

# ICE policy position statement: How can the UK's infrastructure system be made more climate resilient?

March 2023

## Executive summary

Climate change-related disasters across the world have focused attention on the need for climate-adaptive and resilient infrastructure. Even with progress towards net zero carbon emissions targets, climate change is happening and will continue to develop – in the most optimistic scenario with all global pledges implemented, the world would be on a path to 1.5 degrees Celsius warming by the end of the century.

The UK's infrastructure is facing pressures that, for the most part, it was not designed to withstand. Without adaptation and improved emergency response to build in greater resilience, our infrastructure will lose its value, damage repairs will be costly and increasingly frequent, and infrastructure users will face high levels of disruption. Responding effectively to the impacts of climate change will ensure we can protect our economic interests as well as our planet and its inhabitants.

Maintaining the status quo and trying to alleviate problems with quick fixes is not enough. The UK's infrastructure will need to be designed and operated in a way that copes better with today's extremes and is resilient to the more 'extreme extremes' of the future.

Adaptation and resilience are therefore needed to anticipate and react to the impacts of climate and other events on our infrastructure and the public that it serves. This comes at a crucial time with the Department for Environment, Food and Rural Affairs (Defra) publishing the third National Adaptation Programme later in 2023, which will set out the actions government and others will take to adapt to the challenges of climate change over a five-year period.

All this requires a proportionate response as investment needs to be targeted to where it will have the greatest impact – it is unrealistic to immediately adapt every piece of the infrastructure system in every location, and there will be a need for infrastructure owners and operators to manage public expectations about disruption to infrastructure networks brought on by climate change.

Last year, the ICE launched a consultation seeking views on how the UK's infrastructure can be made more climate resilient. Given the many competing priorities for infrastructure investment, it is important to get this right.

This policy position statement draws on the evidence received from the consultation as well as expert insight across the sector, and makes a number of recommendations in order to ensure that the UK is strengthened by the climate-resilient infrastructure it needs.

ICE's policy position statement finds that too little is known about both the condition of existing assets and the performance of the infrastructure system when it comes to climate resilience and adaptation. Infrastructure is an interconnected 'system of systems' that provides the essential foundations for society to thrive. It must be managed as such, which requires us to understand the systems better and to intervene more effectively.

While most infrastructure sectors in the UK are identifying the climate risks to their assets, there is a common lack of understanding of climate impacts in the other sectors they depend on.

Alongside this, a review on the economics of adaptation and resilience will allow us to understand where and how to prioritise investment. In turn, this can be fed into more detailed National Policy Statements, which must include the climate risks affecting our future and how these can be mitigated through specific standards of protection.

Policymakers can no longer keep kicking the can down the road when it comes to enacting real change to make the UK's infrastructure system more resilient to the extremes we face both now and in the future.

The scale of the challenge facing us is not to be underestimated – however, by prioritising resilience and adaptation measures we can develop a stronger and more innovative infrastructure system.

## Recommendations

- **Make the Adaptation Reporting Power of the UK Climate Change Act mandatory for infrastructure owners and operators.** Currently, adaptation reporting is mainly qualitative, which makes it difficult for the government and regulators to compare the degree of preparedness of different infrastructure owners and operators and focus on the less resilient. Mandating quantitative assessment, including financial quantification of expected damages/losses or impacts in a 'do nothing' scenario, would focus resilience efforts on the most material risks and ensure a systems-thinking approach to infrastructure is embedded in policy development and infrastructure planning.
- **National Policy Statements should include a list of climate hazards and desired standards of protection for selected climate scenarios.** The UK Government's National Infrastructure Strategy indicates that national infrastructure must be resilient to future climate change and cost-effective mitigations should be incorporated over the whole life cycle of the asset. In general, nationally significant infrastructure projects take account of flood risk and the impact of climate change on it, but other climate hazards are not always assessed. This information gap should be filled by detailed information about climate risk in National Policy Statements.
- **The UK Government should undertake a national review of the economics of adaptation.** In order to incentivise investment in infrastructure climate resilience and adaptation, we must first understand the value it provides. One of the challenges with making infrastructure climate resilience and adaptation a priority is that it does not have a market value – currently, it is not measured or rewarded. In addition, it is not clear how the regulatory framework which sets out the parameters for funding these investments values resilience. This requires an economic review of resilience and adaptation, led by HM Treasury – this can then feed into developing the resilience standards the government has already committed to in its National Resilience Framework.
- **Infrastructure owners and operators should be encouraged to consider the interconnectivity of infrastructure systems and to use connected digital twins to understand how critical infrastructure assets work as part of a wider system.** To date, there has been a focus on understanding climate risks at an asset scale, particularly new assets, but more effort is needed to understand how infrastructure assets work together in a system. Digital approaches such as connected digital twins have potential for closing this data gap.

