Research Challenge: Integrated Infrastructure Systems

The Newcastle University Institute for Sustainability draws upon its areas of established research excellence and the experience of collaborating partners to make an internationally-leading contribution to the following global research challenge in the field of sustainability:

Transform methods used to design, implement and manage our transition towards integrated infrastructure systems such that they better serve the needs of society, and ensure positive interactions with the environment.

Rationale – The national infrastructure is fundamental in strengthening and driving the economy, creating jobs, acting as a key enabler for future economic development and rising living standards. The National Infrastructure Plan 2013 (NIP 2013), from the UK Treasury, contains information on £375 billion of planned public and private sector infrastructure investment. Through NIP 2013, the UK Government has brought investment related to science and innovation into its list of Top 40 priorities alongside an integrated transport system, digital networks, sustainable, reliable and affordable energy, and water and waste. The OECD (Organisation for Economic Co-operation and Development) estimates infrastructure investments in 2000-2030 will be approximately US$71 trillion worldwide or 3.5% of Gross World Product.

The effective integration and transformation of infrastructure systems promises to contribute towards issues of enormous socio-economic importance considering the resource challenges, population increases and climatic changes faced by national and international communities. Particular research strengths at Newcastle University include low carbon transport, earth systems engineering, low carbon energy, big data and cloud computing, sustainable urban and rural planning which makes Newcastle University ideally placed to join the debate and shape the future of infrastructure systems.

There is an opportunity for Newcastle University to deliver international quality research and develop high-impact methodologies capable of carving a path to a more sustainable future. Research pertaining to integrated infrastructure systems is timely and contentious; it is globally important and fits within Newcastle University’s areas of research excellence which is why the Institute for Sustainability has identified it as one of its three key research challenges.

Context - Global changes in population, demographics, technology, and climate are placing profound stresses on the infrastructure and systems that support our livelihood, wellbeing and safety as well as the intrinsic and extrinsic value of the natural environment. Our infrastructure and systems are required to evolve to reflect the changing scale and nature of the demands placed upon them. This may require a transition towards integrated systems which encompass not only the need for physical resources but also new information and communication technologies whilst being sensitive to drivers such as the decarbonisation agenda and financial constraints.

Infrastructure systems have been used to deliver economies of scale that have extended our capability to deliver improving quality of life. However, it is unlikely that continuous expansion without change can be maintained indefinitely, and there are external effects associated with infrastructure: pollution and environmental damage, increased consumption, and structural inequalities that move away from a sustainable society. The engineering, planning and operating of our urban and rural communities requires specialist consideration of their individual components (such as roads, urban drainage systems and natural
resources) but also the understanding of how these relate to the larger systems in which they operate (such as transport networks, ecosystems, river catchments and neighbouring communities). Sustainable and resilient infrastructure could benefit from integrated planning and modelling of settlements, land-use, water-use, biodiversity and engineering infrastructure (including adaptability and resilience) alongside a sound regulatory framework and governance system to ensure society, industry and the environment can flourish side by side. This should be informed by an understanding of public attitudes and preferences towards the design and implementation of new infrastructure projects, particularly in cases where there are potential conflicts with other highly valued land uses.

There is a drive to transform existing methods used to design and implement integrated infrastructure systems such that they better serve the needs of society today and of future generations, and to ensure positive interactions with the environment. The issues around these infrastructure systems are complex, multifaceted and interconnected underscoring integrated infrastructure as a global sustainability challenge.

Definitions and coverage - We use the term “infrastructure” to encompass not only civil entities in urban and rural settings (for example, transport, energy, water, telecommunications and waste management) but also social structures (including communities, organisations, governance and economic systems) and ecosystems (terrestrial and marine) infrastructure. “Integrated” refers to the need for a human-environmental-technological-coupled or “systems” approach to tackling the issues surrounding this global challenge.

There is a natural link between infrastructure-related activities and the two overlapping challenges of Production and Resources, and Consumption and Waste. All of these (non-exclusive) areas in infrastructure represent exciting, active and aspirational areas for research at Newcastle University; each can be viewed through physical, institutional and social aspects. The Institute for Sustainability will advance Newcastle University’s disciplinary expertise in this area by supporting research that bridges across infrastructure sectors, or enables physical infrastructure to be considered in the context of wider social and environmental processes.

Justice and Governance - There are many aspects of Integrated Infrastructure that inherently raise issues of justice and governance. There are various complex management and institutional arrangements as well as social, ethical and political considerations around the planning and development of civil, natural and social infrastructure.

Coordination and collaboration across governance levels, spatial scales and between infrastructure sectors is a critical concern. Equity of access and use, the process of decision making about what goes where and in what form, who benefits, who shoulders risks and who takes responsibility for the inter-connections themselves are key issues. Concerns about social and environmental justice go beyond corporate social responsibility and include the wider principles of fairness. Freedom of information, transparency of decision making, policy formation, infrastructure design and changes in land use require careful evaluation. The impacts of integrated infrastructure design on the environment and the wellbeing of people must be considered.

Examples - Relevant projects at Newcastle University include:

- Long term dynamics of inter-dependent infrastructure systems (Partner in UK Infrastructure Transitions Research Consortium for research, models and decision support tools to enable analysis and planning of a robust National Infrastructure system.)
- Science Central (World class research into smart grids and low carbon networks, urban design and resilient infrastructure, information and digital technology, environmental monitoring, and integrated transport networks)
- iBUILD: Infrastructure BUsiness models, valuation and Innovation for Local Delivery (Lead a UK research programme to develop new business models to improve delivery of infrastructure systems and the services they provide by exploiting the technical and market opportunities that emerge from the interdependence of modern infrastructure systems)
- SECURE: Self Conserving URban Environments (Developing a Regional Urbanisation Model)
that synthesises resource-supply-demand-waste systems from city and local authorities to regional scales by integrating ecosystems, urbanisation (land use and transport), and buildings and energy (supply and demand).

• Customer Led Network Revolution (Implementing smart grid solutions, combining commercial arrangements and technology, to demonstrate managing the transition to high uptake of low carbon technologies in ICT-enabled electricity distribution networks)

• ESPON Climate: (Climate Change and Territorial Effects on Regions and Local Economies conducted fine-grained geographic analysis of climate change impacts on European regions, at NUTS 3 level, including the impact on infrastructure and an analysis of adaptive capacities in different European governance systems)

• EPSON TANGO (Territorial Governance - Best Practices for New Perspectives identified principles of ‘good’ governance and tested these in 12 case studies from across Europe).