



DEVELOPING CReDo FROM DEMONSTRATOR TO A MARKET-READY TOOL

An executive report exploring the development areas and addressable barriers for the Climate Resilience Demonstrator to achieve minimum marketable product.

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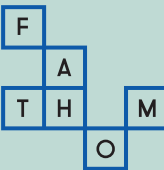
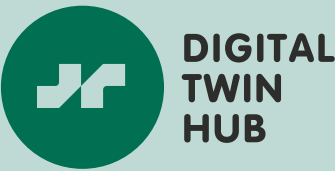
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INTRODUCTION

Climate change is expected to increase the frequency of extreme climate events around the globe. Flooding events are expected to be among the most disruptive in the UK, causing damage to homes, livelihoods, and critical infrastructure.

Infrastructure assets can experience outages either through direct damage from extreme climate events, or through damage to assets on which they are dependent. The Climate Resilience Demonstrator (CReDo) is a multiyear programme developing a tool to map the interdependencies of cross sector assets. It has the potential to allow asset owners, local authorities, and regulators to identify resilience weaknesses and dependencies, and aid decision making processes for infrastructure asset upgrades.

CReDo is in its early demonstration phase with real asset data from three critical asset owners (AO) being modelled in flooding scenarios in East Anglia to determine the failure modes of assets and cascading effects during such flooding events. Whilst key functionality and use cases have now been demonstrated, there is still a significant amount of development required in order to ready CReDo for market.

More information on the background of CReDo can be found on the Digital Twin Hub.

This report reviews the current state of CReDo and identifies some of the key next steps required for the further development.

This is intended for consortium partners to assist in planning critical next steps in developments, and to influence communications with the broader market around CReDo's trajectory. The sections of this report capture some of the key challenges and demonstrate that these areas have been considered by the CReDo team.



The report is broken down into various sections:

Gap Analysis

A gap analysis is a tool used to identify the barriers between the current state of a product and the desired future state. In this case, the future state in question is the minimum marketable product state of CReDo, this is the point at which CReDo would be ready to hand over to market and for the platform to be commercialised. Whilst the route to market and future operational/ownership model for CReDo is not yet known, there are some critical gaps to be addressed before these decisions can be made.

The gaps are summarised into categories to group the tasks that must be carried out to develop CReDo. These gaps are then presented in a summarised flowchart before being broken down in more detail in Table 2 of section 3.

The gap analysis considers both gaps required to improve the existing use cases, but also those that should be addressed to enable future cases which are discussed in more detail in Transport Use Case Dependencies.

Roadmap to Minimum Marketable Product

A technology roadmap has been developed to outline the process that will deliver CReDo from demonstrator phase to MMP state. This roadmap considers the gaps outlined in the gap analysis and formulates a high-level strategy for how these will be overcome.

The roadmap is not a detailed project plan for the next phases of CReDo development, rather a summary of the current objectives and the expected steps to achieving them. Whilst sequence of tasks has been considered to ensure dependencies align, the complexity and duration of specific actions are not signalled in the roadmap. This is a tool to signal to the market the intended steps in the next milestones.

Potential Funding Opportunities

Up to this stage in CReDo's development, the project has been funded by Innovate UK through Connected Places Catapult Milestone projects. Whilst the next development phases have already been planned and are anticipated to continue under the current funding structure, it is important to remain mindful of alternative funding options that may exist for CReDo in the future to provide confidence in the longevity of the programme.

Section 4 of this report reviews a number of existing funds that align with the objectives of CReDo, proving that there could be

suitable funding opportunities for CReDo's future development.

Cross-Sector Funding Mechanisms

Preparing CReDo for market is not just a technical challenge, in order to achieve its full value it must be able to integrate with business-as-usual processes and meaningful insights must be actionable.

One challenge within this category is understanding how cross-sector infrastructure providers will fund projects that look to improve the climate resilience various cross sector assets. Without agreed mechanisms for funding these types of projects, asset owners may be able to come to agreements on who is best placed to finance. Section 5 discusses three potential mechanisms for funding cross-sector infrastructure resilience upgrades.



GAP ANALYSIS

CReDo is in it's early demonstrator phase, modeling the interdependencies of various assets across key national infrastructure.

However, there are still a number of gaps to be addressed for CReDo to reach a state which is ready to be go to market and could be adopted into business-as-usual (BAU) for national critical asset owners.

A Gap Analysis is a process used to identify what the current barriers are to achieving the desired end state / functionality of a product. By reviewing the current state of CReDo, and summarising the desired minimum marketable product (MMP) state, the gap between the two can be identified.

This is useful to highlight the areas for development and plan the next steps in the demonstration project. The gaps and barriers identified can also be useful to plot a roadmap for the development of the product to ensure that task dependencies can be well understood. This section explores the current state of CReDo and the future MMP state and documents the gaps that must be overcome in order to reach the intended future state.

Product Development Gap Categories

When assessing the current and MMP state of CReDo it is useful to consider the demonstrator through a number of lenses. For the purpose of the gap analysis and roadmap of future developments, CReDo has been broken down into the following categories:

Data and security infrastructure

- Considers the framework around the sharing of data between asset owners
- Development of various access levels that will be available to different types of users
- Legal aspects of data sharing

Modelling capability

- CReDo's functionality, scenarios that can be modelled
- Types of extreme weather events that can be modelled
- Criticality assessment of assets
- Analysis of intervention schemes

Expansibility and scalability

- Asset owners inducted and present in CReDo
- Geographical coverage of CReDo
- Data providers and non-data providers
- Interoperability with other asset owners

Funding and ownership

- Mechanism for funding cross sector development projects
- Responsibility and ownership of CReDo
- Ability to access funding for development activities.

Table 1. Categories for barriers to be addressed to develop CReDo to MMP state

Gap Analysis summary

The barriers to achieving MMP state of CReDo can be detailed in a step-by-step format, outlining the discrete gaps that must be addressed to reach the desired end state. This graphic, however, summarises the current state of CReDo and the desired MMP state and provides a high-level summary of the key developments required in each of the task categories.