## The need for a systems-thinking approach

Infrastructure operates as ‘a system of systems’. The Infrastructure and Projects Authority’s Transforming Infrastructure Performance: Roadmap to 2030 uses the word ‘system’ more than 100 times in its description of how the government expects publicly supported projects to be delivered.<sup>1</sup> A systems-thinking approach to resilience and adaptation is therefore needed which builds in sufficient flexibility for infrastructure to adapt to potential future impacts which haven’t yet been predicted.

Infrastructure owners and operators must better understand the other networks and systems they are dependent on and interdependent with. Increasingly, a failure in one sector will impact another due to the interconnectivity of our systems.

The National Infrastructure Commission (NIC) has previously recommended that individual operators develop long-term resilience strategies which take these interdependencies into account.<sup>2</sup> The government has agreed to take this forward in its National Resilience Framework – however, no set timeline has been provided for this.<sup>3</sup>

While climate change is taken into account in the design of specific infrastructure assets, it is very much only on a project-by-project basis, without a proper resilience framework.

Climate resilience and future adaptation must be considered and prioritised during the development of policy and legislation by the government.

Asset owners and policymakers need to take a long-term and systems-wide perspective that considers risks and interdependencies from assets in other sectors, and ensure that they build in sufficient flexibility for infrastructure to adapt to potential future impacts which haven’t yet been predicted.

In the UK, it has been estimated that by 2050, £900 million a year will need to be spent on drought resilience alone.<sup>4</sup> The Environment Agency has suggested that annual investments of £1 billion a year will be needed to adapt flooding and coastal change infrastructure over the next 50 years.<sup>5</sup> Coastal flooding will see an 80 to 100% increase in annual economic damages by 2050 under a BAU (business as usual) emissions pathway.<sup>6</sup>

Organisations such as C40 Cities and Arup have focused future investment on driving resilience and decarbonisation in cities globally, with plans to invest up to US\$300,000 a year.<sup>7</sup> Research, advocacy and technical support efforts will focus on improving climate resilience, taking into account measures implemented in cities like Dhaka North in Bangladesh, where urban green space is being increased by 70%.

These developments will increase climate resilience to heatwaves and flooding, reduce greenhouse gas emissions, and aim to create areas that are both equitable and accessible.<sup>8</sup> Despite being one of the most densely populated cities on earth on the frontline of the climate crisis, Dhaka North is an example of a city seeking to implement nature-based solutions to tackle the impacts of climate change and improve the city’s future resilience.

<sup>1</sup> Infrastructure and Projects Authority (2021) [Transforming Infrastructure Performance: Roadmap to 2030](#)

<sup>2</sup> National Infrastructure Commission (2020) [Anticipate, React, Recover: Resilient Infrastructure Systems](#)

<sup>3</sup> Cabinet Office (2022) [UK Government Resilience Framework](#)

<sup>4</sup> National Infrastructure Commission (2021) [Regulation and Resilience](#)

<sup>5</sup> Environment Agency (2021) [Long-term Investment Scenarios \(LTIS\) 2019](#)

<sup>6</sup> Sayers PB, Horritt M, Penning-Rowsell E and McKenzie A (2015) [Climate Change Risk Assessment 2017: Projections of Future Flood Risk in the UK, Committee on Climate Change](#)

