

ICE response to the National Infrastructure Commission Resilience Study scoping report

Executive summary

This response focuses on the three main questions outlined in the scoping report. It is informed by ICE's institutional knowledge, our engagement with the public through polling and the expertise of ICE members and Fellows.

A core issue with resilience is a lack of a systems thinking approach within the built environment sector which can, and must, be addressed.

If the National Infrastructure Commission is to provide recommendations and frameworks to the Government which will successfully improve resilience in the UK's infrastructure networks, key to this will be encouraging infrastructure owners to work collaboratively. They must give due regard to each other's assets and how these operate within a wider system. Crucially, more emphasis must be placed on the fact that services rely on each other to operate and can be affected in a multitude of ways if one link in the chain fails.

This response supplements and should be read in conjunction with our evidence provided to the Commission in April alongside the Royal Academy of Engineering.¹

Recommendations

1. The infrastructure sector must place an emphasis on systems thinking, whilst adopting common approaches and frameworks that better share lessons learnt.
2. Working with polling organisations and other experts, the Commission should explore what levels of public knowledge exist around long-term resilience and what information would be necessary to garner public support for investment to meet long-term need.
3. Regional infrastructure strategies should be developed across England that consider resilience as a fundamental part of infrastructure planning and delivery.

What are the systemic issues that make infrastructure vulnerable to current shocks and future changes and how could they be addressed?

The root concern when it comes to addressing current and emergent systemic vulnerabilities in infrastructure is a lack of systems thinking within the built environment sector itself.

Individual infrastructure assets do not exist in isolation and, to a higher or lesser degree, should be considered interdependent. Interdependencies occur for two main reasons. First, because one infrastructure asset or network will place demands on another, and second, because increasing demand, due to demographic shifts and economic growth, or changes in technology, will increase one assets dependence on another² or create new demands which need to be met.

The electrification of heat and transport could result in demand on electricity consumption almost doubling by 2050.³ A shift to renewable power, without adequate investment in battery and other forms of storage, is inherently less reliable than the energy mix in the UK today. Intermittent generation will require enhanced support for energy storage and other emerging technologies. This will ensure resilience for renewable energy generation, whilst providing alternatives to back up power generation.⁴

¹ National Infrastructure Commission (2019) [Resilience Study Consultation responses - Royal Academy of Engineering and Institution of Civil Engineers Response to the Resilience Study Scoping Consultation](#)

² ICE (2016) [National Needs Assessment](#)

³ Ibid

⁴ ICE (2018) [State of the Nation 2018: Infrastructure Investment](#)

A siloed approach does, however, permeate the sector. This means that individual asset vulnerabilities and risk management approaches are well understood, but systems resilience, and how infrastructure assets interact, is not. There is a lack of emphasis placed in the infrastructure space on communication and collaboration between infrastructure sectors, little retention of knowledge and barriers which undermine the ability to share best practice or institutional insight. This limits the ability to identify and exploit synergies and restricts the effectiveness of infrastructure as a system, or indeed, adds costs to the creation, operation and decommissioning of infrastructure assets.

Cascade failure

A cascade failure is the knock-on effect of the failure of one or more assets on others connected to it. A breach in a flood defence wall during a storm may lead to the flooding of energy assets located in a flood plain, something which will likely become more prevalent as floods and winds become more severe and frequent, due to climate change.⁵ That failure of the energy grid will then impact other assets. Rail lines might lose power, stranding trains, pumping stations might fail, exacerbating the flooding situation and electronic communications might be knocked out, complicating any recovery efforts.

The summer 2007 floods caused in excess of £3.2bn of economic damage and there was a “threat of power blackouts at the regional scale.” Of the £3.2bn total costs, power and water utilities accounted for around £330m and communications and roads accounted for between £230m and £330m.⁶ More recent flooding events have also had economic impact, with those in 2013 to 2014 costing some £1.3bn⁷ and latterly those in the winter of 2015 to 2016 £1.6bn.⁸

A lack of a systems thinking increases both the likelihood and severity of any cascading failures which might occur as a result of an incident. This is because little planning may have gone into contingency, methods of avoidance, or rapid recovery.