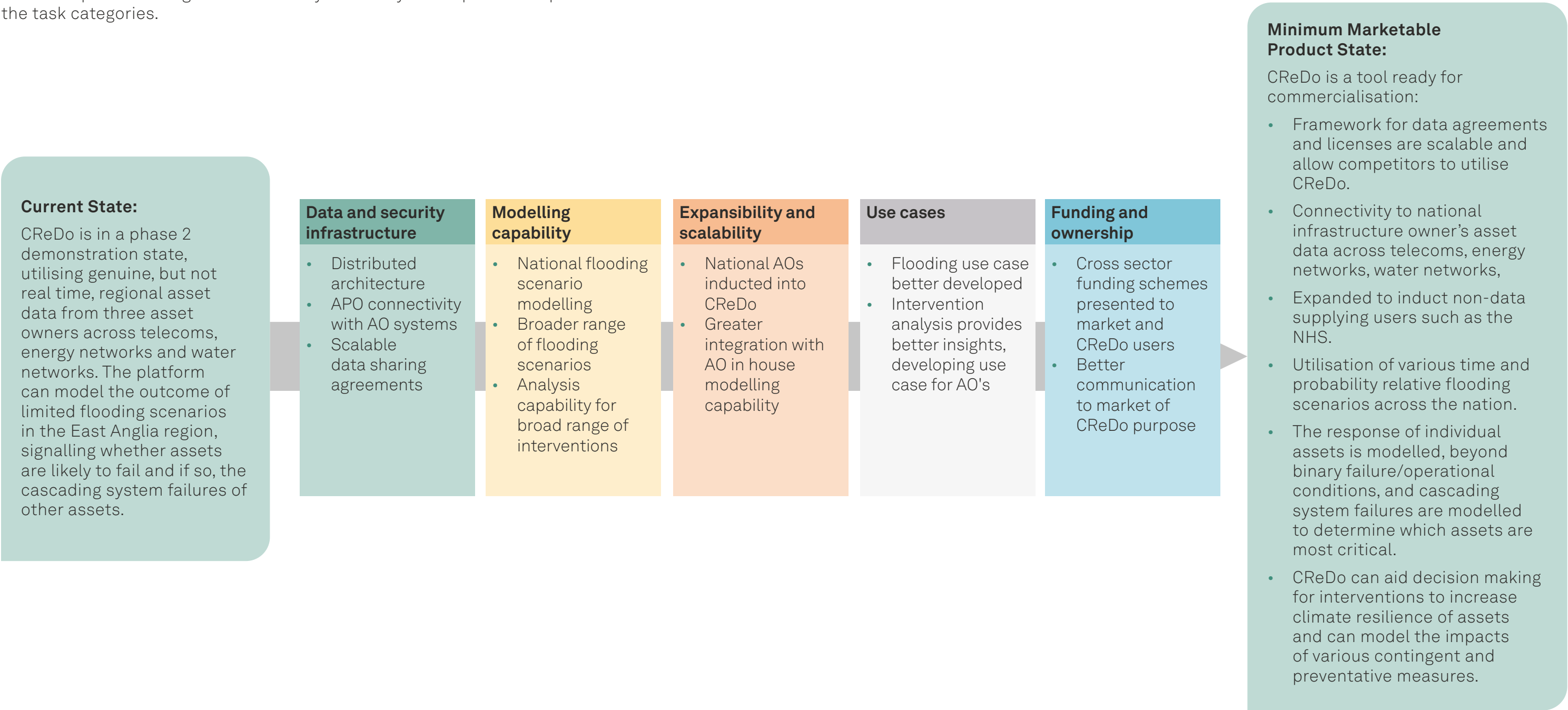


Figure 1. Overview gap analysis of CReDo to MMP state.

Gap Analysis detail

The following Table 2 provides detailed insights into the gaps/barriers that need to be addressed in order to develop CReDo to its MMP state. Each gap is numbered, and the dependencies column signals where particular gaps would need to be addressed in order for the gap in that row to be addressed.

Data and security infrastructure					
Current state	Gap no.	Gap/Barrier	Dependencies	Minimum marketable product	Future potential
All AO asset data is stored centrally which is expensive and increases risk of misuse.	1.1	Distributed architecture framework to be designed and deployed to allow connection to asset data from source.	1.4, 1.8	Distributed architecture reducing data storage needs and costs and improving data security.	Distributed architecture allows multi-directional flow of data. Asset data can be reached from the source and insights can be shared back to users and in-house systems.
Asset resilience data and insights stored centrally, cannot be drawn back to AO systems.	1.2	AO’s cannot load insights into in-house systems. Integration with AO systems required to increase flow of CReDo output data.	1.8	Seamless and secure connectivity with AO’s modelling and other insight generation systems.	
	1.3	Integration with AOs systems presents opportunity for cyber security vulnerability. Penetration testing should be used to ensure secure.	1.1, 1.2		
Data sharing licenses and agreements do support current work, but not accession of new organisations nor ‘need-to-know’ visualisation.	1.4	Currently misalignment or lack of certainty around which asset data can and cannot be shared back to AOs, or with other AO’s.	-	Agreements in place to facilitate for AO’s with commercial sensitivities to share data in order to induct into CReDo, but limit and allow tailored sharing of visualisation, insights, and data that is shared back.	Data sharing agreements that are easily scalable and allow easy induction of new asset owners. Allow climate resilience insights to travel from in-house systems to shared CReDo dashboards.
	1.5	Data sharing agreements and licenses are not fit for competing AOs to share only the required data with CReDo.	1.8		
		1.6	Data sharing agreements need to be scalable and consider both data sharing and non-data sharing users.	1.8	Easy induction of new AO’s with known agreed process for preparing data for induction into CReDo.
Extensive manual process to align AO data format for upload to CReDo.	1.7	Uncertainty around data cleaning and formatting requirements. Responsibility for cleaning data is uncertain.	1.5, 3.4		
One subscription type and access permissions for all users.	1.8	Different user types will require different levels of access to asset data and output insights. Both user types internally within AOs and different types of AOs.	-	Greater confidence for AOs to work with competitors within CReDo with confidence over what data and insights can and cannot be shared.	Various user types can be easily deployed depending on type of user or subscription.
	1.9	User permissions this access to only need-to-know visualisation.	1.8		

Table 2. Detailed breakdown of CReDo gaps to be addressed.

