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Financing Adaptation and Resilience in London and the UK: Moving from Aspiration to Reality
Part I – Case Studies Analysis

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About This Paper

Based on insights from the industry, this paper is part of the research project: “Financing Adaptation and Resilience in London and the UK.” The project identifies and discusses drivers and challenges for investing in adaptation and resilience and necessary changes for developing capital market solutions in London and the UK. This research has been conducted by the Centre for Climate Finance & Investment (CCFI) at Imperial College Business School and the Singapore Green Finance Centre, following papers focusing on adaptation and nature financing (Buhr, B. (2022); Holtedahl, P., Köberle, A. & Koci I. (2023); Whittaker, S. & Nguyen, T. (2023)).

The research project, divided into three separate papers, takes a practical approach by focusing on the real estate and water sectors in London and the UK, ensuring the findings are directly applicable to the local context.

Part I Case Studies Analysis of the research project highlights various adaptation and resilience investment and financing models, with eight case studies in London and the UK. The analysis responds to the following three questions: What is the investment proposition and the role of the private sector in adaptation and resilience? What are the main investment models and financing instruments for private investors in these areas? What are the major investment drivers for institutional investors such as pension funds and insurers?

Part II Urban Adaptation Financing focuses on urban adaptation financing, delving into the current state of adaptation finance in London and making a comparison with Copenhagen and Singapore. This comparison is particularly significant as it allows us to draw lessons from cities with different approaches and experiences, thereby enriching our understanding of urban adaptation financing. The research primarily focuses on private investment and aims to learn about the experience of London (covering the greater London area) in the delivery of climate finance and financing for urban climate change adaptation and understand the potential barriers and opportunities to mobilising finance. The research question ‘To what extent can cities and investors build for innovation in climate adaptation in cities?’ aims to inform and promote a better understanding of financing for climate change adaptation actions.

Part III Policy Recommendations develops policy recommendations taking into consideration the current policy context. Drawing on insights from the case studies analysis and the London urban adaptation finance research (Part 1 & 2 of this policy brief), this Paper develops several recommendations, addressing policymakers, regulators, and the financial industry—primarily banks, asset managers, exchanges, and marketplaces. Several recommendations need to be addressed simultaneously to enable private investment into adaptation in London and the UK; these activities need to be embraced by all actors: investors, regulators, Government, OFWAT, the Bank of England, standard-setting agencies, corporations, and development companies etc.

Executive Summary & Key Messages

Part I Case Studies Analysis of the research project (this paper) highlights various adaptation and resilience investment and financing models, with eight case studies in London and the UK. The research includes an extensive review of regulations and relevant policy documents (see Annex 1). Data was collected from an in-depth analysis of case studies focusing on real estate and the water sector in the UK (See Annex 2).

This analysis responds to the following three questions: What is the investment proposition and the role of the private sector in adaptation and resilience? What are the main investment models and financing instruments for private investors in these areas? What are the major investment drivers for institutional investors such as pension funds and insurers?

To achieve our objectives, we have developed a systematic methodology. This methodology analyses the case studies based on key factors influencing private sector investment. These factors include the valuing and pricing of resilience, revenue streams, and business models, as well as transparency and information to investors. We also consider skills, capacity, and financing capabilities, ensuring a comprehensive analysis.

Private sector financing in adaptation and resilience in the UK is still limited. Encouragingly, there is potential for innovative financing mechanisms, but significant barriers exist across the financial ecosystem. Addressing these barriers will require substantial Government interventions to mature and transform the market. Although case studies do not cover the complete set of climate change risks in the UK, they can be considered a good proxy for investors' interest and the need for government action on signalling and enabling conditions. Insights reveal that while many adaptation benefits are public and demanding for private actors to capture, public funding and regulation can complement private capital in blended finance structures.

The analysis also underscores the interconnectedness of adaptation with nature, suggesting that, in some cases, lessons from nature and biodiversity markets can inform approaches to adaptation financing. As the case studies illustrate, whilst private investments in nature are possible, scaling and replicating them requires concerted efforts.

The investment proposition for adaptation and resilience

Property and water sectors offer increasing opportunities to use private sources of finance, including household investors and commercial banks, for adaptation and resilience. Several case studies contribute to climate adaptation by dealing with water scarcity, an issue increasingly threatening the UK and directly associated with other sectors, such as sustainable agriculture. However, many other hazards, such as heatwaves, are not being addressed. Green infrastructure in urban adaptation is also a significant investment theme, highlighting a primary need for more resources and financing at the municipal and local levels.

Climate-proofing investment offers opportunities for resilience through asset maintenance and renewals. In only a few case studies, adaptation and resilience are the primary considerations requiring dedicated investment. The capital-intensive nature of extensive water and wastewater treatment and desalination plants necessitates substantial additional investment for targeted projects in the water sector. Most case studies show substantial adaptation co-benefits, usually delivered as secondary objectives and integral to mitigation and nature objectives. This is the case, particularly for nature-based solutions that are often too small to replicate and scale to attract financial investment.