<sup>7</sup> C40 Cities (2023) [C40 and Arup Announce New Support for Innovative Climate Action in Cities](#)

<sup>8</sup> C40 Cities (2022) [Building Climate Resilience](#)

### **Case study: Infrastructure Australia's Pathway to Infrastructure Resilience**

Infrastructure Australia (IA), the Australian Government's statutory advisory body, compiles and tracks Australia's priority infrastructure pipeline.<sup>9</sup>

IA's medium-term vision for Australia is to have infrastructure that improves the sustainability of the country's economic, social, environmental and governance settings, builds quality of life for all Australians, and is resilient to shocks and emerging stresses.

In late 2021, IA released a blueprint titled A Pathway to Infrastructure Resilience, outlining how Australia can improve its infrastructure resilience by adopting a 'whole-of-system, all-hazards approach'.<sup>10</sup>

A number of opportunities have been identified to give effect to a systems-wide approach to managing climate-related risk in infrastructure, including:

- 1. Improve strategic alignment of resilience governance (private and public sectors) that adopts a systemic view of risk and establishes the accountability and resourcing.**
- 2. Manage uncertainty through scenario planning and support cross-sector coordination and shared responsibility.**
- 3. Improve climate and disaster data collection and sharing for informed planning, action and decision-making.**
- 4. Adopt place-based approaches for resilience to address community needs.**
- 5. Embed resilience into land-use planning and development decisions.**
- 6. Improve infrastructure investment decision-making through mechanisms and guidance for quantifying the projected economic, social, environmental and governance implications of the impacts associated with managing uncertainty or resilience.**
- 7. Collect and share information on the impacts to interconnected systems.**
- 8. Value blue-green infrastructure (like rivers, canals, ponds, wetlands, floodplains, water treatment facilities, and trees, forests, fields and parks, in urban and land-use planning).**
- 9. Build trust through more inclusive decision-making, including on risk, uncertainty and trade-offs related to infrastructure services.**
- 10. Embed traditional ecological knowledge in decision-making.**

<sup>9</sup> Infrastructure Australia (2023) [Infrastructure Priority List](#)

<sup>10</sup> Infrastructure Australia (2021) [A Pathway to Infrastructure Resilience](#)

## Improving understanding of the UK's existing infrastructure assets

The UK's infrastructure is essential not only to our economic and social prosperity but also to our ability to survive in the world we live in.

However, there is currently a prominent gap in understanding of physical climate risks to our infrastructure. This level of understanding also varies depending on the owners of specific infrastructure assets. Furthermore, there is a lack of accurate record-keeping which makes it harder to understand asset condition data.

As indicated in the National Infrastructure Commission's 2020 report on the need for resilient infrastructure systems, infrastructure operators should proactively adapt, and where necessary transform, their infrastructure systems or services over time to enhance resilience.<sup>11</sup>

Common existing understanding of climate change and its potential negative impacts on infrastructure is still underdeveloped. Many of the current critical infrastructure assets have been designed based on historical needs and predictions, now outdated by the evolving climate challenges facing us. Asset classification should be reconsidered based on these future needs.

Some organisations, such as Network Rail, have taken steps to address threats to assets by understanding how the International Standards Organization's (ISO) document 14090, the world's first international standard on climate adaptation, is relevant to its preparations to address climate impacts and improve its existing assets.<sup>12</sup> Network Rail has published Weather Resilience and Climate Change Adaptation Plans for all its routes, outlining climate hazards, vulnerability assessments, and measures to respond to these.<sup>13</sup>

In general across the sector, under-resourcing and budget constraints limiting the funding available to asset owners for maintenance and adaptation measures have led to a reactive and short-term approach, fixed on the lowest costs.

It is imperative first to understand how to better maintain the condition of existing assets, to improve how their resilience can be improved in the future. Knowledge sharing between the engineering community can play a critical role in providing this information. During system stress events, there must be sufficient capacity to meet these demands.

