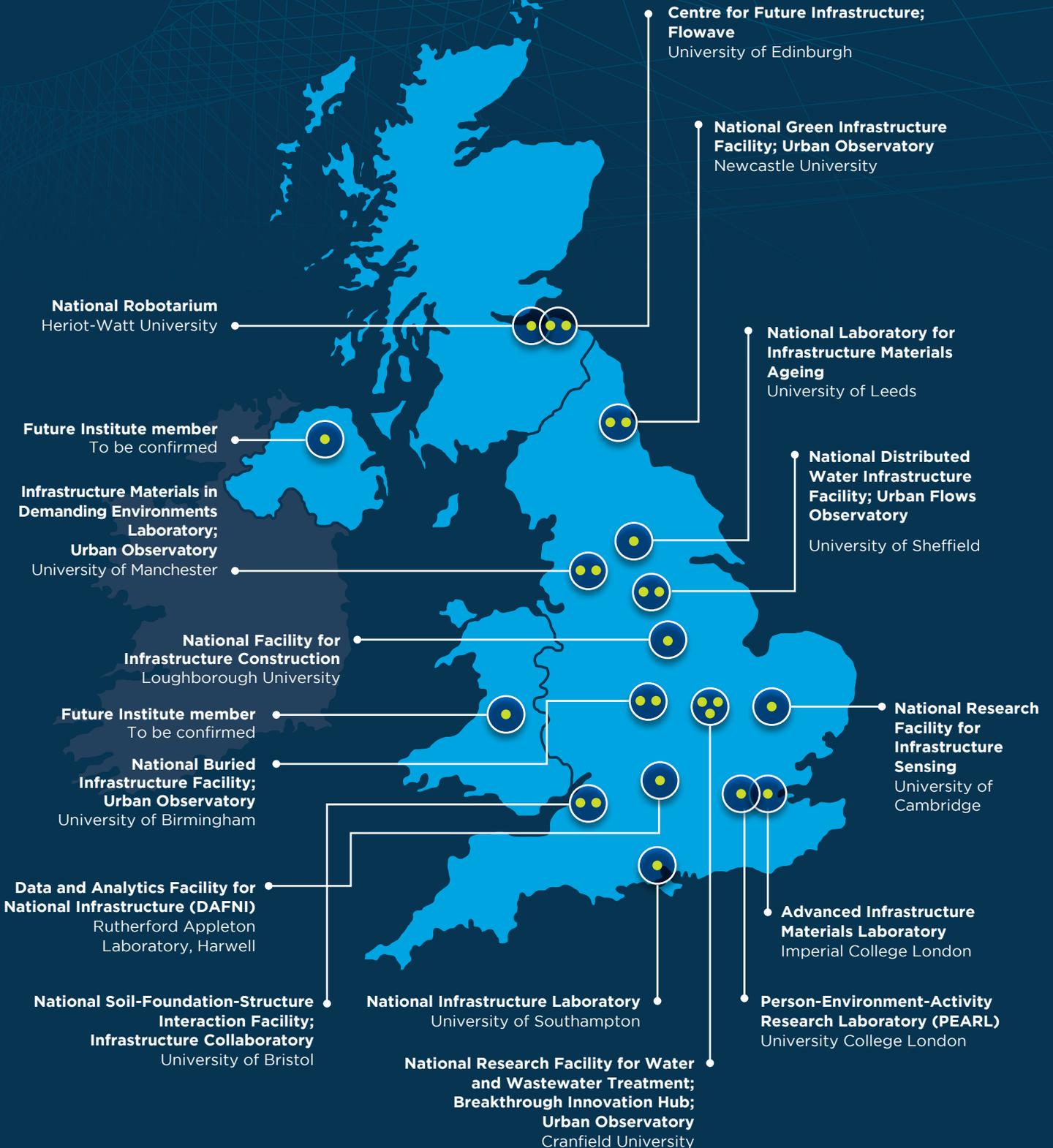


With considerable support from EPSRC, we now operate 15 cross-disciplinary infrastructure laboratory and urban observatory facilities. We are collecting, collating and curating large volumes of diverse data about current and proposed infrastructure. This data will enable policies, regulation, planning and capital investments and strategic, tactical and operational decisions to be made on the basis of evidence, analysis and innovation.