Adaptation, often overlooked in financial valuation, requires the establishment of a market for its outcomes. The benefits of ecosystem services, which are contingent on the adaptation areas and sectors, can be effectively measured through 'Natural Capital Accounting.' This approach takes into account the stock of natural capital that generates the flow of these services. While financial benefits from adaptation projects are a key driver for private sector investment, it's essential to address methodological and data issues, such as site- and context-specificity, long time periods, and high levels of uncertainty, to ensure the accuracy of these measurements.

Investment models and financial instruments

The case studies have shown innovation in investment models across sectors. For the water sector, innovation was observed in the use of regulated asset-based systems for the construction of assets beyond the operation phase or the introduction of more competition through the Direct Procurement for Customers model (DPC), a model that allows customers to directly procure goods or services from a supplier. Carbon and ecosystem credits can support adaptation actions for nature protection and restoration – with revenues not directly linked to climate risk reduction – monetised in carbon and nature markets. In real estate, adaptation actions shown in the case studies benefit owners and occupants, contributing to property appreciation. Further demonstrations and financial quantification of how integrating natural capital and resilience measures in design and planning for real estate could promote a more comprehensive understanding and create further incentives for investors and asset owners to invest in adaptation.

The findings underscore the urgent need to facilitate innovative financing for adaptation measures and projects. Case study findings confirm a stark reality: a tiny proportion of green bonds are currently used for adaptation and resilience financing. While sustainability-linked bonds and loans in resilient buildings and water efficiency are rapidly growing, the inclusion of climate resilience is still limited. A revolving fund for wastewater treatment and stormwater drainage improvements cannot only monetise savings but also increase property values and rental yields. As the physical impacts of the climate and nature crises escalate, insurance will become increasingly critical to protect the resilience of the most vulnerable parts of the population. Beyond public schemes such as Flood Re, crowdfunding at municipal and local levels can address constraints due to lacking resources and financing. Blended finance can also be used to facilitate private investment and finance for adaptation action.

Drivers of investment

Physical risk is currently under-estimated by investors. Managing the impact of physical climate risks is part of investors' fiduciary duties. However, investors might underestimate risks at the portfolio level due to asset risk consideration and reporting under the TCFD framework, not considering the potential impact of several compounding climate hazards (e.g. heatwaves and overheating, beyond flooding) or secondary and indirect impacts. Case studies also highlighted indirect impacts on banks' loan books (i.e. on agriculture loans) of the UK's most significant physical climate risk – flooding.

New operational frameworks (ESG + R), including resilience outcomes, are required. An essential component of climate change adaptation is climate risk disclosure and assessment, with key frameworks being the EU Taxonomy, TCFD requirements or the forthcoming UK Green Taxonomy. Shortcomings of current initiatives are the focus on process rather than outcomes and the lack of granularity at the sector level. At the same time, as highlighted in the case studies, new operational frameworks, including resilience for financial institutions—Environment, Social, Governance and Resilience (ESG+R)—can help lower perceived risks for private investors, therefore unlocking additional financing and funding streams.

Institutional investors with a long-term horizon are increasingly engaging in adaptation, and there is potential to mobilise pension savings capital. Adaptation and resilient investments are already part of investors' portfolios. These include more mature assets such as infrastructure and timber or developing assets such as nature-based solutions, information systems, and climate analytics. However, in many adaptation investments, the benefits and potential revenues that can be generated are realised over a long period, sometimes several decades. There is also a lack of co-investment vehicles designed to encourage institutional investors to invest in adaptation.

Pension funds are looking for diversification in the private markets. The case studies show that investors focus on investments with asset backing, contractually fixed or otherwise secure cash flows (with some inflation linking), and limited economic or operating exposure. Different investment vehicles are used to secure the adaptation investment, targeting risk-adjusted returns of less than 10% IRR net of fees in closed-ended private market funds. Co-investment opportunities offer scale advantages with cost reduction, lower fees, and expertise in funds and secondary products.

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1.Introduction

Global warming has resulted in more frequent and intense heatwaves, extreme precipitation events, rising sea levels and droughts, causing significant health issues, economic losses and infrastructure damage (IPCC AR6, 2022). Recent extreme weather events – such as the heatwaves and wildfires around Europe over the summer of 2022 – illustrate the scale of the issue, with 2023 being the hottest on record (Copernicus, 2023). Irrespective of the climate change scenarios and whether we meet or exceed the Paris commitments of a 1.5°C future, there will be climate change impacts affecting the way society operates (CCC, 2021). These impacts are a global issue but are manifesting locally, including major cities like London.

The UK has already witnessed increasing heatwaves and heavy rainfall. The associated estimated costs amount to 1.5% of GDP by 2045, rising to around 2-4% by the late century (Watkiss, 2022). Even under enhanced adaptation, the Climate Change Committee (CCC) predicts that direct expected annual damages to residential properties in England are projected to rise by between 5-29% by the 2050s (CCC, 2022). The Climate Change Committee's 2021 report suggests annual average damage costs of £1.1 billion by the 2050s, and up to £1.5-2.2 billion by the 2080s. According to Mission Climate Ready UK (2023), flooding in the UK leads to average annual damages worth over £700 million per year and studies suggest that this could rise by up to 40% by 2050.

