Royal Academy of Engineering

Winter is coming: risks for interdependent infrastructure

Event note

Background

The reasonable worst-case scenario in the Academy of Medical Sciences' (AMS) report *Preparing for a challenging winter 2020/21* suggests that winter could see a sustained period of high instances of infection with COVID-19 alongside the typical strain of winter.[1] While this will inevitably have a significant impact on the NHS, it is also likely to result in knock on effects for industry and service provision. This report highlighted the need for effective policies for public information, track, trace and isolate systems and public health surveillance to enable rapid identification of areas of increasing risk. As this roundtable took place on 1 October, cases were starting to rise again, and more local lockdowns had been announced.

Aim

With this scenario as a backdrop, the Royal Academy of Engineering brought together a group of Fellows and experts from across the critical areas of water, food, energy, transport and logistics, and communications networks to consider the potential vulnerabilities associated with interdependencies across infrastructure this winter.[2]

Winter

Every year winter presents a risk of adverse weather events. These are having increasing impact due to interdependencies across networks such as gas, waste management, transport, communications and data centres.

The flooding in Lancaster in 2015 which left 61,000 homes without power completely disrupted the way of life for three days due to the cascading effects resulting from the power outage and caused longer term disruption to homes and industry.[3]

This year, winter coincides with the end of the transition period between the European Union and the UK, which may disrupt the movement of goods. With three concurrent strains already anticipated, the UK could be vulnerable to other shocks. These are hard to anticipate in advance but could include:

[1] Academy of Medical Sciences (2020) Preparing for a challenging winter 2020/21.
[2] National Engineering Policy Centre (2020) COVID-19: Engineering a resilient future.
[3] Royal Academy of Engineering (2016) Living without electricity.

- Adversarial cyberattacks are increasing in frequency and may be higher impact whilst the UK is focused on managing COVID-19 challenges.

There are increasing reports of opportunistic ransomware attacks. Cybercriminals see critical national infrastructure as an opportune target with notable recent attacks on the Ukrainian grid and interference in the Saudi Aramco gas plant.

- Population living and working conditions are also likely to be under strain. With the end of the furlough scheme and many companies going out of business or announcing major redundancies, unemployment rates are expected to rise.
- Mass remote working will change the demands for the electricity and gas networks and reliance on widespread internet connectivity.

During summer there were challenges in meeting unprecedented low energy demand. Over winter maintaining supply of these services and coping with the atypical demands will be vital to wellbeing and productivity.

Key messages

There were seven themes that have implications for policy decisions, these consider the need for businesses to assess their direct and indirect vulnerabilities and for government to enable an agile response.

1. Plan B has become business as usual, what is plan C?

Many UK businesses have been operating in business continuity mode since the pandemic began. Plans have been drawn up to cope with further disruption, but these plans will be immature and untested, and there was a recognition that businesses do not want to be in the position of requiring such plans to be enacted. The UK's current resilience capacity is a key uncertainty - the level of resilience that is necessary and how much we are willing to invest needs to be defined.

2. If things go wrong, they need to be fixed quickly.

To be able to respond to infrastructure failures engineers and support staff need to be fit, healthy and available. Industry have adjusted working practices, incorporating rotas as a protective mechanism. Sharing successful approaches to keeping staff healthy and at work across sectors may be beneficial. As the pandemic goes on there is a risk of increased complacency. The effectiveness and sensitivity of the track, trace and isolate system and testing capacity will have implications for staff availability.

The freedom of movement that allows the necessary expertise to get quickly to the site of disruption or to inspect products, both nationally and internationally will be critical. This may have implications for travel restrictions, provision of hotel accommodation and other supporting services and the definition of key workers.

When infrastructure has a sudden or rapid breakdown, getting real-time information to the people affected needs to be considered more systematically than relying on social media. More could be done to anticipate people's behaviours and mitigate the possible counterproductive ways people may try to cope.

3. Operational agility should be supported.

Operational agility is enabled by the availability of contingency stocks and labour and also by data driven models and synthetic environments. The availability of finance has been vital to make necessary interventions to ensure access to supplies or secure facilities to maintain business continuity. Uncertainties about the virus transmission routes make investment trade off decisions difficult for preventative measures.

Tension can arise when the organisation burdened with the financial and reputational risk is distinct from the organisation delivering changes. For those services brought under government control, the delivery partner requires freedom to operate in trust that they are acting in the public interest.

4. Network interdependence is where the greatest risks lie.

Infrastructure providers generally think that they have short-term resilience covered. However, with the current uncertainty, an 'expect the unexpected' attitude is required to manage the complexity. Coordination is key to avoid societal breakdown.

Stress testing is important but there is typically a lack of understanding of the networks on which the service can depend and it can be difficult to comprehend the extent of cumulative effects. Cross-industry exercises may be required to identify the greatest vulnerabilities and implement preventative strategies.

In August 2019 there was an electricity failure following a lightning strike. Two generators could not ride through the fault disturbance as their protection and control systems did not work as they were intended. Solar and windfarm energy controllers were unable to withstand the grid transient instability, resulting in the loss of electricity supply. While it only took milliseconds to recover the grid, the consequences caused further disruption, supply frequency fluctuations brought European standard trains to a halt resulting in train network disruption.

5. Uncertainty should be minimised.

Advance sharing of data, information and real-time indicators are important for planning. More comprehensive dashboards based on a larger pool of data may be required. This could include early warning for anticipated weather disruptions, anticipated implications of the Brexit trade deal or projected business failures that will result in supply demands. However, the value of the insights relies on multiple analysts considering these data sets through different lenses. Minimising the impact of external factors allows industry to concentrate on maintaining the provision of vital goods and services.

6. Need to focus on short term decisions based on long-term intent.

It is critical that decisions made now do not have unintended consequences that hamper progress towards longer term goals. There is a risk of focusing too much on the short-term issues and not making the necessary progress against longer term societal challenges. Taking action in areas where there will be no regrets will be important; this should include progress on digitalisation and net zero.

7. Time to move from being reactive to proactive

There are all the indicators of highly uncertain winter ahead, but UK government and industry must progress out of reactive mode and into proactive mode. There is a clear need to invest in the infrastructure we need for recovery and resilience. This has physical, digital, human and cultural dimensions.

- To minimise the disruption caused to existing physical infrastructure may require system redundancy, updating ageing assets or upgrading infrastructure to meet current standards.
- Better models and more synthetic environments can improve resilience to some shocks, data infrastructure and digital commons are required to create these digital capabilities at scale. These need to be secure to ensure more vulnerabilities are not created.
- The vulnerabilities of communities and individuals need to be reduced to be able to be able to cope with shocks.
- Culture change is required to value resilience, there may be opportunities to leverage the collaborations and coordination capabilities established for the COVID-19 pandemic and build out.

Climate change is posing a major threat to our infrastructure. For some sectors there are requirements on resilience reporting for climate change that are required by regulators, these mechanisms may need to be expanded to encompass more domains and resilience to other risks. There is a need for a long-term plan with clear milestones en route.

Planning for different scenarios is important however, ownership of prospective risks and actions on preventative measures are vital to increase resilience to future shocks. More coordination across sectors and between industry and regulators is required.

Hotter summers pose challenges for existing infrastructure. Telecommunications infrastructure can become unstable as temperatures rise and wildfires pose challenges to surrounding infrastructure.

In California, the infrastructure providers chose to shut down the electricity grid to avoid wildfires, taking two million people off the electricity grid. While that was thought to be confined to hotter climes, wildfires in Hampshire triggered National Grid to authorise a public safety power shutoff, causing the whole of the South West to run on a double circuit, removing a layer of resilience.