Further quantitative assessment can help us understand risks better. Defra's ongoing consultation on the Fourth Round of the Climate Adaptation Reporting Power is focused on the proposals in the ARP4 (Adaptation Reporting Power) Strategy, due to reach Parliament following the National Adaptation Programme (NAP3) and the refresh of the Green Finance Strategy, due in 2023. It will explore whether the ARP4 process should become mandatory.<sup>14</sup>

It is important for the ARP to become mandatory to ensure organisations are taking the appropriate necessary action to improve future resilience against the impacts of climate change. However, more guidance will be needed on how to measure and quantify resilience for infrastructure owners and operators who will need to report on their assets.

To ensure that this information regarding asset status is collated, shared and fairly made available to interested parties, Defra, under the remit of the ARP, should have the authority to oversee standards of protection for key infrastructure that would be relevant at a systems level and to address concerns around data-sharing by providing equal access. This would ensure that owners and operators have the information they need on the level of resilience of infrastructure their assets depend on to support investment decisions.

<sup>11</sup> National Infrastructure Commission (2020) [Anticipate. React. Recover: Resilient Infrastructure Systems](#)

<sup>12</sup> International Standards Organization (2019) [ISO 14090:2019 – Adaptation to Climate Change – Principles, Requirements and Guidelines](#)

<sup>13</sup> Network Rail (2017) [Weather Resilience and Climate Change Adaptation Plans](#)

<sup>14</sup> Department for Environment Food and Rural Affairs (2023) [Consultation on the Fourth Round of the Climate Adaptation Reporting Power](#)

### **Recommendation**

**Make the Adaptation Reporting Power of the UK Climate Change Act mandatory for infrastructure owners and operators.** *Currently, adaptation reporting is mainly qualitative, which makes it difficult for the government and regulators to compare the degree of preparedness of different infrastructure owners and operators and focus on the less resilient. Mandating quantitative assessment, including financial quantification of expected damages/losses or impacts in a 'do nothing' scenario, would focus resilience efforts on the most material risks and ensure a systems-thinking approach to infrastructure is embedded in policy development and infrastructure planning.*

## **Ensuring new infrastructure is resilient**

Each year, governments and the private sector globally invest trillions of dollars in new infrastructure that may not withstand future impacts from climate change. The long-lived nature of infrastructure assets means that decisions made now will lock-in vulnerability if they fail to adequately consider the impacts of climate change.

Enormous changes are happening that will continue to affect our infrastructure system, yet there is little understanding of how resilient new assets are to a changing climate. Even if, for example, net zero targets are achieved, then the country will still be exposed to scenarios such as wind droughts if resilience is not effectively built into the power system.

Current weak spots for our infrastructure system include impacts generated by higher prolonged temperatures, drought and increased wind speeds. Utilities infrastructure is also threatened by coastal flooding and wind damage. Unless utilities become more resilient to extreme weather events, they are placed at unnecessary risk, in both physical and financial terms.<sup>15</sup>

National policy and guidance currently contain advice on the application of the sequential and exemption tests for flood risk,<sup>16</sup> in part due to the regularity of heavy flooding devastating parts of the UK, including Shropshire, Gloucestershire, south Wales and Yorkshire over the past few years. There is significantly less guidance for other adaptation issues.

This information gap must be filled through the development of detailed National Policy Statements highlighting the climate risks affecting our future and how these can be mitigated through specific standards of protection for each scenario. Areas of risk that need to be examined include extreme heat in summer months (alongside how the design and implementation of green infrastructure can address this), potential droughts and power outages.

By analysing these risks and how they can be mitigated, measures can be put in place to meet the needs of future communities and protect our national critical infrastructure. National Policy Statements should accurately reflect the challenges and prospective mitigations resulting from climate change and set out requirements for necessary action. This would also support meeting the UN SDGs regarding resilience.<sup>17</sup>

### **Recommendation**

**National Policy Statements should include a list of climate hazards and desired standards of protection for selected climate scenarios.** *The UK Government's National Infrastructure Strategy indicates that national infrastructure must be resilient to future climate change and cost-effective mitigations should be incorporated over the whole life cycle of the asset. In general, nationally significant infrastructure projects take account of flood risk and the impact of climate*