To prepare for these physical impacts of climate change it is necessary to invest in adaptation measures now, such as flood protection through sustainable drainage systems, green infrastructure or nature restoration using nature-based solutions. Although total infrastructure investment is projected to reach nearly £650 billion over the next 10 years (Infrastructure Projects Authority, 2021), up to £10 billion per year must be allocated in the UK to adapt to existing and projected climate change impacts until then (CCRA3, 2023). According to the Green Finance Institute (2021), an estimated £44 billion to £97 billion in additional financing is needed to achieve the UK's key nature goals alone by 2030, with adaptation goals requiring significantly higher financing.

In its Annual Progress Report to Parliament, the Committee on Climate Change (2023) highlights the progress in preparing the UK for climate change as mandated by the Climate Change Act. When it comes to financing, they conclude that "adaptation projects are failing due to lack of finance" (CCC, 2023). They also recognise that increased public funding for adaptation and the removal of barriers to private investment are crucial in reducing the UK's vulnerability to climate change impacts.

While local governments and authorities, such as the Greater London Authority, are best placed to help the city adapt, there is a consensus that public financing alone will not suffice (e.g., UNEP, 2023; Whittaker & Jespersen, 2022) and that multiple sources of funding, including from the private sector, are necessary.

The recently published Nature Markets Framework by the UK Government, as well as recommendations from the Taskforce for Nature-related Financial Disclosures (TNFD), **reveal another facet of adaptation, namely its close nexus with nature**. Following from COP28 in Dubai is the notion that climate goals demand nature-positivity[1]. Nature-based solutions play a key role in climate adaptation, with green spaces, mangrove restoration projects or specific forestry management practices supporting adaptation goals of protecting people and their environments, to climate change impacts. It is estimated that 30% of nature investment also contributes to adaptation goals (Race to Zero, 2023). While the nature crisis is an issue which needs to be tackled alongside the climate crisis, much can be learned from nature finance when it comes to innovative financing solutions for adaptation (Casey & Connor, 2023).

For the purposes of this research and in the interviews, key definitions used are cited in the box below and in the glossary at the end of the paper.

[1] See COP 28 Global Stock recommendations to increase ambition and enhance adaptation action and support, in line with decision of the Glasgow–Sharm el-Sheikh work programme, including as point 63 d): "Reducing climate impacts on ecosystems and biodiversity and accelerating the use of ecosystem-based adaptation and nature-based solutions": https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf

Box 1: What activities constitute climate adaptation?

According to the Intergovernmental Panel on Climate Change (IPCC), adaptation is the "process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2022).

Resilience is the "capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. […] Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation." (IPCC, 2022).

Adaptation Investment includes adaptation and resilience solutions that substantially reduce the risk of adverse impacts of current and expected future climate on that investment itself (ARIC, 2024).

To categorise adaptation and resilience investments, this paper builds on official jurisdictional frameworks and accepted market frameworks such as the EU Sustainable Finance Taxonomy, the United Nations Office for Disaster Risk Reduction (UNDRR) Guide for Adaptation and Resilience Finance, the UNDRR and Climate Bonds Initiative white paper Designing a Climate Resilience Classification Framework, the MDB Group Joint Methodology for Tracking Climate Change Adaptation Finance (UNDRR, 2023; UNDRR, 2024; ADB, 2022).

Of particular relevance, the UNDRR definition of climate resilience is: "the capacity of economic, social or ecological assets or systems to resist, absorb, accommodate, adapt to, transform and recover from the current and projected impacts of climate change, both direct and indirect, maintaining their basic structure and function" UNDRR (2023).

For investors' approaches to climate adaptation and resilient investment, see Box 3. For the methodological approach to the case studies analysed in this paper, see Box 5. See also the Glossary at the end of the paper.

2. Reporting, Disclosure and Regulation of Climate Adaptation and Nature

While adaptation finance is lagging globally, capital is available for climate action. In 2023, according to Climate Policy Initiative (CPI) estimates, adaptation finance reached USD 63 billion, far short of the estimated needs of USD 212 billion per year by 2030 only for developing countries (CPI, 2023). With limited private sector involvement, public sector actors dominate tracked adaptation finance flows. However, the Sixth Assessment Report of the Intergovernmental Panel on Climate Change concluded that there is sufficient global capital to close the global investment gap, and governments and financial regulators can redirect capital to climate action through public funding and clear signals to investors (IPCC, 2023).