Modelling capability					
Current state	Gap no.	Gap/Barrier	Dependencies	Minimum marketable product	Future potential
Limited flooding scenarios for one region only.	2.1	Flooding models for nationwide coverage required. Capability to model asset failure with a time variable, and probability variable.	4.1	National flooding modelling capability.	Other extreme weather events modelled (e.g. extreme heat, extreme wind, combination of different climate phenomena)
Flooding models only based on maximum flooding depth.				Various flooding scenarios with time scale element as well as probability.	Flooding models that incorporate AO drainage assets
Simple expert elicitation models for flooding, and data is limited, so difficult to deploy models.	2.2	Expert elicitation methodology needs to be generalised to ensure consistency and enable scale.	2.1	Greater degree of accuracy from flooding models.	Insights for asset failure beyond flooding models. Highest priority being extreme heat.
Analysis of intervention strategies is limited.	2.3	Does not currently enable strategic investment planning because different interventions are not assessed. Assets require more detailed modelling with discrete failure modes.	2.1	AOs can assess the impact of different mitigation strategies and alternative network configurations.	
Model outputs are binary, assets have either failed or are operational					
Cascading analysis is based on binary analysis.	2.4	General logic for cascading effects to be agreed. Modelling of more detailed failure modes will allow for greater modelling of cascading system failures.	2.3	Nonbinary cascading failures of assets.	Detailed failure model insights provided.

Expansibility and scalability					
Current state	Gap no.	Gap/Barrier	Dependencies	Minimum marketable product	Future potential
Asset data for one region only	3.1	National data from other AOs required in order to scale CReDo to national coverage.	1.7	Sufficient AO’s and assets inducted into CReDo in order to consider it a national tool.	Use cases can be further developed once tool is national.
One national infrastructure operator inducted (i.e. BT	3.2	All national infrastructure operators inducted.	1.7		
AO data cleaned and reformatted by CReDo team	3.4	Unscalable process for cleaning and preparing AO data for induction to CReDo	-	Clarity over AO costs and requirements to induct into CReDo.	Simple induction of new asset owners.
Utilising only CReDo climate models to determine asset failure and cascading effects.	3.5	AOs have access to internal climate models which can model failure of their own assets. By only using CReDo modelling the insights may be different where models produce different outputs. Missed potential of insights.	1.2	Greater modelling and integration functionality for AO’s.	Seamless integration with in-house climate modelling for greater range of insights.

Table 2. Detailed breakdown of CReDo gaps to be addressed.

Use cases					
Current state	Gap no.	Gap/Barrier	Dependencies	Minimum marketable product	Future potential
Limited flooding use case developed.	4.1	Return on investment can be improved by better defining the use case for flooding and other extreme weather insights since the potential users and impact of CReDo would be increased.	-	Better developed flooding use case, increasing attractiveness of CReDo to other AO's and potential investors.	Use cases beyond flooding developed. Extreme heat for example.
Insight for AO's to determine resilience of assets and interdependencies with other AO assets.	4.2	Unknown commercial direction of CReDo in future means use cases should be diversified for greater range of different user types. For example, regulators or research bodies.	-	Greater functionality and benefit obtained from utilising CReDo. More attractive for broader AO's to be inducted.	Clear return on investment for funders/investors since value of CReDo is increased for users.
AO's only receiving insights.					
Non-competing AO's inducted only.	4.3	In order to achieve modelling that is representative of the real world, competing AOs will be required to be inducted. Data sharing concern.	1.5		
One simple dashboard view for all use cases.	4.4	User interface of CReDo requires improvement to encourage the take up for a broader range of users.	4.2	Better user experience and functionality of CReDo through developed UI and fit for purpose visualisation which align with specific use cases.	
Flood models are not dynamic, do not consider drainage assets which reduce effectiveness for potential use cases.	4.5	Drainage assets that influence flooding of nearby critical infrastructure assets should be modelled within CReDo to enable other use cases.	-	More realistic insights of asset failure.	CReDo has potential to be used as standard for determining the resilience of a system.

Table 2. Detailed breakdown of CReDo gaps to be addressed.



Funding and responsibility					
Current state	Gap no.	Gap/Barrier	Dependencies	Minimum marketable product	Future potential
Limited funding available to CReDo. Funding being sought out per development task and through milestone deliverables.	5.1	Viability of CReDo may be questioned if suitable funding mechanisms for the future have not been identified early.	-	Suitable funds identified, providing the market with greater confidence of future development of CReDo and unlocking funds to conduct next development stages.	Future funding / investment to CReDo better known and market more ready to invest and drive the future developments.
Lack of understanding of CReDo functionality and purpose within the market.	5.2	Reduces the attractiveness of CReDo to potential new users, funders, or investors.	-	Greater understanding from market and policy makers of the role of CReDo. Strong and compelling case for CReDo that funders understand. Attractiveness to investors/ funders increased.	
Return on investment and business case for CReDo in development stages and not well understood by the market.	5.3	Business cases need to be developed and well communicated to the market.	-		
Lack of BAU process for cross sector funding of infrastructure resilience upgrade projects.	5.4	Usefulness of CReDo will be limited if users cannot collaborate to act upon insights.	-	Mechanisms presented to regulators and/or funders to work across sectors to actively fund cross sector problems.	CReDo is ready to integrate into BAU processes for many AOs.
Unknowns around potential ownership or responsibility for climate resilience KPIs for UK asset owners.	5.5	Risk that the insights from CReDo will not lead to significant resilience improvements due to lack of accountability for system-level climate resilience of Critical National Infrastructure.	-	Options identified for suitable responsibility matrix or resilience champions. Integrating CReDo into future cross sector mechanisms.	

Table 2. Detailed breakdown of CReDo gaps to be addressed.



ROADMAP TO MMP

A roadmap has been developed to signpost the development route to a market ready CReDo. This looks to address the key barriers identified in the gap analysis.