<sup>15</sup> McKinsey (2019) [Why, and How, Utilities Should Start to Manage Climate-change Risk](#)

<sup>16</sup> Town and Country Planning Association & Royal Town Planning Institute (2023) [The Climate Crisis: A Guide for Local Authorities on Planning for Climate Change](#)

<sup>17</sup> UK Government (2021) [Implementing the Sustainable Development Goals](#)



*change on it, but other climate hazards are not always assessed. This information gap should be filled by detailed information about climate risk in National Policy Statements.*

## Incentivising investment in resilience and adaptation

Investment in resilience and adaptation is essential to protect us from natural disasters. It cannot be seen as a supplementary or an additional 'nice to have' once key project outputs have been delivered. Infrastructure climate resilience and adaptation provides enormous value – however, currently it does not have a measurable market value.

The UK Government has taken steps to invest in transport infrastructure resilience, with a new £10 million Net Zero Transport for a Resilient Future Hub funded through UK Research and Innovation's Building a Green Future strategic theme to accelerate the UK's transition to a secure and prosperous green economy by 2050.

The Hub is intended to research solutions for resilient transport infrastructure, including how to improve the design of transport-related infrastructure to better cope with potential climate impacts and reduce emissions, for example increasing the use of recycled materials and localised climate modelling of temperature, sea level and weather to gain a better understanding of potential climate impacts on specific areas. This is, in part, to prioritise those places most in need of possible adaptive measures and projects and to bridge the gap between infrastructure research and policy – researching ways to shorten the time between developing innovative solutions and their wider adoption.<sup>18</sup>

More measures like the Hub need to be implemented, as currently there is not enough funding available to incentivise making assets more resilient to climate change.

In New Zealand, which has recently experienced extreme weather events including floods and cyclones, organisations such as the Auckland Lifelines Group and National Lifelines Council have been calling for further investment in infrastructure resilience.<sup>19</sup> According to the 2020 edition of the New Zealand Critical Lifelines Infrastructure National Vulnerability Assessment, urgent action is needed to prevent key utilities from being locked into inflexible or short-term response options.<sup>20</sup>

Auckland's CRL (City Rail Link) project managed to withstand the February 2023 Cyclone Gabrielle and earlier flooding thanks to extensive flood planning at CRL construction sites.<sup>21</sup> The advance cyclone warning allowed CRL and Link Alliance crisis management teams to install additional measures for Cyclone Gabrielle, including dams erected in the Maungawhau/ Mount Eden Station tunnels. Other measures included installation of extra bunds, pumps across all sites and the removal of plant and machinery to higher ground.

Investing in planning ahead and resilience measures similar to those applied by CRL and Link Alliance teams in Auckland will strengthen infrastructure systems and protect populations from experiencing the extreme effects of climate change first-hand.

It is clear that governments and regulators need to work together to set stable policy frameworks, decide which types of infrastructure should be prioritised, what role they want private companies to play, and ensure the right regulatory, economic and policy platforms are in place to ensure finance is available and the incentive is there to develop resilient infrastructure.

As outlined in the UK Government's response to the Joint Committee on the National Security Strategy's October 2022 report on Critical National Infrastructure in an Age of Climate Change, the regulators' statutory duties require them to protect consumers as well as ensure suppliers are able to meet consumer demand with secure supply. It is therefore

<sup>18</sup> Department for Transport (2023) [New Research Hub to Help Tackle Decarbonisation and Improve Transport Resilience](#)

<sup>19</sup> National Emergency Management Agency (2023) [Lifelines Reports and Resources](#)

<sup>20</sup> Ibid.

<sup>21</sup> City Rail Link (2023) [CRL Project Update – Flooding and Cyclone Impacts](#)

already part of the duty of regulators to ensure companies are resilient operationally. As part of its work to reform the framework for economic regulation, the government will consider how to ensure that companies can more easily secure the investment they need for climate mitigation and climate adaptation.<sup>22</sup>

It is important that regulatory frameworks have flexibility and funding streams embedded within them, to enable us to build our network in an optimal way to avoid climate-related issues, such as being able to withstand floods.

