22nd September 2021

Climate risk and adaptation: Delivering resilient UK infrastructure

Chaired by: **Richard Dawson**, Adaptation Committee

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Climate Change Committee

Climate Change Risk Assessment 3
Chapter 4 - Infrastructure

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UK CLIMATE RISK

Aim of the CCRA3 Technical Report

'Exam question'

'based on the latest understanding of current, and future, climate risks/opportunities, vulnerability and adaptation, what should the priorities be for the next UK National Adaptation Programme and adaptation programmes of the Devolved Administrations?'

- Urgency scoring framework – 3-step process

Steps

1. *What is the current and future level of risk/opportunity?*
2. *Is the risk/opportunity going to be managed, taking into account government commitments and non-government adaptation?*
3. *Are there benefits to further action in the next five years, over and above what is already planned?*

What did we do?

Evidence review

- Calls for evidence
- Stakeholder workshops
- CCRA3 Research projects
- External review

What was new?

- Thresholds, lock-in, inequalities
- Interacting risks
- Net Zero
- Greater emphasis on country-level

CCRA3 stakeholder workshop February 2020

UK CLIMATE RISK

Chapter 4 urgency scores

I1 Risks to infrastructure networks from cascading failures

I2 Risks to infrastructure services from river and surface water flooding

I5 Risks to transport networks from slope and embankment failure

I12 Risks to transport from high and low temperatures, high winds, lightning

I8 Risk to public water supplies from reduced water availability

I3 Risks to infrastructure services from coastal flooding and erosion

I4 Risks to bridges and pipelines from flooding and erosion

I7 Risks to subterranean and surface infrastructure from subsidence

I10 Risks to energy from high and low temperatures, high winds, lightning

I13 Risks to digital from high and low temperatures, high winds, lightning

I9 Risks to energy generation from reduced water availability

I6 Risks to hydroelectric generation from low or high river flows

I11 Risks to offshore infrastructure from storms and high waves

Urgency scores for Chapter 4 risks by country

Risk Descriptor	England	NI	Scotland	Wales
I1 - Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures				
I2 - Risks to infrastructure services from river and surface water flooding				
I3 - Risks to infrastructure services from coastal flooding and erosion				
I4 - Risks to bridges and pipelines from flooding and erosion				
I5 - Risks to transport networks from slope and embankment failure				
I6 - Risks to hydroelectric generation from low or high river flows				
I7 - Risks to subterranean and surface infrastructure from subsidence				
I8 - Risks to public water supplies from reduced water availability				
I9 - Risks to energy generation from reduced water availability				
I10 - Risks to energy from high and low temperatures, high winds and lightning				
I11 - Risks to offshore infrastructure from storms and high waves				
I12 - Risks to transport from high and low temperatures, high winds and lightning				
I13 - Risks to digital from high and low temperatures, high winds and lightning				

River, surface water and coastal flooding

- Notable events: Ciara, Denis etc
- Future flooding projections (Sayers et al 2020)
- Surface flooding: all infrastructure assessed faces an increased risk with continuation of current level of adaptation ambition
- River flooding: Mixed picture - Railway lines and stations increasingly exposed
- 35 power stations, 22 clean water facilities and 91 sewage treatment works across the UK have been identified as being located in areas at significant risk from coastal flooding.
- Progress on flood defences has been made, though not enough to fully manage the risk
- Better understanding of current and future risk, monitoring and evaluation of the projected impact of current policies and actions and the creation of ‘what if’ scenarios of high rates of change.