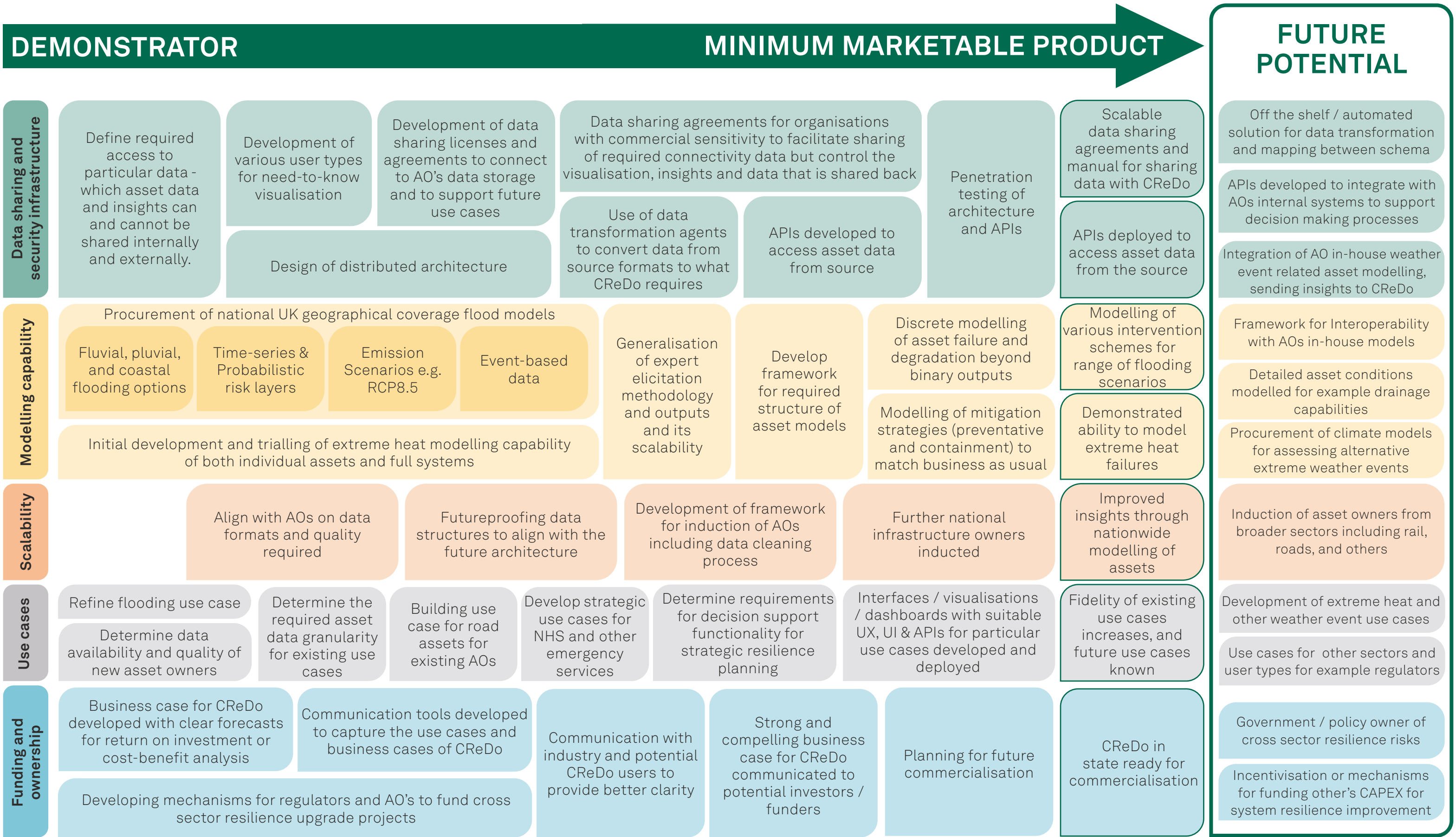
It may also highlight key areas where the market can support the development of the system - where this is the case, please get in touch through the [Taking Action page on the Digital Twin Hub website](#). The roadmap is a visualisation of the steps that will be required to tackle the gaps and barriers identified within the gap analysis and will act as a tool for the CReDo team to understand what will be required in future milestones.

The roadmap outlines the development strategy in line with the trajectory of the CReDo demonstrator, it summarises a current understanding of the key tasks that will be required in the next milestones. Using the same categories as in the gap analysis, the tasks have been grouped to achieve the objectives that align with CReDo's current users and partners.

This roadmap is not intended to be used as a detailed project plan and does not provide an accurate depiction of the expected complexity or duration of each task. The sequence of tasks in the roadmap have been considered particularly where there are noted dependencies between them, however this is subject to change as development and project planning continues.

The final column of the roadmap exceeds MMP state of CReDo and signals to some of the future potential features in order to capture the thinking and long-term vision of the project partners. Depending on the demonstrator's progress of the development and the eventual commercial model of the product, this future potential may evolve or become much more concise.





CReDo FUNDING OPPORTUNITIES

Until this stage, the development of CReDo has been primarily funded through Innovate UK, and most recently via a Connected Places Catapult Milestone project.

However, for particular areas of development CReDo has accessed specific funds where development gaps have aligned, that is the Ofwat Water Breakthrough Challenge and the Ofgem Strategic Innovation fund. The next stages of development are intended to be funded in a similar way, primarily through milestone funding with access to specific funds where this is deemed suitable. Innovation funding can be an opportunity for industry partners to collaborate on the development of CReDo by accessing funding within their specific sector, this is very powerful for CReDo's development as it ensures the objectives continue to align with potential end users.

This section outlines a number of funding opportunities that exist today that allocate funds to projects that align with the objectives of CReDo. The purpose is not to identify the exact funding route that CReDo will undertake in the future, but to highlight that the space which CReDo looks to operate in, is a key focus for a number of organisations which provide funding for research and development projects. Some of the examples in the table may align with specific categories of development for CReDo, whereas others align with the overall objectives of the platform. These funds, or future replacements, may one day make suitable funding avenues for CReDo developments. With current developments of CReDo led by CPC, some of the funds discussed below may not be directly accessible due to limitations in the organisations which fall within scope, but since the objectives align there is potential to access these in the future once ownership of CReDo has been transferred.

