

Infrastructure Resilience Roundtable

Ensuring resilient national infrastructure systems

September 2020

Introduction

This report summarises the discussions from a roundtable convened on behalf of the National Infrastructure Commission on the topic of resilience of national economic infrastructure (i.e. power, water, transport and digital communications).

The National Infrastructure Commission's report¹, [Anticipate react recover: Resilient infrastructure systems](#), highlights that the UK's economic infrastructure has for the most part, proved resilient to shocks and stresses over recent years. It suggests that we cannot afford to become complacent. In the last

two years we have seen major floods, the worst loss of power and water for a decade, and many disruptions to rail and telecom service provision. Covid-19 has shown that significant, high impact disruptions can and do happen.

The report sets out a framework with recommendations which drives action to:

- **face up to uncomfortable truths**
- **value resilience properly**
- **test and address vulnerabilities**
- **drive adaptation before it is too late.**

Three recommendations have been developed that focus on the role of government, regulators, and infrastructure operators:

1. Set clear resilience standards

Government should publish a full set of resilience standards every five years following advice from regulators, alongside an assessment of any changes needed to deliver them.

2. Regular stress testing

Infrastructure operators should carry out regular and proportionate stress tests overseen by regulators, to ensure their systems and services can meet government's resilience standards and take actions to address any vulnerabilities.

3. Long term strategies

Infrastructure operators should develop and maintain long term resilience strategies. Regulators should ensure their determinations in future price reviews are consistent with meeting resilience standards in the short and long term.

1. National Infrastructure Commission, [Anticipate, react, recover: Resilient infrastructure systems](#), 2020

Aims

This roundtable brought experts from across the infrastructure sectors and included representatives from regulators, infrastructure operators, consultancy, academia and professional engineering institutions. A list of participants is included at the end of this paper.

The aim of this meeting was to bring cross-sector engineering perspectives to bear on the following questions:

- what steps must be taken to bring the broader cultural change needed to value resilience?
- how can operators be supported to take a proactive approach to testing for vulnerabilities, planning, and managing uncertainty?
- the evidence, research and decision-support is needed to address infrastructure resilience and what are the implications for future skills?
- the actions that can be agreed upon for infrastructure adaptation ahead COP26 (1–12 November 2021).

Next steps

The NIC have subsequently published technical annexes to support their resilience study, which provide further information on good practice to encourage a cultural shift towards enhanced resilience. These cover:

- Case studies and good practice for resilient infrastructure systems
- Principles for setting levels of service
- Impacts and costing note.

We are keen to keep this conversation going, and we encourage practitioners to take forward the messages from the NIC's resilience study into their organisations to drive forward the resilience agenda.

If you would like more information about this roundtable or NEPC work in this area, please contact:
nepc@raeng.org.uk

Key themes of discussion

Five themes emerged from the roundtable discussion:

1. The **increasing complexity** of the infrastructure system-of-systems
2. The relationship between the **net zero carbon and infrastructure resilience** agendas
3. The need for a **whole-system approach** to resilience
4. The need for the right methods for **valuing resilience**
5. The need for **better communication**.



1. Increasing complexity

There are key trends that are **increasing the levels of complexity and interdependence** across our infrastructure systems. Examples include the move towards both distributed generation and demand balancing at household level in the electricity system, the increasing interdependence between transport and electricity and the increasing role of software in the smooth operation of infrastructure. 'An overarching trend is towards **'always on, always connected'** commercial and domestic practices that

are driving ever-increasing reliance on access to electricity and ICT.

Resilience planning needs to adapt to the increased complexity introduced by these changes. For example, in distributed electricity generation, care needs to be taken over **common failure modes**. If all embedded generators are using the same protection equipment, they may all cut out in the same way, effectively acting as one largescale loss of generation.



2. Net zero and resilience

It was generally agreed that **our ability to address climate change is dependent on a resilient infrastructure system** and that the net zero and infrastructure resilience agendas must converge, not diverge or compete. However, there were some contradictory views expressed on this topic:

- Some participants argued that there was a danger of placing too much emphasis on resilience and potentially not enough attention to embedding progress toward the UK's target for net zero carbon emissions.
- Others feared that climate mitigation is a clearer target that might more easily capture the political and public imagination, whereas infrastructure resilience as an end goal might prove a less clear and tangible goal, receiving insufficient attention.

Others expressed concerns that the government's recent announcement of infrastructure spending may not necessarily result in the right things being built to ensure progress to both net zero and future resilience. The challenge will be to build in much faster what we already know about resilience.

Ultimately, **identifying where the net zero carbon and infrastructure resilience agendas overlap and where they may compete, is one area where further work is needed and would be valuable**. It will require a closer and more informed dialogue with politicians and the public to build understanding and to find ways to value the right outcomes.



3. Whole-system approach

Systemic resilience results from **embedding resilience across all levels of the system-of-systems**: requirements need to be set at the national level, regulators need the right balance of 'carrots and sticks' while individual organisations, households and people need to contribute to wider systemic resilience by taking on board and managing their own dependencies.