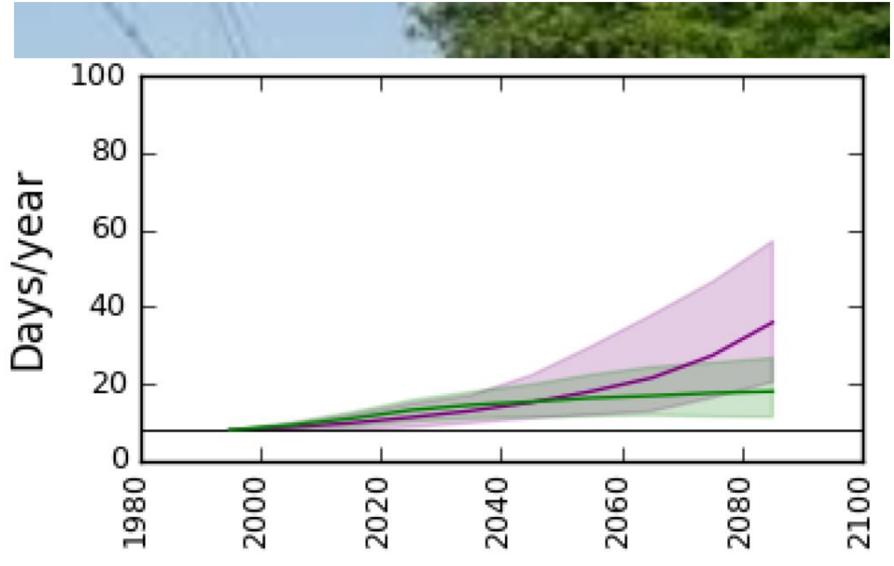
Flood damage on Burway Bridge, Ludlow June 2007 By DI Wyman, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=13997411

Risks to transport networks from slope and embankment failure

- Stonehaven event
- There are 20,000km of slopes and embankments supporting the UK's transport infrastructure.
- Increased incidence of high rainfall combined with preceding periods of desiccation and cracking are expected to lead to an increase in the rate of their deterioration and increase incidents of slope failure within the transport network.
- Older less well compacted assets such as those supporting the rail network are deteriorating at a faster rate than newer assets.
- Slope failures in coal tips is also a specific risk for Wales.

Risks to transport from high and low temperatures, high winds, lightning

- High temperatures can lead to: the buckling of rail lines; line sag and rail speed restrictions; wildfires; damage to bridges and pavements; deterioration of airport runways road surfaces; disruption of communications and IT services leading to transport delays and the overheating of passengers.
- Projections of 2°C and 4°C worlds.
- High winds lead to disruption of rail operations due to debris on lines, damage to road infrastructure, closure of bridges, and suspension of port and vessel operations.
- Lightning strikes on railways damages electronic equipment, line-side trees and buildings, and cause line-side fires.



Transport network risk days > 26C under pathways to 2°C (green) and 4°C (purple) global warming in 2100 for England (Modified from Arnell et al 2021)

Risks to energy from high and low temperatures, high winds and lightning

- Lightning can lead to power cuts e.g. August 2019.
- High temperatures: lead to a reduction in the generation, transmission and efficiency of distribution of electricity, reduce the efficiency of photovoltaic cells, cause power lines to sag, affect the operation of gas compressor stations, and cause faults on the electricity network. Drives demand for air conditioning.
- Without adaptation increasing mean and extreme temperatures exacerbates the severity or frequency of these incidents.
- High winds and resultant blown debris can cause damage to power lines and generators.

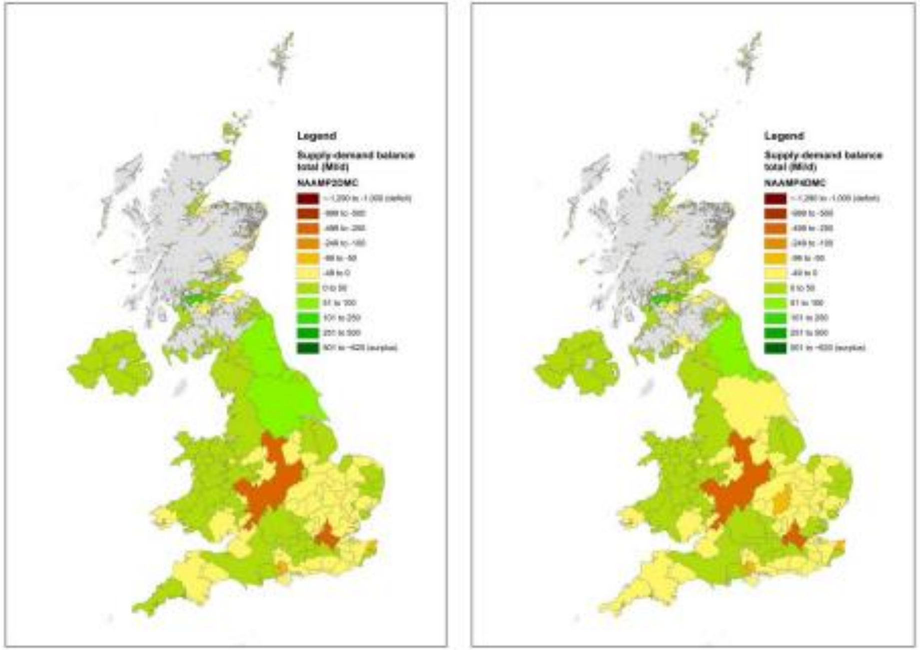
Source: UK Climate Risk Energy Sector Briefing