A key issue relates to an understanding of what activities constitute climate adaptation. Standardised definitions and terminology allowing market clarity will facilitate investment and the creation of targeted financial products. To mobilise private finance for adaptation and resilience, there is a need to develop policy frameworks that support efforts to 1) measure, address and mitigate physical climate risks and quantify resilience benefits and 2) integrate adaptation and resilience metrics (IIGCC et al., 2023)[2]. There is also a need to understand the climate/nature nexus better, to define adaptation co-benefits stemming from nature action and implications for private sector financing.

In this section, we look at recent initiatives on taxonomies and voluntary guidance for creating a standard reference, actions to integrate adaptation and resilience from planning and design into financial decision-making processes, and recent climate and nature financing regulations.

[2] See the call for Collaboration issued by investors' stakeholder group at COP 28: https://onebillionresilient.org/wp-content/uploads/sites/2/2024/01/Call-for-Collaboration-January-2024.pdf

2.1 Guidance and Green Taxonomies

Green Taxonomies – such as the forthcoming UK Green Taxonomy – are vital tools to mobilise capital flows into sustainable economic activities and ensure high standards for green investments. So far green taxonomies have been developed mainly for climate mitigation that offers clear and measurable metrics and definitions. Climate change adaptation, though, started to be recognised as an investment category by several voluntary guidelines often created by the private sector (e.g. Green Bond Principles and Green Loan Principles, UNDRR resilience principles) and within more formal regulated reporting standards (e.g. EU Sustainable Finance Taxonomy; Singapore-Asia Taxonomy for Sustainable Finance).

Existing classifications and standards have certain constraints and require additional refinement. The EU taxonomy is process-focused rather than outcome-focused, in respect of adaptation and resilience. "The proposed approach for an adaptation taxonomy recognises that adaptation is context- and location-specific and requires the use of a process-based approach to determine if an activity contributes to adaptation and the broader system's climate resilience (EU Technical Expert Group on Sustainable Finance, 2020) (See Box 2). Beyond process-based and compliance- driven approaches, a recent UNDRR white paper presents an evidence-based approach proposal for developing a climate resilience classification framework. Building on this framework, the Climate Bonds Initiative is developing a Climate Bonds Resilience Taxonomy (CBRT). The forthcoming UK Green Taxonomy will also include climate adaptation[3].

For actionable and investable opportunities, **more granular guidance is needed to define climate resilience investments**. However, recent literature review revealed a need for more information across the market on specific performance thresholds related to climate resilience in the context of investments. The UNDRR, Standard Chartered, and KPMG have collaborated to develop a market Guide for Adaptation and Resilience Finance to nature-related hazards, aiming to accelerate the development and structuring of financial products focused on adaptation and resilience, such as loans, bonds, private placements, structured notes, letters of credit, and deposits (UNDRR, 2024).

Climate resilient considerations at the sector level are often part of broader ESG frameworks for investors. Several international initiatives promote a common ESG investors' approach to identifying sustainable, quality, and/or green infrastructure projects – including various 'meta-standards' – such as the FAST-Infra (Finance to Accelerate the Sustainable Transition-Infrastructure) label, the SuRe (Standard for Sustainable and Resilient Infrastructure) standard, and the Blue Dot Network (BDN) (Losos & Fetter, 2022).

[3] Recent Green Technical Advisory Group (GTAG) reports, chaired by the Green Finance Institute, offer technical advice to HM Treasury on developing the Green Taxonomy. These reports reason that "climate change adaptation [technical screening criteria (TSC)] in general requires a more detailed review", specifically that 1) an investment-enabling adaptation framework and policies should be developed so that the Green Taxonomy can deliver into it and business and finance can follow; 2) an Adaptation Working Group should be set up to "advise on the design and implementation of an enhanced set of adaptation TSC to help catalyse the investment needed to achieve resilience and deliver wider economic opportunities relating to adaptation" (p.32, GTAG, 2022)