A recent real-life example is the incident of the 9th August 2019, when a combination of a lightning strike and two power losses from generating facilities led to widescale disconnections from the national grid. Whilst most connections were restored relatively quickly there was an acute effect on rail services, which were disrupted for around 24 hours as up to 30 trains could only be restarted on site by an engineer.⁹ Rail infrastructure which is more adaptive or had plans in place for wholesale power loss might have onboard battery back-up for either restarting engines or traveling short distances without direct grid power, as in the example of the Bombardier Talent 3 Locomotive.¹⁰

Potential methods to address systemic issues

A lack of coherent systems thinking is a core concern to be overcome but steps can be taken in the short-term to address immediate issues.

Identifying and utilising multiple lines of defence

Finding a method of responding to and learning from catastrophic failure was a core concept of ICE’s 2018 report *In plain sight: assuring the whole-life safety of infrastructure*. This report recommends an approach to addressing failure which adopts multiple lines of defence. This “Swiss Cheese Model” mitigates against risks which could permeate inherent weaknesses in any system. It relies on analysis of the causes of failure, identifying how to reduce that risk and illustrates how apparently unrelated and often small errors in different parts of a complex system can combine to create catastrophic failure.¹¹

ICE recommends an approach which breaks down lines of defence to knowing, applying and ensuring. This framework includes 13 individual lines of defence, including an understanding of asset condition, a framework for incident reporting, the installation of suitably qualified and experienced persons, independent scrutiny and assurance.¹² This principle could be applied on a system wide basis as much as to an individual incident or asset.

⁵ Climate Adapt (2019) [Flood defence framework for National Grid substations in United Kingdom \(2019\)](#)

⁶ Environment Agency (2010) [The costs of the Summer 2007 floods in England](#)

⁷ Environment Agency (2016) [The costs and impacts of the winter 2013 to 2014 floods](#)

⁸ Environment Agency (2018) [Estimating the economic costs of the 2015 to 2016 winter floods](#)

⁹ Ofgem (2019) [Technical Report on the events of 9 August 2019](#)

¹⁰ Bombardier (2019) [Realise your vision with Bombardier TALENT 3 BEMU](#)

¹¹ ICE (2018) [In plain sight: assuring the whole-life safety of infrastructure](#)

¹² Ibid

The role of technology and common approaches to defining resilience

The growing importance of digital technology to the design, operation and maintenance of assets will provide data and automation for better decision-making and more efficient management. Digitally enabled infrastructure will also produce more opportunities for easier communication between infrastructure owners and classes in real time, supporting service delivery at peak times or at moments of disruption during incidents.¹³

Ensuring that there are common approaches to the recording, management and language around resilience will become increasingly important and will simplify cross-sector understanding and co-operation.

The need for an integrated approach

Building contingency and resilience between infrastructure assets and sectors must be a key focus going forward. This can be achieved by fostering co-operation, collaboration and opportunities to better understand interdependencies. As with any process of transformation in culture, there will need to be focal points and actors willing to lead or be tasked with ensuring integration.

One way of achieving this is through the development of regional infrastructure strategies across England that consider resilience as a key driver of infrastructure provision and delivery. This is discussed in more detail on page four of this response.

What does the public expect of infrastructure services and how should their views be considered in decisions about resilience?

ICE welcomes the Commission's contracting of a social research project to better understand the public's expectations of infrastructure resilience as set out in the consultation document.¹⁴ There is a lack of research in this area and ICE hopes this will inform the debate around user expectations of levels of service and infrastructure resilience.

Whilst ICE has not conducted public polling or engagement work specifically on resilience, ICE has conducted polling on public attitudes to infrastructure performance, willingness to pay, and the public's desire to be informed.

The public have an appetite to learn more: over 60% of the public think there is not enough information about infrastructure and that more information about the benefits of specific projects would make them more interested in infrastructure.¹⁵ In a separate poll, 61% of adults stated they would like more information about how public money is spent on UK infrastructure projects.¹⁶

The public are generally favourable about the impact infrastructure has and would like to see more invested. More than three quarters, 79%, of the public support the notion that infrastructure helps the national economy¹⁷ and 75% of adults believe that more money should be spent on improving the UK's core infrastructure networks.¹⁸

There is, however, a disconnect between the cost of investment and the benefit derived which results in the public being unwilling to pay more. Some 59% of GB Adults would not be happy to spend more money on household bills even if it meant better utility services.

Sustained investment will be needed over the coming decades to ensure that infrastructure provision and levels of service do not fall. This will inevitably come from the public, either in the form of higher taxation or bills for the use of infrastructure networks.