Risks to ICT from high and low temperatures, high winds, lightning.

- High temperatures: pressure to keep data centre’s cool in order to operate; soil shrinkage disrupting underground infrastructure can also disrupt co-sited ICT.
- 15% of small (<50m) telecommunications masts are in areas highly susceptible to subsidence.
- High winds and lightning can lead to power failures to mobile phone base stations.

Risks from reduced water availability

- Without further adaptation a water deficit across the UK of 1,220 - 2,900 Ml/day could arise by the end of the century. England is particularly at risk.
- Thermal power stations drawing water from the Thames and Trent Basins and the Yorkshire Ouse will likely face restrictions due to freshwater availability by 2030 (Byers et al 2014, Murrant et al 2017a; 2017b, Konadu and Fenner, 2017).



Supply-demand balance by mid-century, in a 2°C (left) and 4°C (right), central population projection and assuming no additional adaptation action, at water resource zone scale Grey indicates areas reliant on private supply. Reproduced from HR Wallingford (2020)

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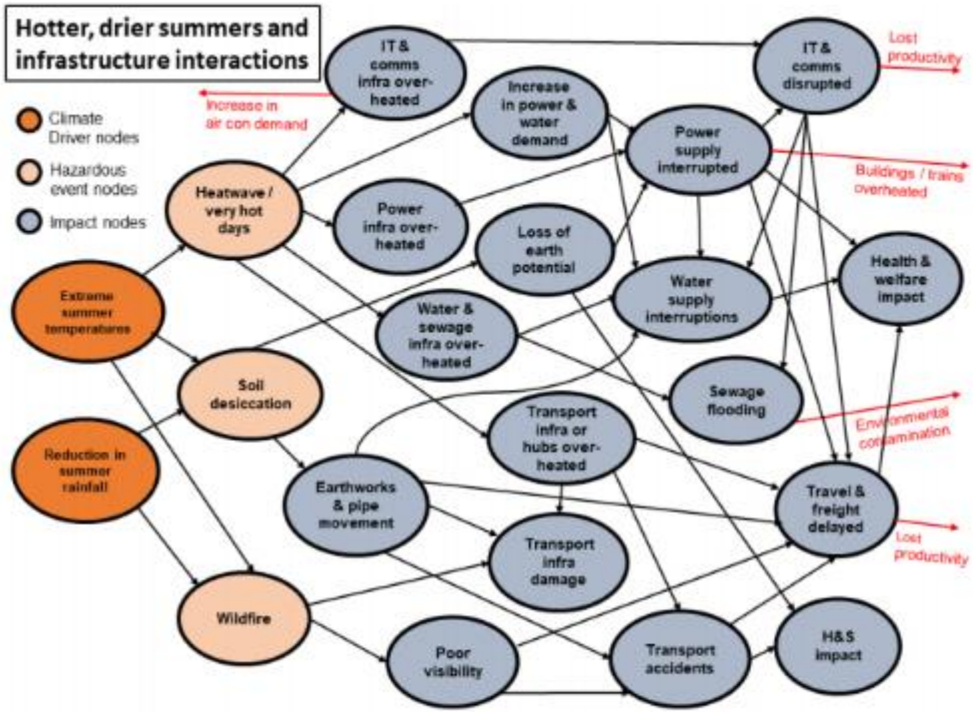
Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures

- Infrastructure interdependencies arise as:
  - (i) their services are reliant on other networks for power, fuel supplies and ICT;
  - (ii) they are co-located and experience the same hazard; or
  - (iii) they are managed or used by the same organisations or people (Dawson, 2015)



Box 4.4 Figure 4.1: Example of interacting risk analysis for extreme temperatures and reduced summer rainfall on infrastructure. The three outcomes of heatwaves, wildfire and soil desiccation can result in a series of impacts on infrastructure which in turn lead to other impacts across the sector and beyond. Transport infrastructure includes roads, rail tracks, runways. Transport hubs include stations, airports, ports. Transport accidents include road vehicles, trains, ships, aircraft (Modified from WSP, 2020).