We are working to benefit society by encouraging disparate areas of infrastructure to work collaboratively with each other; areas such as water, waste, transport, energy, connectivity, and data. We engage with stakeholders to better understand and address complex infrastructure challenges through collaborative research, and we are always looking for opportunities to help improve situations. UKCRIC does not have a single geographical home. Each academic partner leads a theme and contributes to others, creating a strong collaborative network with multiple centres and connections between them. This spreads the benefits across the UK and into teaching programmes throughout higher education in the UK and beyond.

UKCRIC is well placed to provide a range of contributions to those charged with realising the ambition of the Oxford-Cambridge Arc. Its collaborative operating model and convening power across multiple sites and establishments can mobilise world-class research to tackle both well-defined engineering problems and the complex, systems-level challenges which emerge from the interdependencies which characterise many of our infrastructure systems. The research capacities and capabilities accessible through UKCRIC provide an important resource for the reshaping of our infrastructure systems so that they work for both people and planet.

## Facilities map



Partners



Imperial College  
London





Centre for Future Infrastructure



National Green Infrastructure Facility



Manchester Urban Observatory



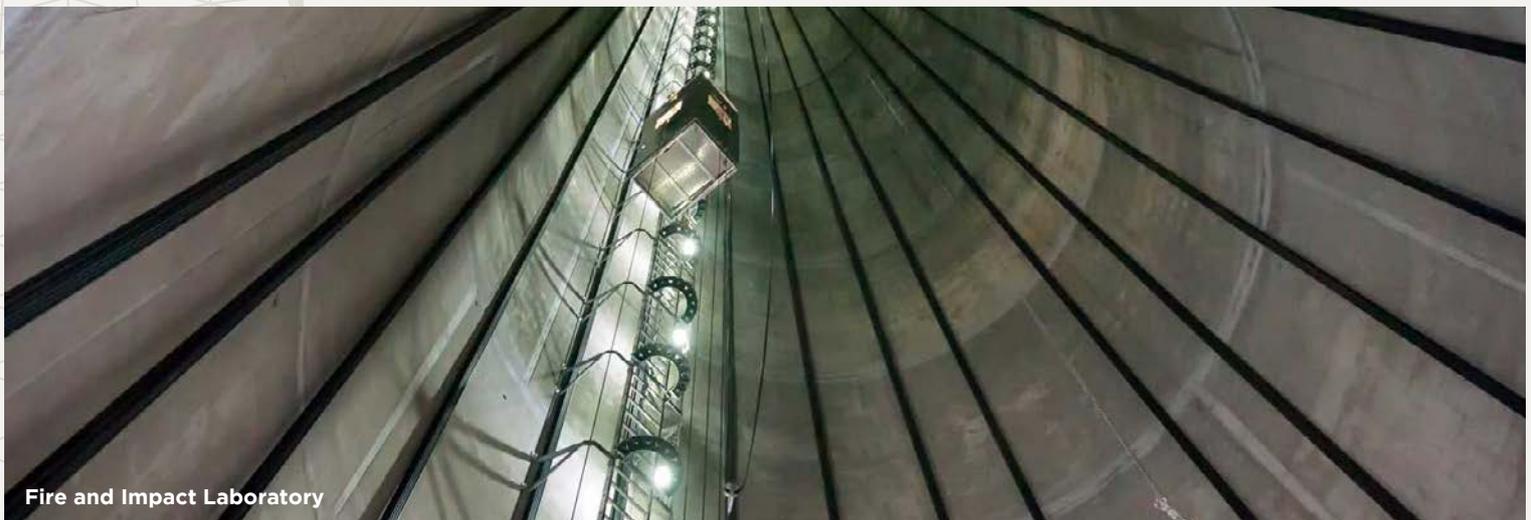
Person-Environment-Activity Research Laboratory



Advanced Infrastructure Materials Laboratory



Bristol Infrastructure Collaboratory



Fire and Impact Laboratory

## The Oxford-Cambridge Arc

The Arc between Oxford, Milton Keynes and Cambridge has been identified as an economic asset of international standing with potential for significant growth to the benefit of local communities and the country as a whole. Realising this potential will require new ways of working between business, local stakeholders and Government so that the benefits of growth can be delivered for local people and the country whilst protecting and enhancing the natural environment. Ensuring that the advantages of development are delivered in a way which enhances sustainability and resilience will require major innovations in networked services such as transport, energy and water.