Given increased complexity and interdependence, resilience depends upon clear understanding and communication across sectors, organisations and stakeholders. This includes **examining the assumptions made about the resilience of other parts of and actors within the system**. If implemented, one benefit of the NIC recommendations for resilience standards to be set for the main infrastructure providers is that **this would provide more clarity to actors and organisations reliant on those services as to the standards of resilience to expect in order to carry out their own resilience planning and investment**.

Within the whole-system view, how to **encourage and develop resilience 'lower down' in the system, at community and household level**, is a key challenge. The recent experience from Covid-19 pandemic has highlighted the importance of local authorities and their ability to reach into and across local organisations and networks. Some local authorities have effectively galvanised community responses but there has also been a realisation that the network of local resilience forums is patchy, and that **central government lacks mechanisms to prescribe or drive standards for resilience at local level**.

Covid-19 has highlighted the importance of **local information, networks and clear channels of communication**, for example better identification, understanding and reach to those groups who are particularly vulnerable in different scenarios. The notion of **stress testing, recommended by the NIC for the supply-side of infrastructure provision, might usefully be applied to Local Authorities and resilience fora**. Standards could be set centrally, with

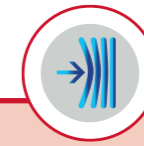
some ring-fenced funding attached to support local level implementation.

Some scenarios for future infrastructure, such as highly decentralised grid systems with community and dwelling-level electricity generation and storage, would only increase the importance of resilience at the community and household level. In terms of the information needed by households, it is not necessarily important to differentiate between particular threats, but to focus on the essential provisions and information needed in the face of an incident.

Modelling of infrastructure systems provides the opportunity to:

- interrogate different failure scenarios and stress-test systems
- model future projections such as developments in electricity generation and storage (e.g. increased deployment of solar, on-shore wind or battery technology) and better understand the implications of these changes for network resilience
- identify vulnerability, test assumptions and build an understanding of the implications of interdependence within and across infrastructure systems
- appraise options for investing in resilience.

Modelling failures in interdependent infrastructure systems can help to understand the knock-on effects of these failures into supply chains, business interruption and the economy, which scale up as the disaster gets bigger i.e. **there is a multiplier effect**. This is also provides a platform for communication across stakeholders and for building a better understanding of and managing interdependencies. In the long term, such modelling provides the basis upon which to build **digital twins for national infrastructure**.



4. Valuing resilience

Finding the right ways to value infrastructure resilience is a key challenge. Much of the conversation focused on the fact that, given the social and economic impacts of loss of service and the levels of investment often needed to ensure resilience, the value of resilience is fundamentally a societal question.

Many decisions on resilience are made by the boards of infrastructure owners and operators and **a clearer methodology which integrates social, economic and environmental value would be a significant step**. This would require the assimilation of a lot of information, some of which is not readily quantifiable. Scenario analysis is key to identifying the right investment decisions.

The group noted that the public often had a tendency to be particularly **risk averse to large single incidents, as opposed to repeated smaller incidents**, even where the cumulative effect of smaller incidents matches or exceeds that of a single, large incident.

Infrastructure should serve society's needs and the public's understanding of the relevant considerations cannot simply be assumed. The profession needs to do a **better job engaging the public around infrastructure provision, promoting better understanding of resilience issues and ensuring the public's views inform decisions**.



5. Better communication

Communication is key to resilience. While there are instances of good practice, significant improvements could be made to communication both in terms of **improving preparedness and in the response to individual infrastructure failures**.

Communication in both cases would benefit from an **interdisciplinary approach**. The group agreed there were valuable lessons to be learnt from **history, anthropology and behavioural sciences**. An example is clearer messaging around why we must value infrastructure and resilience, across all levels of the system, including households and individuals. Expressing this in terms that people would find most engaging could benefit from behavioural science's insights.

Formulating the right message and ensuring that the target audience is receiving the intended message are not necessarily the same thing. There is a need to better understand the channels of communication

and the effects these can have on the message. Understanding how to effectively persuade, influence and communicate with different segments of the population, and how to manage both message and delivery is crucial.

Public understanding of risk could benefit from better communication. For example, flood risk maps currently denote areas of 'high risk' in blue whereas the colour red might be more intuitively associated with higher/increasing risk.

Opportunities may be available from digital technologies to improve communication. For example, as a response to the recent bush fires, the Australian government have produced an automatic text alert system. Examples of utilising such technologies do exist in the UK but their utilisation for the disseminate targeted information could be improved.

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National Infrastructure Commission

The Commission is responsible for providing independent analysis and advice to the government to help the UK meet its long-term infrastructure needs. Its role is to support sustainable economic growth across all regions of the UK, improve competitiveness, and improve quality of life. In doing so, it aims to be the UK's most credible, forward-thinking and influential voice on infrastructure policy and strategy. The Commission publishes a National Infrastructure Assessment once in every Parliament setting out its assessment of long-term infrastructure needs, with recommendations to the government, the first of which was published in July 2018. It also undertakes in-depth studies into the UK's most pressing infrastructure challenges and monitors the government's progress in delivering infrastructure projects and programmes recommended by the Commission.

More information about its work can be found at nic.org.uk or on Twitter [@NatInfraCom](https://twitter.com/NatInfraCom)

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