Table 4.2 Summary of the most significant risk pathways modelled in the CCRA3 Interacting Risks project (WSP, 2020), along with the impact ratings (based on annual average impact and likelihood) in 2020 and 2080.

Climate drivers	**Hazardous events**	**Main impact cascades**		**2020**	**2080**
Increase in summer temperatures and reduction in summer mean rainfall	Heatwaves and very hot days	Transport infrastructure overheating, or disruption to IT and communications services	Travel and freight delays	Low	Medium
			Transport infrastructure damage	Medium	Medium
Extreme winter rainfall events and increase in winter mean rainfall	River, surface and groundwater flooding	Power infrastructure flooded	Power supply disrupted	Low	Low
		Water, sewerage infrastructure flooded, reduced water quality or power supply disrupted	Water supply disrupted	Low	Medium
			Sewer flooding	Low	Medium
		Transport hubs or infrastructure flooded, or power supply disrupted	Travel and freight delays	Medium	High
		Damaging water flows, slope or embankment failure	Transport infrastructure damage	Medium	High

Common themes for infrastructure

- Development and use of common indicators to monitor risk and adaptation progress across infrastructure assets and networks.
- Agree standards of resilience across infrastructure sectors and share data.
- Use of ISO 14090 & 14091 and BS 8631 to identify risks and plan adaptation.
- Use of inspection and monitoring systems together with enhanced maintenance regimes.
- Use of climate services as early warning systems to better prepare for / avoid impacts.
- Ensure standards and designs take climate change (e.g. the latest flood and rainfall projections) into account for new infrastructure and avoid lock-in.
- Regular revision of the climate data used for design standards and adaptation plans as understanding of climate impacts evolves e.g. through the use of adaptation pathways.
- Use of Green Infrastructure to mitigate flood and heat risks.

Interactions with net zero

- Concentration of system risks through increasing interdependencies between transport, electricity and ICT from both electrification and ‘smart’ technologies / IoT..
- Introduces new sources of water demand – for carbon capture and storage and hydrogen production.
- Promotion of active travel: changes the balance of risks to cyclists and pedestrians relative to other modes during periods of extreme weather.
- Transition to Net Zero provides opportunities to embed resilience into new infrastructure.

Flooding in the street during the Sept **2008** flood in Morpeth by Johndal. CC BY-SA 2.0