The Joint Committee on the National Security Strategy made a recommendation for cross-sectoral standards for resilience to be introduced to provide a basis for more effective future planning and investment. Any regulatory framework would need to reflect these to ensure appropriate incentives are in place, and for standards implemented to guide investment across critical national infrastructure.

This requires an economic review of resilience and adaptation, led by the Treasury – this can then feed into developing the resilience standards the government has already committed to in its National Resilience Framework.<sup>23</sup> The government has affirmed its commitment to looking at the regulatory system ‘in the round’,<sup>24</sup> therefore this next step would ensure there is a longer-term plan to implement resilience and adaptation measures.

While the HM Treasury Green Book,<sup>25</sup> which sets out the rules for project appraisal that influence which projects are granted public funding, accounts for resilience expenditure, highlighting that ‘the maintenance and renewal costs associated with the servicing of infrastructure assets’ should be included in project cost-and-benefit calculations, it does not sufficiently cover how projects will be rewarded for focusing on resilience. There is a lack of detail around how resilience in general is valued.

A 2020 Vivid Economics report emphasises that the conventional cost-benefit analysis (CBA) approach to project appraisal in the UK inadvertently disadvantages those for whom the environment and its corresponding services are at stake.<sup>26</sup> Even when there are well-known adverse environmental repercussions relating to projects, challenges expressing these changes in monetary terms and lack of valuation evidence can result in their omission from CBA, despite what is outlined in the Green Book.

### **Recommendation**

**The UK Government should undertake a national review of the economics of adaptation.** *In order to incentivise investment in infrastructure climate resilience and adaptation, we must first understand the value it provides. One of the challenges with making infrastructure climate resilience and adaptation a priority is that it does not have a market value – currently, it is not measured or rewarded. In addition, it is not clear how the regulatory framework which sets out the parameters for funding these investments values resilience. This requires an economic review of resilience and adaptation, led by HM Treasury – this can then feed into developing the resilience standards the government has already committed to in its National Resilience Framework.*

<sup>22</sup> Joint Committee on the National Security Strategy (2023) [Readiness for Storms Ahead? Critical National Infrastructure in an Age of Climate Change: Government Response to the Committee's First Report](#)

<sup>23</sup> UK Government (2022) [UK Government Resilience Framework](#)

<sup>24</sup> Joint Committee on the National Security Strategy (2023) [Readiness for Storms Ahead? Critical National Infrastructure in an Age of Climate Change: Government Response to the Committee's First Report](#)

<sup>25</sup> HM Treasury (2022) [The Green Book](#)

<sup>26</sup> Vivid Economics for WWF UK (2020) [Keeping Us Competitive: A UK Investment Strategy for Net Zero](#)



## Infrastructure climate adaptation and resilience at a local level

Local government has a key role to play in supporting climate-adaptive infrastructure. It is important that long-term strategic and local development plans focus on adaptation measures and that local government leadership makes this an organisational priority.<sup>27</sup>

The NIC has called for regulators to engage more with devolved administrations, Metro Mayors, local government, utility companies, consumer groups, elected representatives and members of the public – and take their views into account in strategic decision-making, including investment.<sup>28</sup>

Communities must be placed at the heart of the decisions that shape the future of their local areas. Changes needed to the regulatory system to support resilience and climate-adaptive infrastructure should also include placing a statutory responsibility on local authorities to consider climate adaptation in the development and growth of their communities and local areas. Currently, it is not clear how the regulatory framework which sets out the parameters for funding infrastructure investments values resilience.

The local plan process works to track and analyse feedback from local people in developing a holistic overview of what the future of their area looks like and provides a framework for housing needs and other economic, social and environmental priorities. Adaptation and resilience must be a key consideration for councils and communities shaping future local plans.

In particular, climate policies relating to furthering resilience and adaptation must be embedded within policy narratives of local plans. This can be mandated by placing a statutory responsibility on local authorities to consider climate adaptation in the development and growth of their communities and local areas within their local plans.