Government are working together with local partners to unlock the area's potential through four inter-related policy pillars:



**Productivity:** ensuring we support businesses to maximise the Arc's economic prosperity, including through the skills needed to enable communities to benefit from the jobs created;



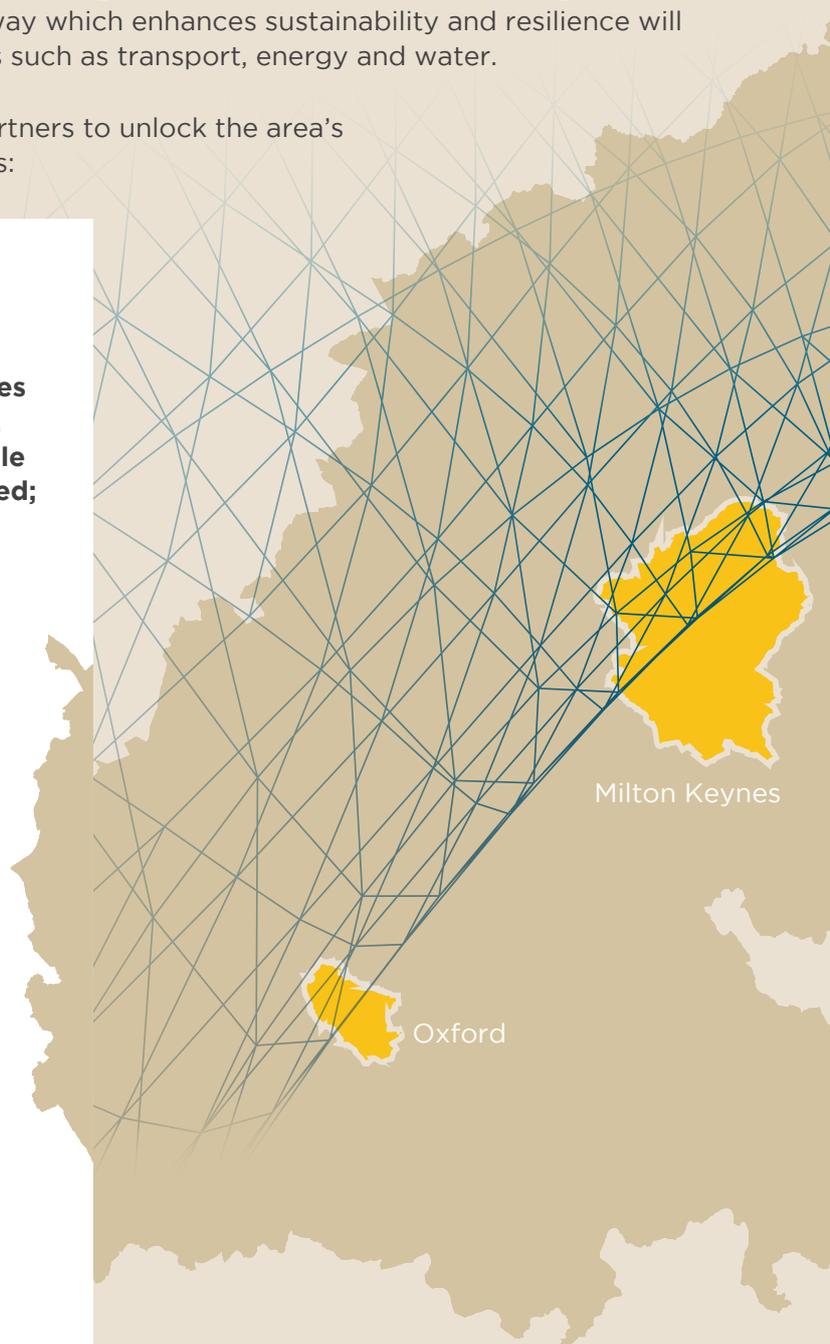
**Place-making:** creating places valued by local communities, including through the delivery of sufficient, affordable and high-quality homes, to increase affordability and support growth in the Arc, as well as wider services including health and education;



**Connectivity:** delivering the infrastructure communities need, including transport and digital connectivity, as well as utilities;



**Environment:** ensuring we meet our ambitions for growth while leaving the environment in a better state for future generations.





## The Arc Universities Group

The Arc Universities Group (AUG) is a network of universities between Oxford and Cambridge, formed to foster collaboration, research, skills and innovation to support the economic growth of the Oxford-Cambridge Arc.

With a combined turnover of £5bn, together they are responsible for nearly 20% of the UK's innovation and spin out activity from Universities. By uniting the distinct universities across the region, the Arc Universities Group are working alongside business and government to foster research, skills and innovation to support growth, inclusivity and resilience across the region.