In order to make the case for more investment there will need to be additional engagement with the public. They are willing to learn more and are responsive to arguments which link investment to benefit. ICE set out in a paper earlier this year that ministers should talk more about the benefits of major infrastructure projects, rather than the costs, a statement which 74% of the public agree with.¹⁹

¹³ ICE (2019) [What should be in the National Infrastructure Strategy](#)

¹⁴ National Infrastructure Commission (2019) [Resilience Study scoping report](#)

¹⁵ ICE/Copper Consulting (2017) [Independent survey of attitudes to infrastructure in the United Kingdom](#)

¹⁶ ICE (2018) [State of the Nation 2018: Infrastructure Investment](#)

¹⁷ ICE/Copper Consulting (2017) [Independent survey of attitudes to infrastructure in the United Kingdom](#)

¹⁸ ICE (2018) [State of the Nation 2018: Infrastructure Investment](#)

¹⁹ ICE (2019) [Reducing the gap between cost estimates and outturns for major infrastructure projects and programmes](#)

ICE believes the disconnect might be down to the time lag between payment and delivery of infrastructure. Infrastructure can take decades to plan and deliver to meet resilience needs which may only become apparent in decades; a relatively intangible timescale. Working with polling organisations and other experts, the ICE recommends that the Commission explore what levels of public knowledge exists around long-term resilience and what information would be necessary to garner public support for investment to meet long-term need.

Whilst communicating this is a task for the infrastructure sector and its advocates as a whole, ICE believes the Commission is uniquely positioned to make this case to Government. It is critical that investments are linked to benefits and that there is a joined-up plan for infrastructure provision which draws the public in.

Individual and community resilience

There is an interplay between user expectations of service and what is delivered in actuality. Levels of resilience can also be increased by the public themselves provided they have proper information. Those at greater risk of flooding can be enabled to provide their own contingencies with advice, for instance, by moving electrical sockets higher up the wall, installing stainless steel kitchens or using waterproof plaster, which increases resilience and reduces time for a home to recover.²⁰ Well communicated action plans in the event of disruption to service can also ensure customer expectations are managed and lessen the severity of these incidents or the need for emergency response.

Decentralisation of provision can also boost resilience and reduce the severity of network issues. Household generation and storage of power on a large scale would reduce dependence on the mains grid, whilst localised urban drainage and greywater recycling schemes could reduce the impacts of flooding events and the need for additional water supply.

The location of infrastructure should also inform resilience. Rural infrastructure has less in the way of redundancy if an asset fails than urban infrastructure. Any framework the Commission develops should be responsive to local needs and consider what can be done to enhance resilience in rural settings, including considering decentralised alternatives to national or regional networks.

What changes to governance and decision-making could improve current levels of resilience and ensure future challenges are addressed?

Changes to governance and decision-making structures are needed which will support and entrench systems thinking in the planning, delivery, operation and recovery of infrastructure assets and systems. Governance of recovery responses and cross-sector collaboration is often fragmented.

First, there must be a consistent commitment by planning, advisory and decision-making bodies in considering resilience as a fundamental part of their process. There has been a lack of consistency in the past, with the ICE recommending to the Infrastructure Commission for Scotland, (ICS) that they include, in their key strategic drivers, the need to consider resilience as “a primary driver... understood within a systems context.”²¹ The OECD believes that, in the specific example of resilience to climate change, there are a number of barriers which can prevent climate-resilience planning, including long time horizons, uncertainty about the future, a lack of information and capacity, policy misalignments and externalities. If decisions do not benefit the economic case, are beyond the time horizons of decision makers, or incentives are distorted, resilience can be overlooked.²²

Second, planning should be conducted at multiple geographic scales, including, crucially, at a regional level. Regional infrastructure strategies should be developed across England to ensure effective integration of networks.²³ More localised plans offer the potential to identify synergies and overlapping resilience dependencies in regional economies. Greater alignment of budgets, funding streams and programmes at the regional level for economic and social infrastructure would also contribute to greater productivity and more efficient use of resources, tying together planning and delivery.²⁴

²⁰ ABI (2017) [A guide to resistant and resilient repair after a flood](#)

²¹ ICE (2019) [ICE submission – Infrastructure Commission for Scotland’s Call for Evidence](#)

²² OECD (2018) [Climate-resilient Infrastructure](#)

²³ ICE (2019) [What should be in the national infrastructure strategy?](#)

²⁴ ICE (2019) [State of the Nation 2019: Connecting Infrastructure with Housing](#)

About ICE

Established in 1818 and with over 93,000 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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