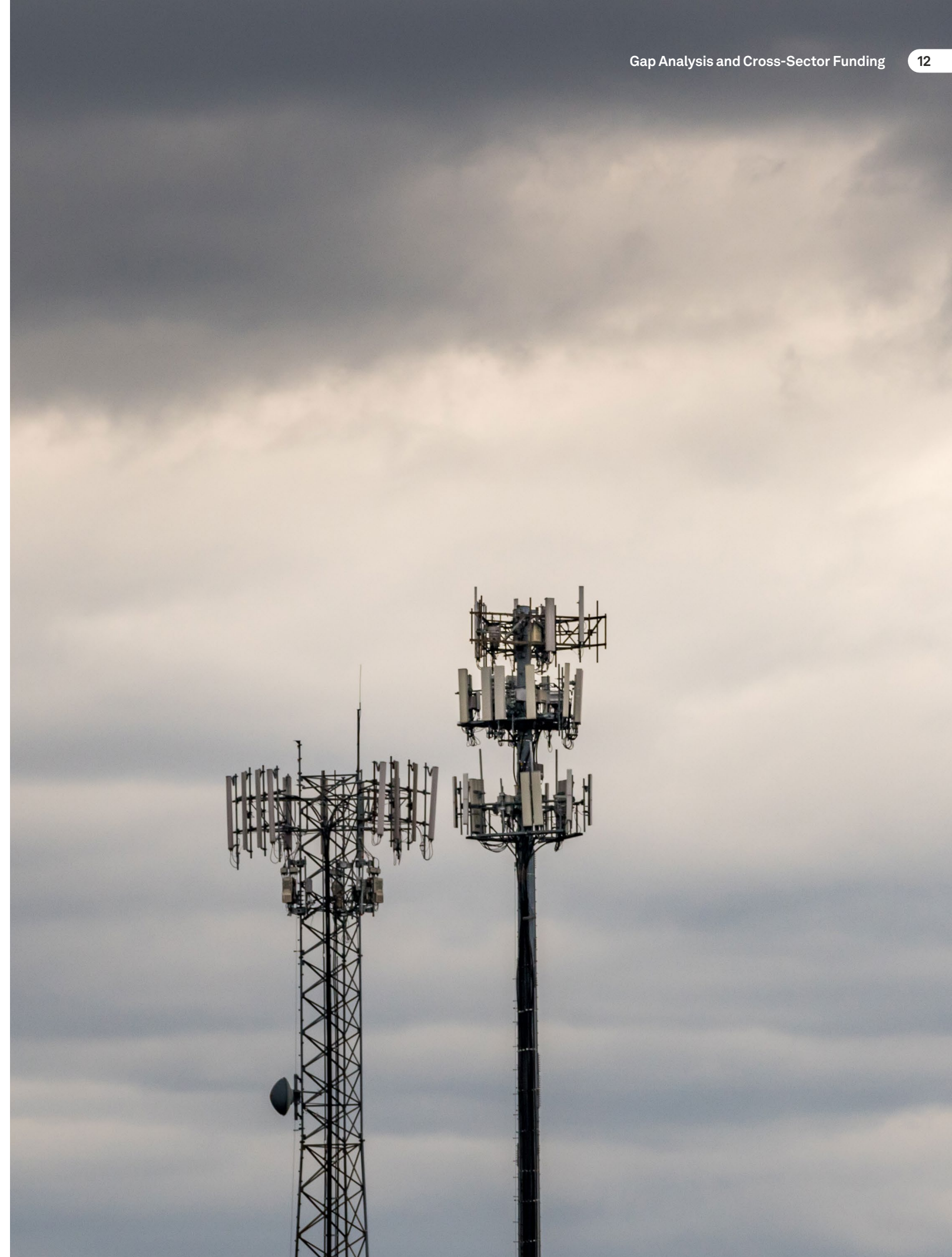


Table 3. Existing funding opportunities which align with CReDo development activities.

Opportunity name	Scope	Value / mechanisms	Objectives	CReDo alignment
Knowledge Asset Grant Fund (Innovate UK)	The Knowledge Assets Grant Fund supports organisations across the public sector in the UK to explore exciting new uses of datasets, technology, intellectual property, ideas, and expertise. Funding is available for use in supporting the development, re-purposing, commercialisation or expanded use of public sector knowledge assets.	Explore Grant (up to and including £25,000) Expand Grant (£25,001 to £100,000) Extend Grant (£100,001 to £250,000)	Unlock potential for developing and exploiting public sector knowledge assets. Unearth potentially valuable knowledge assets. Value can include financial, economic, and social benefits.	CReDo will require access to data of critical infrastructure assets that will be modelled to display interdependencies in a format which has not been achieved in the past. Data from critical asset owners is required in order to provide benefits for the public good.
TWINE demonstrators: digital twins for environmental science (NERC, Met Office)	How research using Earth Observation (EO) data and emerging digital twinning technologies can transform environmental science in the following priority areas:- climate change, mitigations and adaptation- biodiversity and ecosystems-natural hazards, including weather, and their mitigation	£250,000 - £750,000 (fund total: £2 million)	The aims of the TWINE programme, and the projects that are successful through this funding opportunity, are to:- harness the UK’s leading position at the nexus of environmental, observational and computational sciences, and bring together multidisciplinary teams to realise the value of digital twinning technology to address environmental challenges- improve the understanding, modelling and prediction of events, inform future decision-making, and test the impacts of different scenarios and interventions to help make better decisions on improving our environment- build the foundations of a coherent and lasting landscape of digital twins for environmental science, with a high level of cross-fertilisation of learning and a focus on design for interoperability with current and future activities.	CReDo will provide insights into the infrastructure failures associated with extreme weather events, thus providing important data required to assess to overall impact, hazard, and cost of such events. This fund would only be accessible to CReDo if the development was to be university led.
Ofgem Strategic Innovation Fund (Ofgem, Innovate UK)	Vision:to find and fund ambitious, innovative projects which can help shape the future of the energy networks and accelerate the transition to net zero, at lowest cost to consumers to help transform the UK into the ‘Silicon Valley’ of energy, making it the best place to be a) an energy consumer and b) an energy entrepreneur.	up to £10million (fund total: £450 million)	Fund consists of two key challenges, one of which aligns with CReDo, exploring whole system network planning and utilisation to facilitate faster and cheaper network transformation, and asset rollout	Whilst CReDo is not aligned with developing a net zero energy system, it is aligned with addressing the challenges in the way of a net zero system which includes resilience. CReDo could be utilised to determine where to prioritise net zero upgrades in the energy system, in turn improving resilience.
Water Breakthrough Challenge: Catalyst Stream (OFWAT)	The Catalyst stream aims to encourage new ways of working that go beyond business-as-usual innovation practices in the water sector, in particular, increasing and improving collaboration and building partnerships from within and outside the water sector. Approximately £8 million is available for entries seeking funding from £150,000 up to £2 million.	£150,000 - £2 million (fund total: £8 million)	Aims to encourage new ways of working that go beyond business-as-usual innovation practices in the water sector, in particular, increasing and improving collaboration and building partnerships from within and outside the water sector.	Through partnership with water companies, CReDo aligns with the catalyst objectives of changing ways of working through fostering collaboration with other sectors.

Table 3. Existing funding opportunities which align with CReDo development activities.