Cambridge



## Transport

UKCRIC provides access to a suite of transport infrastructure research facilities. The world's largest moving model crosswind tunnel at the University of Birmingham is being used to develop a GIS framework to assess crosswind risks for road and rail vehicles with related work looking at the aerodynamics of autonomous vehicles travelling in groups.

The Person-Environment-Activity Research Laboratory (PEARL) at UCL is a unique facility with the ability to explore the ways people interact with different environments and capacity to create full scale, controlled condition environments such as railway stations and pedestrian concourses.

Already under way collaborations include explorations of railway-soil dynamic interactions (Southampton and Bristol), assessing property value as a function of new rail and road routes (UCL and the National Infrastructure Commission), substrate vulnerability to clogging in road runoff (Newcastle and Sheffield), and creating robots to conduct street works (Sheffield, Leeds, Birmingham and Bristol).





## Supporting East-West Rail

A joint workshop with UKCRIC in 2019 resulted in the prioritisation of several research activities to underpin delivery of a more sustainable East-West rail link. Two of these were delivered in early 2020 via post-graduate group design projects at Cranfield University.

### Solar energy for East-West Rail

The objective of this project was to identify what the potential contribution of solar energy could be to East-West Rail's net zero carbon emission ambition. Looking specifically at utilising the stations and track assets only, the study concluded that a maximum of 22% of the total system demand could be covered by solar sources.

The analysis included assessment of the potential solar power contribution from two novel technologies; solar sleepers (particularly useful to provide electricity to the signal lights) and solar panels on train roofs.

The study concluded that of the

**22%** TOTAL SYSTEM DEMAND

could be covered by solar sources

### Reducing Carbon emissions during track construction

Adopting a whole system perspective on the challenge, this study identified and quantified the various ways in which East-West Rail could achieve net zero carbon in its track capital delivery programme. Life Cycle Analysis was based on a representative 1km length of track with embedded carbon calculations following the method adopted by the HS2 project.



The use of new construction materials and techniques as well as of recovered materials from other sectors provided novel options to reduce embedded carbon values.

## Water

The test and experimental facilities comprising UKCRIC's urban water group cover the three primary classes of asset in the sector; treatment, conveyance, and storage. The National Research Facility For Water And Wastewater Treatment at Cranfield comprises pilot-scale infrastructure laboratories for wastewater and drinking water treatment as well as a test and control sewer loop and dedicated lab spaces for the development of point-of-use water treatment technologies and advanced sensors. At Sheffield, the National Distributed Water Infrastructure Facility provides a unique laboratory for research into the performance of distributed urban water infrastructure (potable, sewer and drainage), enabling the study of failure of water assets under a range of multiple, complex loadings and the interaction between an asset and its surrounding environment.

The National Green Infrastructure Facility (NGIF) at Newcastle underpins research into Sustainable Drainage Systems (SuDs), Green Infrastructure approaches, and making urban centres more resilient and sustainable for future generations. A full-scale suite of experiments and demonstrators have been established to provide a unique opportunity to gather evidence needed by decision makers to implement Green Infrastructure solutions to fulfil in the increasing need to attenuate, infiltrate, treat and control flow in the built environment. Complementary UKCRIC contributions to solving urban water challenges come from Imperial College London (surface science), University of Birmingham (buried infrastructure performance), and University of Cambridge (sensing and monitoring).





## **Working with Water Resources East and Water Resources South East**

UKCRIC are working with the two regional water planning bodies whose geographical remits cover the Arc to identify and develop multi-sector collaborative solutions. This will ensure that the region has sufficient water resources to support a flourishing economy and thriving environment, in addition to providing water for communities.

Our contributions include analysing future agricultural water consumption and assessing supply demand balances across the region's many catchments.

## Urban Observatories

Alongside the large scale infrastructure laboratories, UKCRIC operates six urban observatories which are collecting vast amounts of open access data on parameters such as infrastructure condition, air quality, noise, and traffic flows. These facilities are designed to capture the complex interrelations and interactions of engineered systems with the environment, people and the economy. Their work is being used along the Arc already, such as Cranfield's rapid study of air quality throughout the Oxford-Milton Keynes-Cambridge Arc.



The study starts at a time when Covid-19 lockdown measures are being eased and the scientists are keen to understand the effect of increased human activity on air quality within the region. The study will utilise Cranfield's Urban Observatory which harnesses the latest sensor technology and includes environmental and infrastructure sensors to monitor behaviour and factors such as air and noise pollution and water usage. The data, analytics and visualisations can be used to view and compare infrastructure and environmental performance, quality of life and wellbeing, allowing the investigation of healthy and sustainable environments and the effects of planned change in a dynamic way.