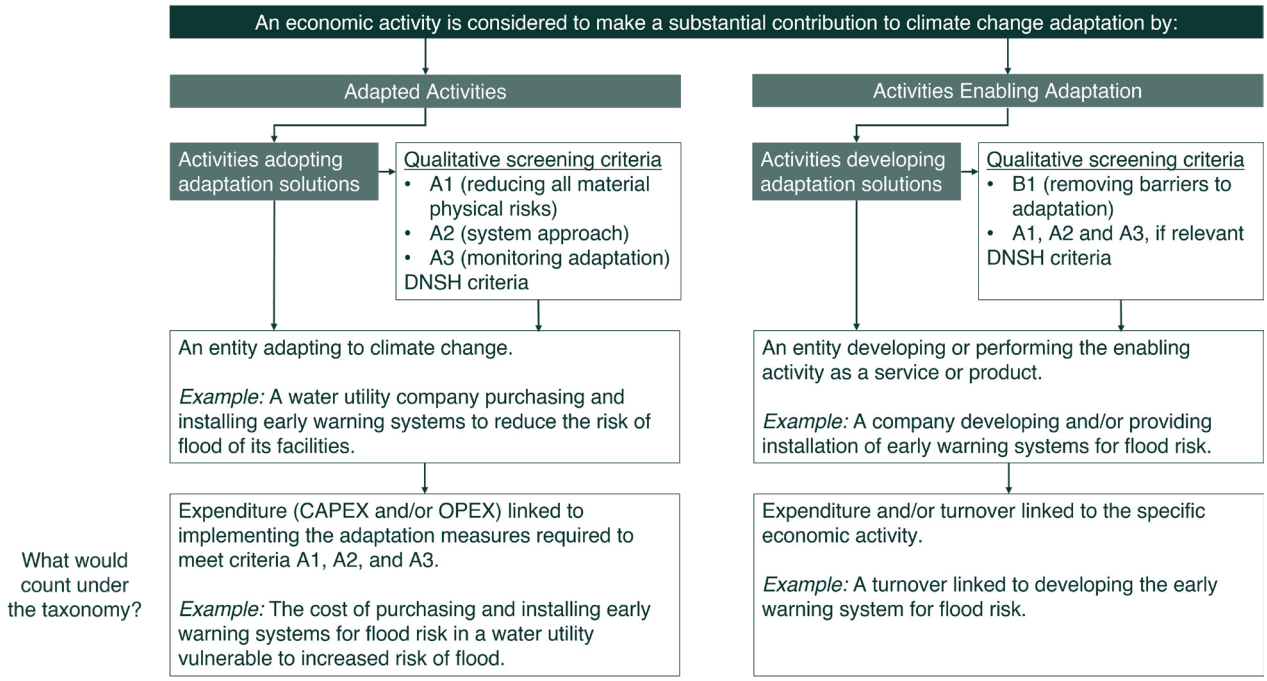
Box 2: Summary of adaptation and resilience within the EU Taxonomy[4]

The EU taxonomy is based on Substantial Contribution and 'do no significant harm' DNSH principles.

The following two-step process aims to demonstrate that an activity contributes to a substantial reduction of the negative effects of climate change:
a. Assessing the expected negative physical effects of climate change on the underlying economic activity that is the focus of resilience-building efforts, drawing on robust evidence and leveraging appropriate climate information.
b. Demonstrating how the economic activity will address the identified negative physical effects of climate change or will prevent an increase or shifting of these negative physical effects.

An economic activity is considered to contribute substantially to adaptation where:

Figure 1. Assessment of substantial contribution to climate change.



The taxonomy also lists related criteria for 'do no significant harm' in the context of adaptation. In fact, for any substantial contribution of an adaptation activity, it must also do no significant harm to any of the other five objectives of the EU taxonomy.

2.2 Integrating Adaptation and Resilience Into Financial Decision-Making Processes

Technical regulations and standards for design and planning climate adaptation and infrastructure resilience can play a significant role. Climate risk assessment and adaptation planning have recently started to become a part of regulation design, for instance, as those part of the licencing agreements set out by the Environment Agency in England, which follow the ISO 14090:2019 standards for adaptation planning (HM Government, 2023). The ISO 14090 is the first international standard on climate adaptation and offers a framework for adaptation planning for any organisation or administration, grouped in a suite of guidelines (ISO, 2022)[5]. There are also two sister standards: ISO14091 for risk assessment and ISO14092 for local governments and communities. Further standards on adaptation pathways and investment planning are in their infancy. While infrastructure systems and their services are increasingly affected by natural and man-made hazards, technical engineering standards for infrastructure assets do not always include forward-looking climate projections. ISO is developing relevant standards considering the systems approach and complex nature of risks, as seen in the ISO 22372 Resilient Infrastructure Guidelines (UCL, 2023).

[4] Source: EU Technical Expert Group on Sustainable Finance. Taxonomy Report: Technical Annex. https://finance.ec.europa.eu/system/files/2020-03/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf
[5] Find out more here: https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100449.pdf

The UK's Green Finance Strategy aims to incorporate environmental considerations into financial decisions across sectors, thereby "green" the financial system (UK DMO, 2023). Notably, the Taskforce for Climate-related Financial Disclosures (TCFD) framework is now integrated into the UK's Sustainability Disclosure Requirements (SDR) Framework, impacting reporting cycles for large and listed companies. Additionally, in June 2023, the International Sustainability Standards Board (ISSB), an independent standard-setting body within the IFRS Foundation, announced its inaugural standards: IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information (IFRS S1) and IFRS S2 Climate-related Disclosures (IFRS S2), which is more relevant for adaptation as it relates to climate-related physical risk (ISSB, 2023). As part of IFRS S2, entities must disclose information about their climate-related risks and opportunities. This ranges from governance, strategy, and financial considerations to metrics related to climate resilience – such as "the amount and percentage of assets or business activities vulnerable to climate-related transition/physical risks" or "the amount of capital expenditure, financing or investment deployed towards climate-related risks and opportunities" (IFRS, 2023).