Opportunity name	Scope	Value / mechanisms	Objectives	CReDo alignment
NERC strategic capital funding opportunity 2023 (NERC, Innovate UK)	Funding to improve the environmental research landscape through new or improved equipment. Applicants must:- create new or build upon existing equipment- support NERC’s environmental science remit	Explore Grant (up to and including £25,000) Expand Grant (£25,001 to £100,000) Extend Grant (£100,001 to £250,000)	The primary objective is to provide strategic investment in UK capital infrastructure and deliver a step change in research capability. Proposed assets will likely create or offer a novel addition or improvement to an existing capability and will fulfil strategic research needs beyond those aligned to individual research projects. Specifically, this funding opportunity will support the procurement of equipment.	<p>CReDo will be a research tool to allow informed investment into critical infrastructure upgrades, to prioritise areas where the most value and resilience can be achieved.</p> <p>This fund would only be accessible to CReDo if the development was to be university led.</p>
Flood and Coastal Resilience Innovation Programme (DEFRA, Environment Agency)	Covers 25 projects taking place around the British coast demonstrating how practical innovative actions can improve resilience to flooding and coastal erosion in a changing climate.	£250,000 - £750,000 (fund total: £2 million)	Total of £200 million is being invested into 25 projects each with slightly different focus. The projects are categorised under five key areas, technology being one; and 10 resilience actions have been identified. Included in these are 'community infrastructure resilience' and 'monitoring and management of local assets'.	CReDo aligns very closely with the overall project aims and specifically with two of the resilience actions.



CROSS-SECTOR FUNDING MECHANISMS

The future funding avenues for the development of CReDo are somewhat uncertain. However, there are numerous collaborative research and development funding options which align with the objectives of CReDo.

This section discusses some potential mechanisms and the pros and cons of each.

Currently, critical national infrastructure projects are usually funded through regulator funding which is allocated annually by UK Government. Asset resilience upgrades, and other developments that improve the direct service to the consumer are assessed by relevant regulators to ensure it is viable, cost effective and produces the outcomes that will ultimately either reduce costs or loss of service events for customers.

Once CReDo has been adopted by regional or national infrastructure providers, it will be a tool used to assess and prioritise resilience upgrades for assets. Since CReDo will highlight cascading failures during extreme climate events, it will often identify opportunities to increase the resilience of one or many assets through the upgrades of another, at times an asset from another sector. Once such situations have been identified, there will become a need to fund the proposed upgrades, however due the cross-sector benefits, the funding of such developments is likely to be debated.

For this reason, it is important to consider some potential methods for governing funding of cross-sector resilience upgrades before CReDo is widely adopted.

Three potential funding mechanisms have been drafted and explored within this section; the inputs to these drafts include desktop research around previous cross-sector funding, asset owner interviews around past projects, and regulator interviews regarding current funding mechanisms. These draft mechanisms are not expected to be a quick resolution to what will be a complicated problem, rather ideas to trigger further discussion to determine the most suitable schemes. It is likely that the funding mechanisms that cross-sector resilience upgrades will utilise will be determined once the future operational and ownership state of CReDo have been determined, since certain mechanisms may align better with different commercial models.

Until this stage, the development of CReDo has been primarily funded through Innovate UK, and most recently via Connected Places Catapult Milestone project.

Climate Resilience Credits

Regulators and relevant Government authorities utilise high-level CReDo and other climate resilience insights to determine the urgency of resilience upgrades for each infrastructure sector. These credits are released to industry regulators and can be given to regulated companies to redeem a nominal amount of funding to be used to infrastructure resilience upgrades. Credits are specific to each sector and can only be redeemed by companies in that sector.

Using CReDo, asset owners can identify dependencies on other sector or operators' assets which require upgrades in order to improve their own asset resilience. In these cases, asset owners can purchase, trade, or bid for credits for the sector of the reliant asset which can then in turn be given to the reliant asset's owner to fund the upgrades of the infrastructure.

In situations where an asset owner identifies intervention needs of their own assets that will improve the resilience of other sector's assets, they may redeem their own credits to receive funding for the project, or bid/purchase for additional credits on the credit market.

This model is essentially a mechanism for utilising innovation funding from other sectors to improve infrastructure resilience, with the credits being a proxy for the funds.

Sources

This model is somewhat inspired by the carbon credit model in which corporations can purchase, trade, or sell credits which permit a certain level of carbon emissions related to their operations.

Decision points

- Who would manage the sale and trade of credits?
- How to ensure the distribution of credits is not biased within and across sectors?