Future planning reforms should include requiring all planning bodies to ensure that all new and existing infrastructure developments are climate-adaptive. Some local authorities have already started to consider climate resilience and adaptation in their local planning, such as Bristol City Council. The council has developed a Keep Bristol Cool mapping tool, including a Heat Vulnerability Index, for council officers and other policymakers and practitioners in the area, such as urban designers, landscape architects or emergency planners, to explore how current heat vulnerability varies across different neighbourhoods and how climate change may increase temperatures in the future.<sup>29</sup> The tool gives insights into how urban heat risks vary across the city and within communities and identifies the areas where high temperatures and heatwaves could have the biggest impact on people's health and wellbeing.

Significant changes to the National Planning Policy Framework (NPPF) are needed, including providing local planning authorities with the power to prioritise the Climate Change Act in planning policy over developer viability, and removing competition between climate mitigation and adaptation criteria and other planning contributions. A legal duty that ties planning to net zero goals and climate adaptation should be considered to ensure that energy infrastructure is fit for purpose relating to both climate mitigation and adaptation.

Local planning authorities should set out clear expectations for the information they require from applicants on climate impacts and ensure that this information is accessible to all. No new development should be permitted that exacerbates existing climate risks.

Local governments must be able to assume accountability for the resilience of the infrastructure within the communities they serve. This would be achieved through providing local governments with a statutory responsibility to consider climate adaptation in the development and growth of their communities and local areas through Local Plans. Local planning

<sup>27</sup> Town and Country Planning Association & Royal Town Planning Institute (2023) [The Climate Crisis: A Guide for Local Authorities on Planning for Climate Change](#)

<sup>28</sup> National Infrastructure Commission (2019) [Strategic Investment and Public Confidence](#)

<sup>29</sup> Bristol City Council (2023) [Keep Bristol Cool](#)

authorities should set out clear expectations for the information they require from applicants on climate impacts and ensure that this information is accessible to all.

#### **Case study: Essex County Council: Green infrastructure scheme in Canvey Island**

Essex County Council has developed a green infrastructure scheme that uses rain gardens, swale, tree planting and more than 1,300 plants to reduce surface-water flooding for a community on Canvey Island.

This scheme has been designed to increase the resilience of the area to extreme rainfall and flooding, and bring both social and nature benefits, including having a net-positive impact on climate change through tree planting.<sup>30</sup>

With long-term, non-competitive and ring-fenced funding for climate adaptation, local authorities across the UK would be better placed to address infrastructure climate resilience and adaptation at a systems-wide level. Making infrastructure more climate resilient must become a priority for local authorities and support must be provided at the national government level to enable local leadership in this space.

## **Encouraging innovation through rollout of data-driven technologies**

Data-driven technologies provide a huge opportunity to strengthen the climate resilience of the UK's infrastructure. For example, for organisations like National Highways, using real-time monitoring of road conditions can help to react to issues before they become a risk to safety or performance. New models such as digital twins can play a key role in this real-time monitoring.

As highlighted by the Energy Systems Catapult, digital twins, shadows or models (i.e. digital twin technologies) offer an opportunity to build evidence and highlight the impacts of possible future policy decisions, as well as retrospectively measure the impact of those already in progress.<sup>31</sup> Digital twins can also close the data gap to help us understand how infrastructure assets work together as part of a wider system. There is currently insufficient information around how infrastructure assets can work together in a system.

One of the major barriers to infrastructure adaptation is the lack of direct access to climate information suitable for infrastructure design. More effort should be made to bridge the gap between climate projections (e.g. UK Climate Projections 2018)<sup>32</sup> and derived climate variables needed by infrastructure designers (e.g. maximum wind gust for a certain return period). This can be unlocked through the implementation of digital tools that would allow for a quick interrogation of the latest climate data against impact metrics for a given location and infrastructure. This type of technology can support both the development of resilient designs as well as the investigation of climate risks to infrastructure, in turn identifying the key areas for investment.

At a system level, digital twins have the potential to connect multi-sectoral assets at a regional scale to map interdependencies and assess vulnerabilities of the system as a whole. Stress testing the system against a set of climate change hazards (e.g. major flood, heatwave, drought) of different intensity could then pinpoint weak spots causing cascading failures and their impact in the overall level of service.