Climate risk and adaptation: Delivering resilient UK infrastructure

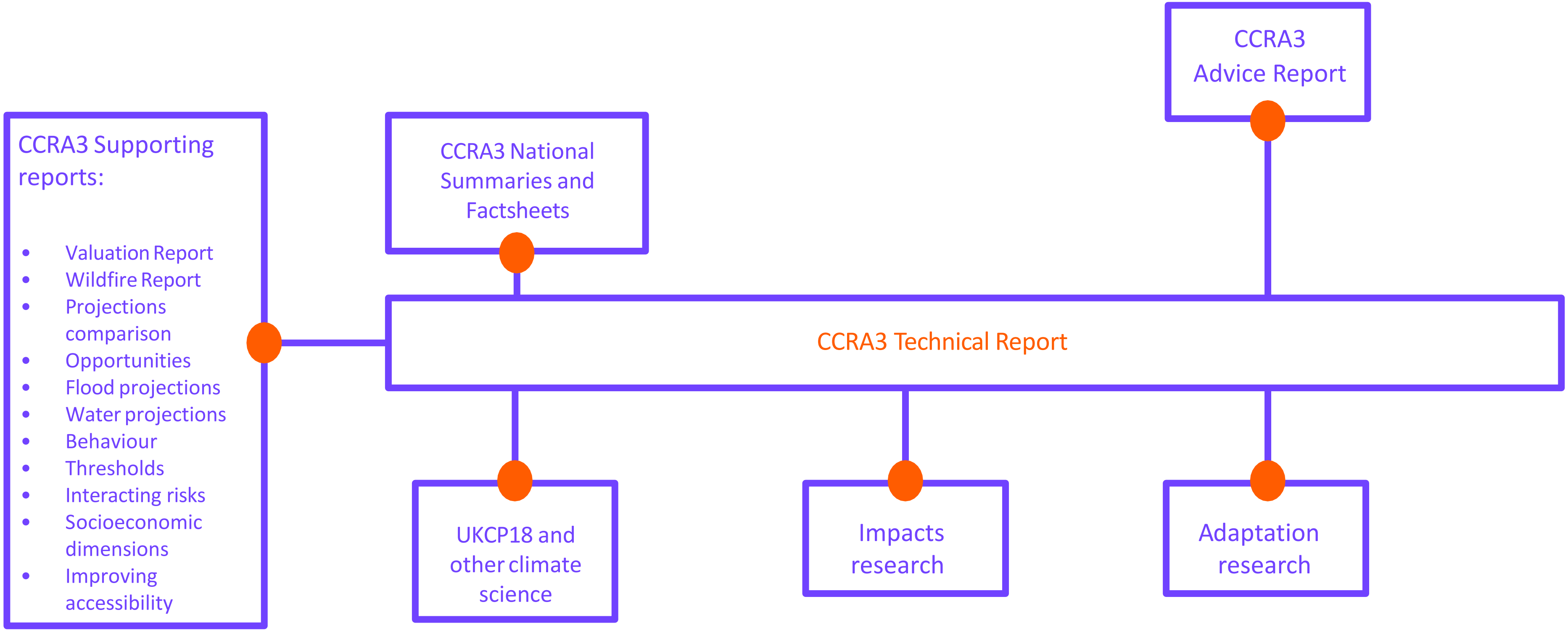
CCC's Independent Assessment

Cara Labuschagne

Climate Change Committee secretariat

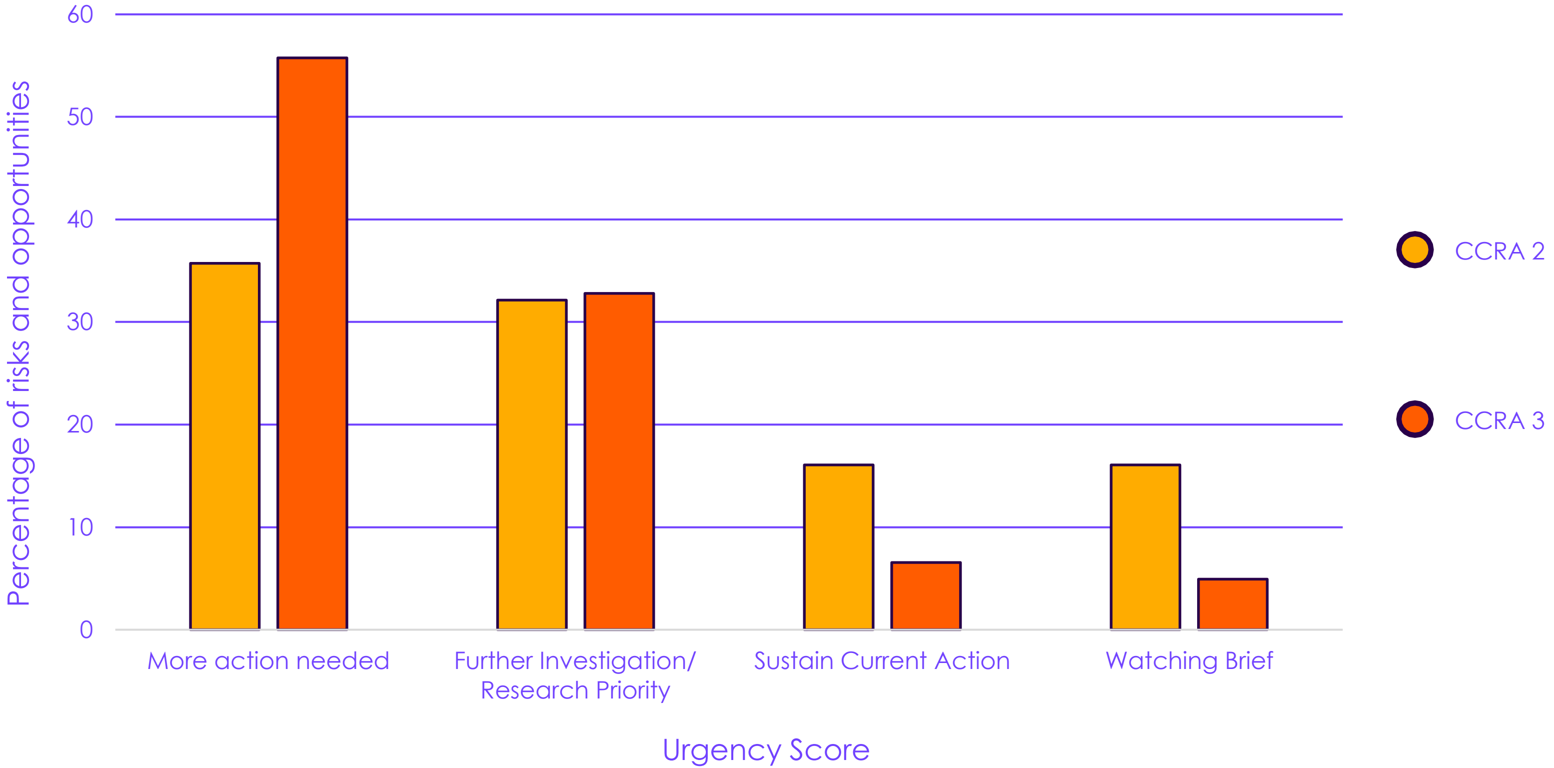
Independent Assessment of UK Climate Risk