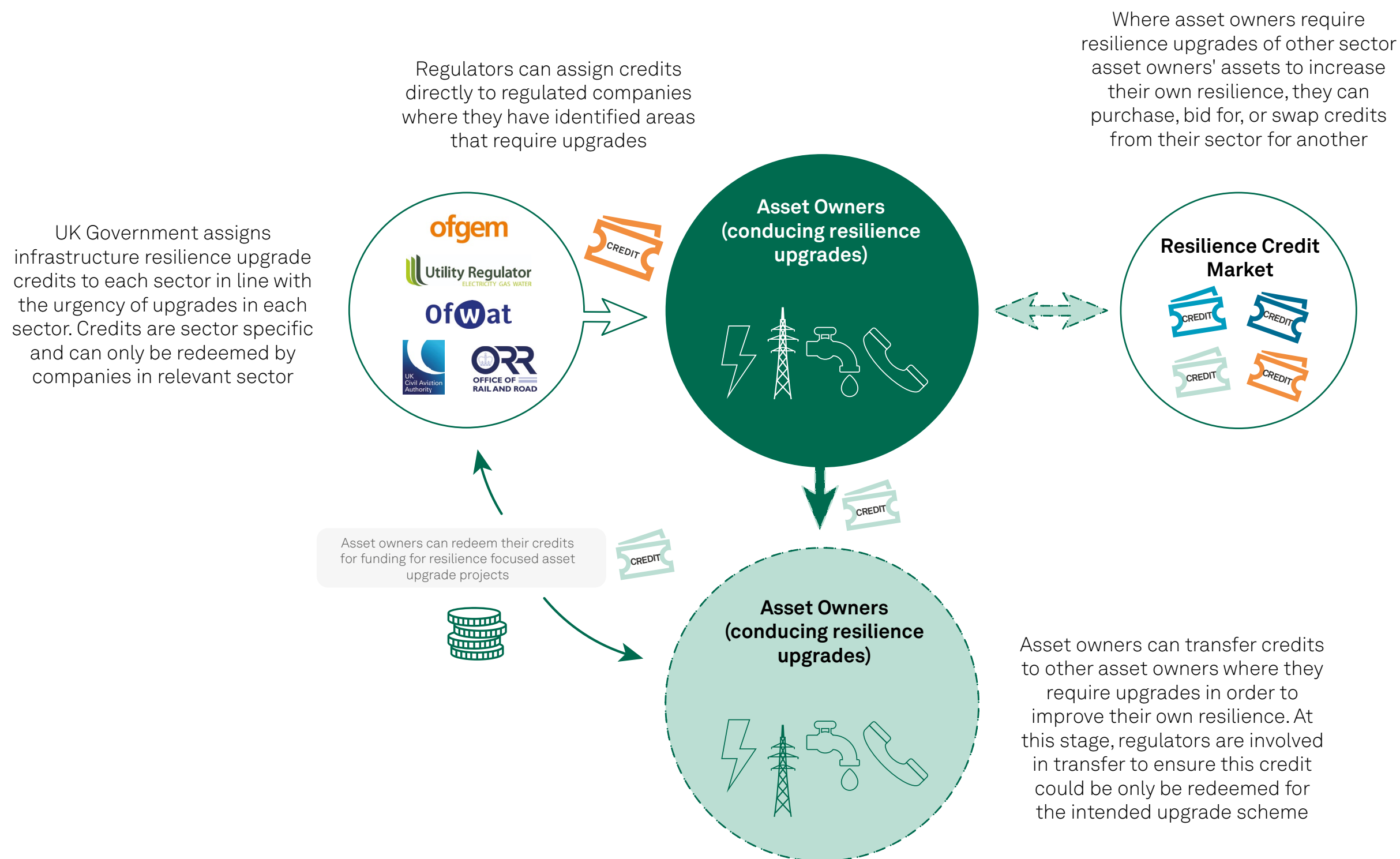


Figure 2: Overview of infrastructure climate resilience credits potential funding mechanism.

Cross Sector Infrastructure Resilience Fund

This model consists of a Government authority owning the resilience of critical infrastructure providers, and assuming that CReDo will be the primary tool in assessing the interdependency of assets. Insights from CReDo will be used to determine which asset owners own the risk of failure of particular assets across other sectors than their own.

Similarly, to current innovation grants and funds that exist per sector, a cross-sector fund could be deployed that is assessed by representatives from a cross-section of industry regulators to ensure bias is eliminated. Applications to access funds will be submitted by asset owners via their relevant regulators, who will assess applications from their regulated companies and utilise CReDo insights to prioritise projects which would result in greatest cross sector benefit. Asset owners would be encouraged to partner with one another to apply for this funding to demonstrate the mutual understanding of asset criticality and cascading failure potential.

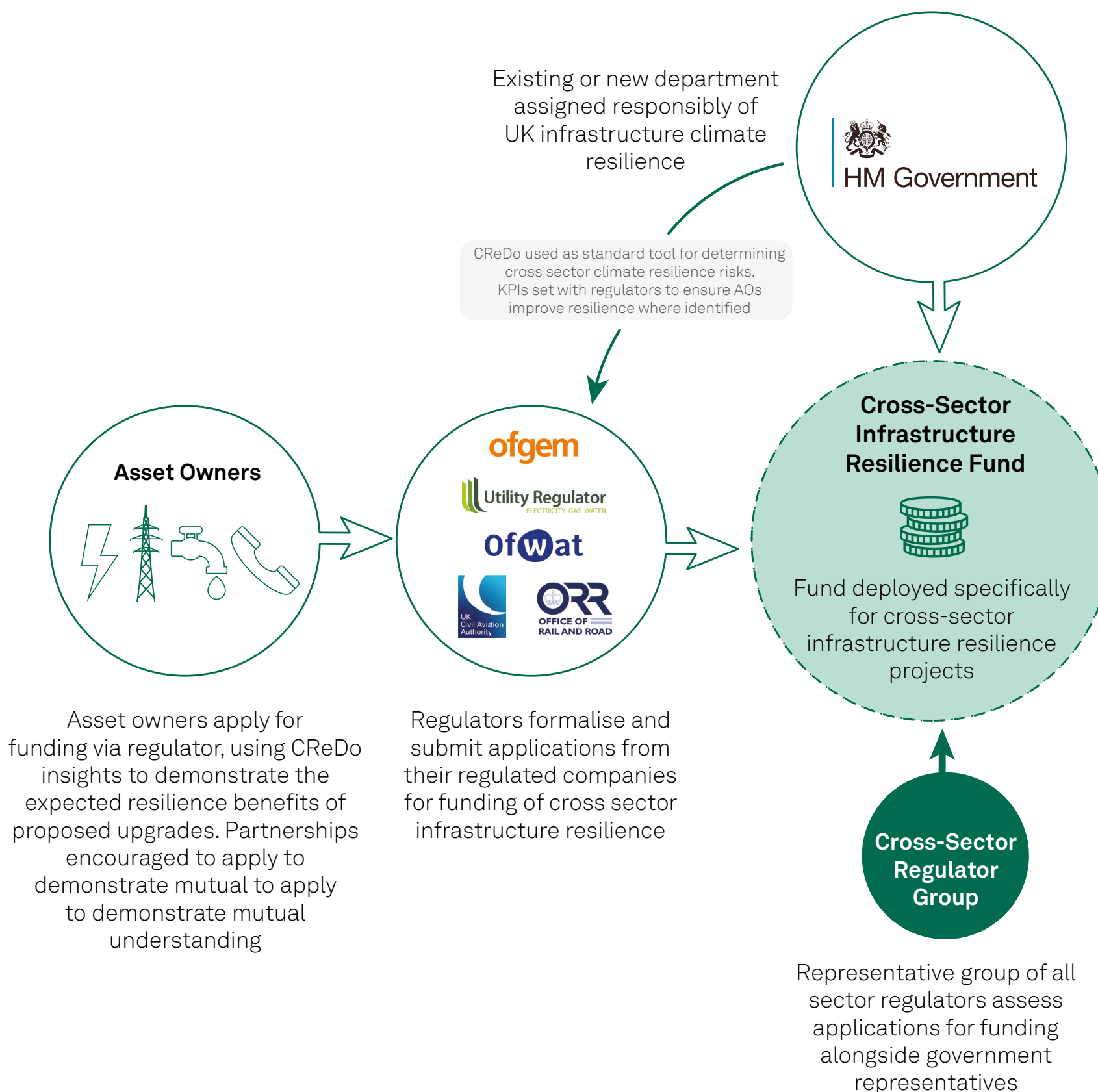
Sources

This proposed funding mechanism is inspired by the current process for cross-operator upgrade projects within the energy distribution sector, however with an innovation fund in place specifically for cross sector benefitting projects.