## Air Quality in the Oxford-Milton-Keynes-Cambridge Arc

Cranfield University is a controlled mixed (urban and rural) site in the Arc's heart. It has a self-contained campus with a unique combination of infrastructure, site types and facilities. The Cranfield Urban Observatory reference station is operating, and multi-species sensor units have been deployed at sites across the Oxford-Milton Keynes-Cambridge Arc in order to provide a detailed observational record during a period of low traffic and industrial activity while COVID-19 restrictions are in place. Real-time information can be provided on the interaction between air quality and the easing of social distancing measures. These measurements made during a period of known intervention measures will inform infrastructure planning for the Arc and the design of Low Emission Zones and air quality policy more generally.

The data will be available for use by researchers looking at the effects of these measures.



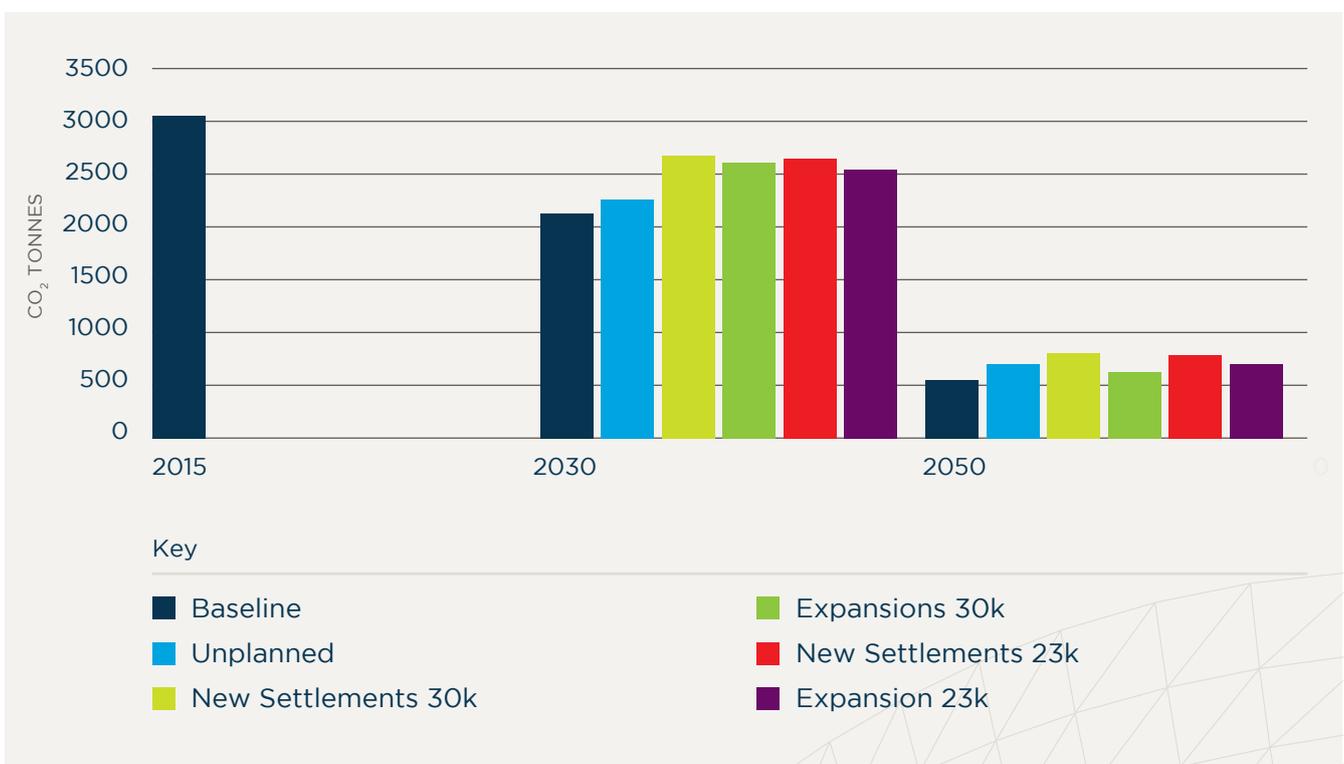
# Integrated Regional planning

## Infrastructure planning with DAFNI

The Infrastructure Transitions Research Consortium (ITRC), the precursor of DAFNI (see [here](#)) has developed models, scenario analysis and geospatial design methodologies that can help to explore and inform choices about how the Arc will be developed. They provided a multi-scale infrastructure systems analytics assessment based around three contrasting growth scenarios for new dwellings within the Arc, together with the development of the road and rail networks between Oxford and Cambridge (see report at [www.itrc.org.uk/in-practice](http://www.itrc.org.uk/in-practice)).