Adaptation is also part of disclosure frameworks for companies and organisations, especially in Europe, where the **EU's Corporate Sustainability Reporting Directive** mandates disclosure on taxonomy alignment for adaptation (Casey & Connor, 2023). The recently published Disclosure Framework by the Transition Plan Taskforce (TPT) focuses on enhanced disclosures and transition planning for companies as part of the economic transition to a "net zero and climate-resilient economy" (TPT, 2023). More specifically, it incorporates adaptation into transition plan standards by including "enhancement of resilience to climate change" as a specific disclosure objective and priority in defining an entity's Strategic Aims. Subsequently, the implementation strategy, a roadmap of actions, engagement strategy, and associated governance and metrics and targets (including financial metrics) that support these should be disclosed (TPT, 2023). With the final framework and associated sector guidance and capacity-building materials published, the HMT will now consider the next steps in implementing the recommended approach.

2.3 Links to Nature and Biodiversity Financing

There is growing recognition in the financial sector that nature-related financial risks and climate risks are closely interconnected. Nature restoration and preservation can play an important role in climate resilience, and natural capital can provide an opportunity to increase private finance in adaptation.

Natural capital can provide adaptation benefits, potentially generating cost savings or commercial benefits to be monetised in financial returns. For example, future carbon savings from peatland restoration can be credited to investors; local residential property prices can capture amenity benefits from urban green spaces; water utilities benefit from sustainable farming practices for water quality; sustainable drainage schemes can reduce pressure on water security (Dasgupta, 2021). Growing voluntary carbon markets, underpinned by robust standards and processes to ensure tangible environmental benefits, provide an opportunity to increase private finance flow into a range of sectors, including forest and land use.

Nature and biodiversity finance, areas closely related to adaptation finance, are increasingly driven by international efforts, such as the COP15 meeting of the Convention on Biological Diversity in Montreal in 2022 and the disclosure recommendations by the Taskforce on Nature-related Financial Disclosures (TNFD), published in September 2023[6]. The recommendations guide organisations in reporting and acting on nature-related dependencies, impacts, risks, and opportunities and integrating nature into decision-making. The Network for Greening the Financial Sector (NGFS) has also recently developed a Conceptual Framework to create a shared understanding of nature-related financial risks.

On a national level, the UK Government Nature Markets Framework aimed at scaling up private investment into nature recovery by setting out rules and principles for the nature market to function with integrity and deliver positive outcomes (HM Government, 2023)[7]. This document includes a new arrangement with the British Standards Institution to develop high-integrity nature investment standards. The UK's key policy and regulatory actions are set out below; see Annex 1 for a complete list.

[6] TNFD: https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/
[7] This is also complemented by national work in the Devolved Administrations - e.g. SG's Interim Principles for Responsible Investment in Natural Capital: https://www.gov.scot/publications/interim-principles-for-responsible-investment-in-natural-capital/

Table 1. Critical nature and policy frameworks for nature finance.

Policy or regulation	Jurisdiction	About
UK Nature Markets Framework (2023)	UK-wide	This nature markets framework sets out how government will guide and support the development of nature markets capable of supporting elevated investment levels and the government's vision to hardwire integrity and principles into the market framework to build trust and confidence so markets can grow at pace with ambition.
BSI Nature-Investment Standards	UK-wide	A new stakeholder-driven standards programme to boost confidence in nature markets and increase private sector investment into nature recovery.
Carbon Codes	UK-wide	The UK Saltmarsh Carbon Code will enable UK saltmarsh carbon to be marketed and traded as carbon offsets, whilst providing assurances to buyers that the climate benefits being sold are real, quantifiable, additional, and permanent. The Peatland Code is a voluntary standard for UK peatland projects, whereby investors in restoration projects can make carbon savings[8]. The Woodland Carbon Code is a voluntary code, designed to help individuals and businesses wishing to contribute to tree planting to help offset the carbon they emit, with contracts lasting between 35 – 100 years.
Natural Environment Investment Readiness Fund (NEIRF)	England	The Fund of up to £10 million provides grants of up to £100,000 to more than 75 environmental groups, local authorities, businesses, and other organisations to help them develop nature projects in England to a point where they can attract private investment.
Biodiversity Net Gain (2023)	England	A way of creating and improving natural habitats. BNG makes sure development has a measurable positive impact ('net gain') on biodiversity, compared to what was there before development. Becoming mandatory in England. Developers must deliver a biodiversity net gain of 10%.

Source: Adapted from Adaptation Scotland (2023)

3. Understanding Private Sector Investment in Adaptation and Resilience

Despite the economic benefits to society, there is a gap between the level of risk from climate change and the level of adaptation in response (IPCC, 2022)[9]. At the same time, investments in decarbonisation and the need to manage physical impacts are opening new opportunities for investment. For investors, adaptation and resilience can be seen as a series of climate change investment strategies related to systemic adjustments to climate change, while climate resilience refers to the ability to recover from climate risks and impacts (GARI, 2024). By 2050, due to higher physical risks of climate change, according to some estimates the net value of an infrastructure asset could reduce by 4.4% to 26.7% on average depending on the scenario taken into consideration (EDHECInfra, 2023).