Decision points

- Will it be feasible to develop a board of cross-sector regulators?
- Should applications be raised via regulator of biggest beneficiary or via the regulator of owner of infrastructure asset in question?
- Can CReDo be used to set KPIs for asset owners?

Figure 3: Overview of cross-sector infrastructure fund potential funding mechanism.



Regional Resilience Funding

Central government in collaboration with local authorities and regulating bodies, utilise CReDo and other expert advice to determine regions of the country in which infrastructure climate resilience is poor. Through liaising with the market to determine the potential costs of some key upgrades in the area, local funding opportunities are opened up for regional infrastructure operators to apply to in order to finance resilience upgrades.

Where asset owners identify resilience upgrades that would improve the resilience of multiple sectors' assets, they can partner to apply to the fund in a joint manor. This would highlight the benefit of this project and likely make a strong case for the application.

This mechanism is not substantially different from current examples of regional funding opportunities already in existence today. However, it will be aimed to encourage collaboration across sectors by prioritising projects which display, through CReDo, that there are broad benefits.

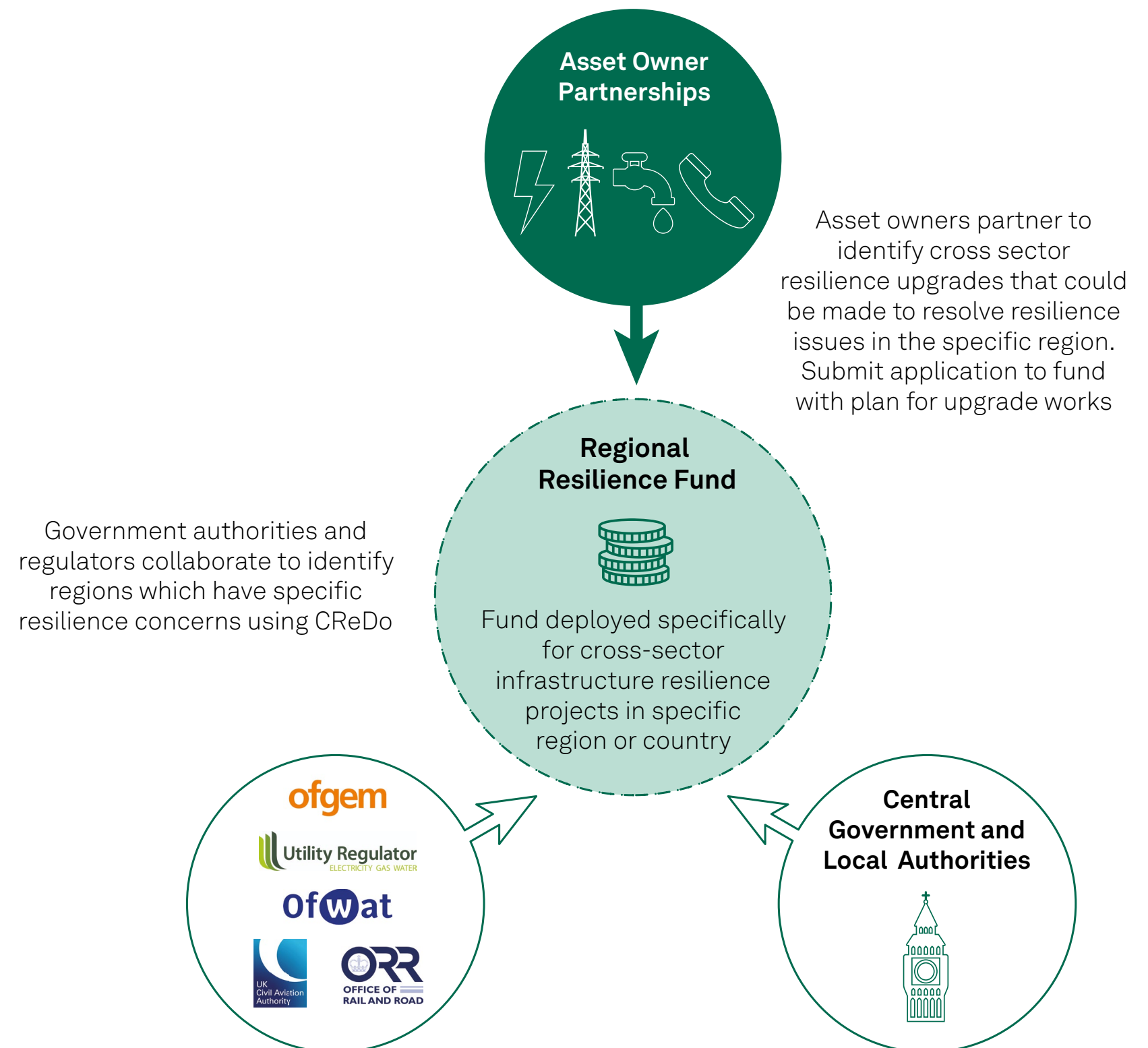
Sources

Similar regional programmes and funds already exist in places to improve resilience of flood defences, and in part these consider the improved resilience of infrastructure in flood risk areas. The Flood and Coastal Resilience Innovation Programme, supported by the Environment Agency, consists of 25 projects with different focus areas for improving the resilience of coastal areas. Within these projects, one of the key focus areas involved improving the community infrastructure resilience – this type of government funded project would be a suitable example of a mechanism for utilising CReDo to determine the best place to direct funding.

Decision points

- Would extreme heat and flooding come under one fund?
- How to ensure no bias is given to particular regions?

Figure 4: Overview of regional resilience funds potential funding mechanism.



SUMMARY

In summary, there are various mechanisms that may be suitable for the funding of cross sector infrastructure resilience upgrades, a key potential barrier to business-as-usual deployment. However, there is still significant thinking and planning to be done to ensure that these schemes can be activated in a non-bias, well managed way. The most suitable outcome to addressing this barrier will heavily rely upon the ownership model that CReDo will eventually operate under since certain schemes will align better with certain ownership types.



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