DAFNI's system-of-systems approach offers the capability to quantify the implications of changing local needs for infrastructure services, within the context of the national 'big picture' of population change, economic growth, technological innovation and climate change. Study conclusions included confirmation that the vision of a carbon neutral Arc is achievable, caution around the impact of planned new roads unless passengers are transferred onto other modes of transport such as rail, walking and cycling, and a warning that without new infrastructure to improve supply, the risk of restrictions on water use doubles by 2050.

### Yearly CO2 emission for car trips in the Arc



## Sustainable communities

Placing sustainable communities at the heart of the Arc development offers opportunities to fast track research on green technologies to enable timely scale-up and implementation.

UKCRIC research teams are already making significant advances in relevant areas including work at Imperial College London on the microstructure and durability of concrete prepared using new multi-component low-carbon cements, at Leeds on developing off-gas housing estates which would use infrastructure as a thermal energy source, and at Newcastle on the potential of Sustainable Drainage Systems (SuDS) as an urban energy resource.

**Efficient use and protection of limited natural resources also sets a challenging ambition for growth in the Arc.**





## The UKCRIC Offer

**As society grapples with the multi-faceted nature of infrastructure rehabilitation, renewal and expansion (inadequate infrastructure in the UK is estimated to cost £2m a day) we will need advanced scientific understandings to inform appropriate solutions which deliver on the sustainability agenda and enhance the resilience of both urban services and city communities. Additional expectations around equitable service access and affordability, minimal disruption, and net zero carbon make for a complex infrastructure delivery performance envelope which demands innovation across a wide range of disciplines and sectors.**

Research funded by both commercial and public investments which is of significance for the Oxford-Cambridge Arc is already being conducted through UKCRIC; much of it using systems thinking approaches to frame cause-effect and other relationships, deploying the concept of learning journeys to improve knowledge sharing, and providing a sharp focus on the inter-dependencies between different infrastructure networks and the urban environments they serve.

In addition to supporting the various infrastructure sectors faced with responding to the development ambitions of the Arc through advanced science and engineering, UKCRIC has the potential to address some of the more recalcitrant challenges which our cities face; enhancing inter-sectoral resilience against extreme events, enhancing value capture and cost reduction by better exploitation of shared assets, and understanding how to embed adaptive potential in blue-grey infrastructures.

## Work with us

**There are many opportunities to get involved with UKCRIC's work.**

**We are looking for collaborators from industry, government, the third sector, finance, commerce and investment communities to work with us to solve the complex problems they face that relate to infrastructure, cities and systems.**

**We are continually seeking new research collaborations that align with our Missions. Get in touch with us at [hello@ukcric.com](mailto:hello@ukcric.com).**

## Our missions

UKCRIC's energies and activities are guided by a set of four Missions designed to facilitate the delivery of interconnected, integrated and multi-disciplinary research programmes and projects.

The four Missions are:

### INFRASTRUCTURE AND URBAN SYSTEMS FOR ONE PLANET LIVING

Empowering society to thrive within the capacity of the planet through responsible consumption, resource efficiency and sustainable growth.

### OWNERSHIP, GOVERNANCE AND BUSINESS MODELS FOR INFRASTRUCTURE AND URBAN SYSTEMS

Coping with greater system interdependencies, changing patterns of use and new, disruptive technologies whilst at the same time delivering social justice and affordability.

### TRANSFORMATIONAL INFRASTRUCTURE AND URBAN SYSTEMS FOR A CHANGING WORLD

Enabling infrastructure and urban systems to adapt to the challenges of climate change, changing patterns of use, societal expectations and emergent technologies.

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

Forging healthy, happy and productive lives for all through urban design, planning, policy and infrastructure.

**Our Missions bring into focus problem-specific societal challenges that require many different sectors to interact to find a solution. This focus on problems, rather than on sectors, means that solutions can be applied to multiple challenges faced by society.**

**UKCRIC's Missions, and the way that we use them, continue to evolve through discussion and workshops and in response to shifting societal needs.**



# UKCRIC

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