In this section, we first highlight the investment opportunity in adaptation and resilience for investors and then show the sources and finance instruments available. We ultimately focus on significant barriers to investment for private investors financing in adaptation and resilience[10].

3.1 Investing in Adaptation and Resilience

A variety of adaptation actions are opening investment opportunities. Engineered solutions, for example, include build, design and retrofit measures in the transport energy and water sector. Nature-based

[8] https://ahdb.org.uk/news/understanding-regulated-carbon-markets
[9] https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf
[10] Analysis of barriers at the urban level is also presented in Part 2 of this research project (see About this Paper).

solutions (considered low-regret measures for disaster risk reduction and climate change adaptation) are used to protect, manage, and restore green infrastructure and create urban ecosystems. New technologies include remote sensing, digitalisation and big data for evaluation and management of adaptation (see box 3).

Adaptation options have different capital requirements and maintenance and operating costs, which affect sourcing and attracting finance. Many adaptation actions will require new investments (e.g. constructing a seawall for coastal flooding or planting trees to help reduce flooding risk). At the same time, some adaptation actions may also require ongoing expenditure on existing assets (e.g. regular repairs and maintenance of flood defences). The capital cost of an infrastructure asset often only accounts for 15-30% of the overall expenditure over the design lifecycle, while 70-80% represents operations and maintenance expenses (UN, 2021 as cited in CDRI, 2023). In countries such as Austria, Denmark, Italy, Moldova, New Zealand and Slovenia, over 50% of the total budget for road transport is spent on maintenance (OECD International Transport Forum, 2020).

Adaptation options have high economic benefits but offer typically lower returns on investment. Several studies have tried to emphasise the benefits of adaptation, including the Global Commission on Adaptation (GCA, 2019)[17] and the concept of the triple dividend for disaster risk reduction, which can also apply to adaptation (i.e. avoided losses, economic benefits, and social and environmental benefits) (Tanner et al., 2016). These studies highlight that adaptation can generate a high economic rate of return, with benefit-cost ratios ranging from 2:1 to 10:1 and, in some cases, even higher[11]. However, due to the typically low revenue streams, it can make sense from an economic perspective (for society overall) but still not be financially viable (in terms of the private return to an investor).

Box 3: Investment Opportunities in Adaptation and Resilience

Although investment is still limited, climate resilience is becoming an emerging investment theme with opportunities to invest across public and private equity and debt. Adaptation or resilience bonds are gaining traction as interesting investment products for fixed-income investors (see box 4 Buhr (2022); Erlandsson (2023); UNDRR (2023)).

Analysis by Impax Asset Management found that adaptation sectors had a total cumulative return 16.3% higher than the MSCI ACWI over five years and only slightly less than mitigation sectors (17.9%) (Ranger et al., 2023). Impax has developed a climate taxonomy which defines '**adaptation solutions**' as sectors and activities: i. Directly reducing the immediate physical impacts of climate change, including, for example, improving energy systems resilience, water supply resilience, resilient buildings, and sustainable agriculture ii. Providing new business models and solutions arising from climate change, such as the need for healthcare solutions to address the increased spread of vector-borne diseases, the need for improved data for business continuity solutions, as well as environmental products and services to forecast and mitigate financial losses caused by extreme weather events (Ranger et al., 2023).

Infrastructure is already a well-established and attractive asset class in private markets, offering the potential for appealing risk-adjusted returns and portfolio diversification. It has shown returns of 11.5% per annum over the period 2013-2023, based on the EDHECinfra index (GIH, 2023). Adaptation infrastructure investments can include green streets, coastal defences, and new builds and retrofits of climate-resilient property (Ranger et al., 2023; Lloyds, 2018).

Publicly traded companies play a crucial role in the climate resilience and adaptation sector, offering an opportunity to invest at scale. According to BlackRock (2023), there are ample opportunities in public equities in industrial sectors needed for physical infrastructure, utility and energy sectors adapting to decarbonisation and climate events, and technology to predict and monitor environmental conditions. A recent market analysis leveraging CDP disclosure data has identified a universe of over 800 public companies that offer climate resilience and adaptation solutions GARI (2024).