Digital twins can therefore be used by decision-makers to visualise climate risks and explore adaptation measures under different scenarios for decision-makers and stakeholders. This would help prioritise investments and build resilience

<sup>30</sup> Essex County Council (2023) [Essex Green Infrastructure Strategy](#)

<sup>31</sup> Energy Systems Catapult (2023) [Digital Twins: Model, Shadow, Twin – The Case for Policy Use](#)

<sup>32</sup> Met Office (2018) [UK Climate Projections 2018](#)

efficiently. Current estimates indicate that the market for digital twins in Europe alone will be around €7 billion (£6 billion) by 2025, with an annual growth rate of 30 to 45%.<sup>33</sup> Investing in digital twins will be key to supporting a systems understanding of infrastructure and ensuring data from digital twins is used to develop world-leading infrastructure standards. Achieving net zero will also require substantial public support for innovation, with Vivid Economics highlighting that the government will need to create new markets as well as address market failures.<sup>34</sup>

### **Recommendation**

**Infrastructure owners and operators should be encouraged to consider the interconnectivity of infrastructure systems and to use connected digital twins to understand how critical infrastructure assets work as part of a wider system.** *To date, there has been a focus on understanding climate risks at an asset scale, particularly new assets, but more effort is needed to understand how infrastructure assets work together in a system. Digital approaches such as connected digital twins have potential for closing this data gap.*

## **Educating and raising awareness of the need to adapt**

It will be important to engage with the public in highlighting the existing condition of infrastructure assets and the challenges and opportunities regarding resilience and adaptation. The UK has the potential to develop world-leading resilient infrastructure, while also delivering on net zero. The interconnection between net zero delivery and resilience needs to be more clearly articulated.

In doing so, it will be necessary to be open with the public that the UK's infrastructure system will not be able to withstand climate change in all areas and we will have to change our approach to be adaptive.

Many assets are 50–100 years old or more and need significant investment. It will not be possible to adapt every piece of infrastructure quickly and projects and sector leaders will need to manage public expectations around improvements to infrastructure in the future.

Ultimately, there is a need to own fewer hard or long-term assets, develop more natural ones which look after themselves, and focus resources on adapting those high-risk and critical areas to make them as resilient as possible.

Projects and organisations should also focus on developing case study examples that highlight the interdependencies within the infrastructure system to ensure the public understand how climate change will affect service levels, using social and digital media to amplify this message.

Initiatives such as Climate Resilient Schools, started by the Mayor of London in partnership with the Department for Education and Thames Water, target those most vulnerable to the impacts of climate change, prioritising the top 10 per cent of schools in London with the highest surface-water flood risk and which fall within the worst bands of the Climate Risk Map.<sup>35</sup> As highlighted by the Global Center of Adaptation, adaptation education needs to be contextualised to address local climate change impacts that all generations learning about adaptation can easily connect with.<sup>36</sup>

It will be absolutely key to manage public expectations around resilience and adaptation and highlight the need to change our approach to infrastructure maintenance to ensure our infrastructure system is climate adaptive. In order to ensure the message lands, implementing case study examples will educate the wider public about the conditions of infrastructure, the interdependencies across infrastructure systems, and how we need to change our approach to be adaptive.

<sup>33</sup> McKinsey (2022) [Digital Twins: The Art of the Possible in Product Development and Beyond](#)

<sup>34</sup> Vivid Economics for WWF UK (2020) [Keeping Us Competitive: A UK Investment Strategy for Net Zero](#)

<sup>35</sup> London Assembly (2023) [Climate Resilient Schools](#)

<sup>36</sup> Global Center of Adaptation (2022) [Case Studies on Adaptation and Climate Resilience in Schools and Educational Settings](#)

## About ICE

Established in 1818 and with over 96,000 members worldwide, the Institution of Civil Engineers exists to deliver insights on infrastructure for societal benefit, using the professional engineering knowledge of our global membership.

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