A comprehensive assessment of climate risks and opportunities



The level of urgency of adaptation has increased since 2017

12 of 13 infrastructure risks require **More Action** or **Further Investigation**



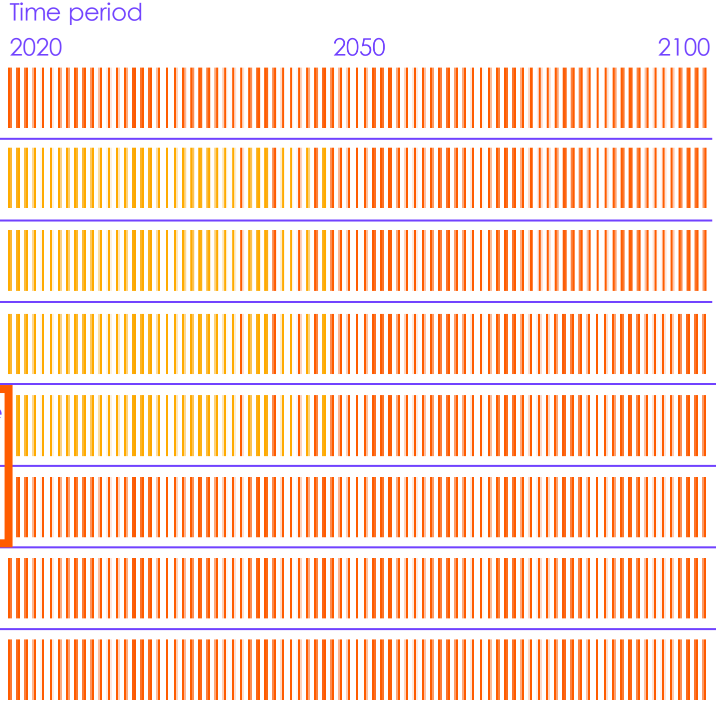
Source
CCC Analysis

Climate Change Committee

Committee's highest priorities for further adaptation in next two years

Magnitude of risk

High / Medium



Risk	Key policy areas
Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards	Biodiversity, soil and water protection and restoration, environmental land management, sustainable farming and forestry, Net Zero, green finance
Risks to soil health from increased flooding and drought	
Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions	
Risks to crops, livestock and commercial trees from multiple hazards	
Risks to supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks	Public procurement, business resilience
Risks to people and the economy from climate-related failure of the power system	Infrastructure, energy, Net Zero
Risks to human health, wellbeing and productivity from increased exposure to heat in homes and other buildings	Building regulations and strategies, planning reform
Multiple risks to the UK from climate change impacts overseas	National resilience, overseas aid, research and capacity building

Resilient Net Zero electricity system

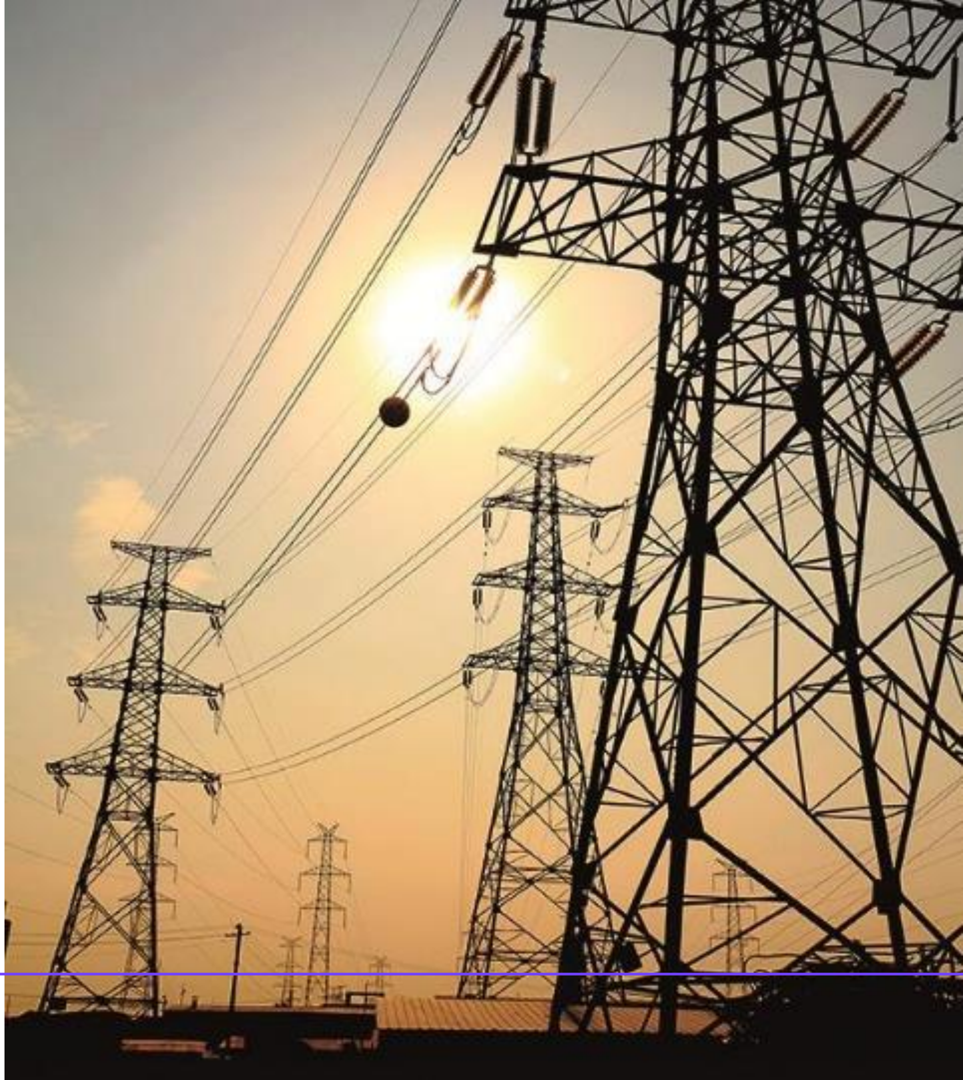
- Climate hazards will pose increasing risks to operation of generation facilities, systemic risks to operation of the network and cascade risks across sectors

- Net Zero is driving fundamental shifts in the role of electricity: **single source of energy** for major activities and critical services

- Important role of policy to embed climate resilience in the power system:

- Gov't response to NIC Resilience Study
- Implementation of 2020 Energy White Paper
- National Infrastructure Strategy
- Net Zero Strategy

- Adaptation actions include more resilient design standards, use of nature-based solutions and decreasing resource consumption

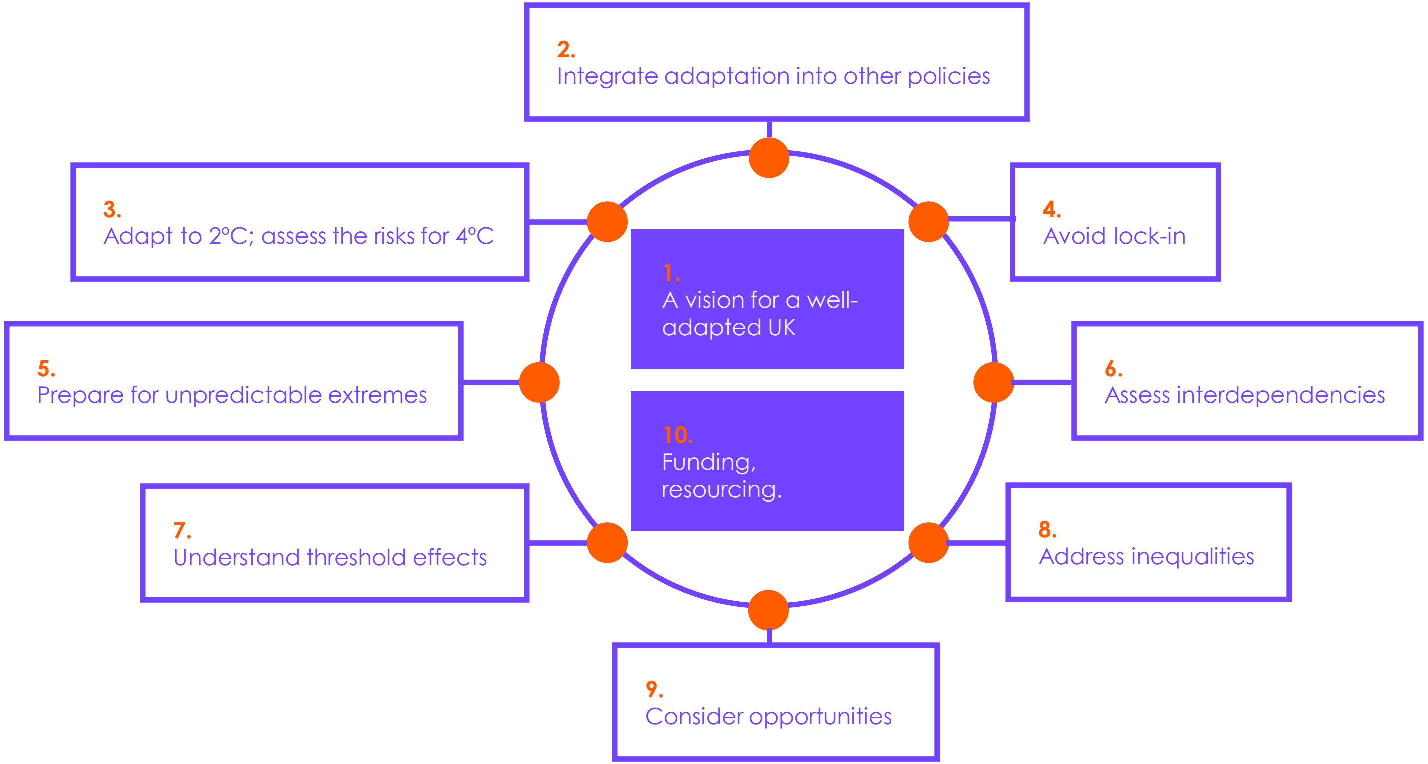


Resilient supply chains & distribution networks

- Domestic & international climate hazards will increasingly affect supplies, infrastructure & transport routes
- Crucial role of infrastructure in supporting resilient supply chains. Adaptation actions include:

- Identify & map new interdependencies with electricity networks, digital/ICT sector, and wider supply chain
- Stronger reporting requirements for businesses and infrastructure providers
- Resilience standards for enabling sectors e.g. power, digital/ICT, transport
- New technology & infrastructure, avoiding lock-in
- Diversification of supply chain risk and capacity building

Principles for effective adaptation policy



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