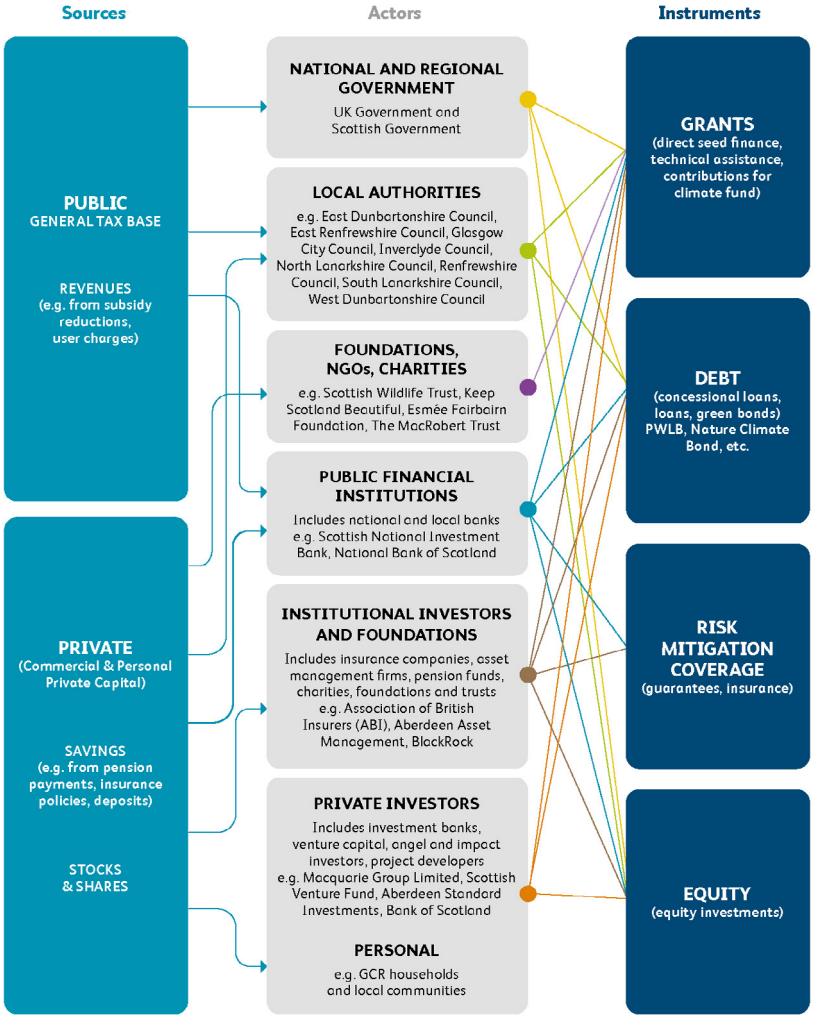
[11] In a recent study, BCG analysed the CDP database to find the benefit-to-cost ratio (BCR) for companies that implement water efficiency technologies, regenerative agriculture, and other resilience-building measures commonly ranging from 2:1 to 15:1 (BCG, 2023). Standard Chartered Bank's Adaptation Economy Report highlights that for every $1 spent on adaptation this decade, an economic benefit of $12 could be generated by SCB (2022).

3.2 Financing Instruments and Revenue Sources

Adaptation is contingent upon access to finance (the upfront capital) and the availability of revenues to repay the finance over time (CCC, 2023). Extensive literature is dedicated to discussing the financing instruments suitable for adaptation (GCA, 2019; Bisaro & Hinkel, 2018). Notably, discussions have emerged around the creation of a new global asset class, adaptation or resilience bonds, specifically for adaptation and resilience projects (see box 4 Buhr (2022); Erlandsson (2023); UNDRR (2023)). It's worth noting that CPI estimates that of the tracked USD 1.5 billion private adaptation finance in 2021/2022, 38% was debt from commercial financial institutions, followed by grants from philanthropies (30%), with the remainder funded as equity by corporations (CPI, 2023).

Successfully mobilising the funding required for adaptation requires a systematic consideration of the totality of financing needs and the appropriate mix of different sources and instruments to meet a project, organisation or place's needs. An example of this produced for Glasgow City Region is shown in the Figure below:

Figure 2: The sources of funding and finance are linked to relevant actors and financing instruments.



Source: Climate Ready Clyde 2021: Adapted from CPI and CICERO, 2015

Revenues are the cashflows generated by the project and, in many cases, pay for the provision of the adaptation goods and/or services (CCC, 2023). Revenue models are typically based on climate risk, cost reduction and avoided losses, while other models include additional income. Revenue streams supporting the private sector can derive from users' fees in the regulated infrastructure sector, such as water and electricity. Capturing direct monetary benefits of adaptation and broader social and environmental outcomes (e.g., ecosystem services) allows innovative financial structures. Often, these co-benefits make projects bankable (e.g., England, Watkiss and Hunt, 2023).

Box 4: Adaptation & resilience bonds

Adaptation and resilience bonds could be modelled after US municipal bonds, which finance most domestic infrastructure projects (Buhr, 2022). An example is the recent USD 169 million water bonds issued in Texas to future-proof the state against drought (Yao, 2023). This adaptation bond framework would have numerous benefits. These include expanding the range of adaptation projects that could be funded by local governments, increasing the range of opportunities for investors and helping to reduce the adaptation financing gap. One of the most significant impediments to creating this framework on a global scale is getting governments to change (and harmonise internationally) the tax treatment of such bonds to replicate the US municipal market, where income on municipal bonds is not taxable at the federal level (Singelton, 2022). Additional impediments include concessionary rates available from the Public Works Loan Board (PWLB), the challenges of getting a credit rating, and the more centralised regulation, which limits the ability to generate revenue streams compared to the US[12].

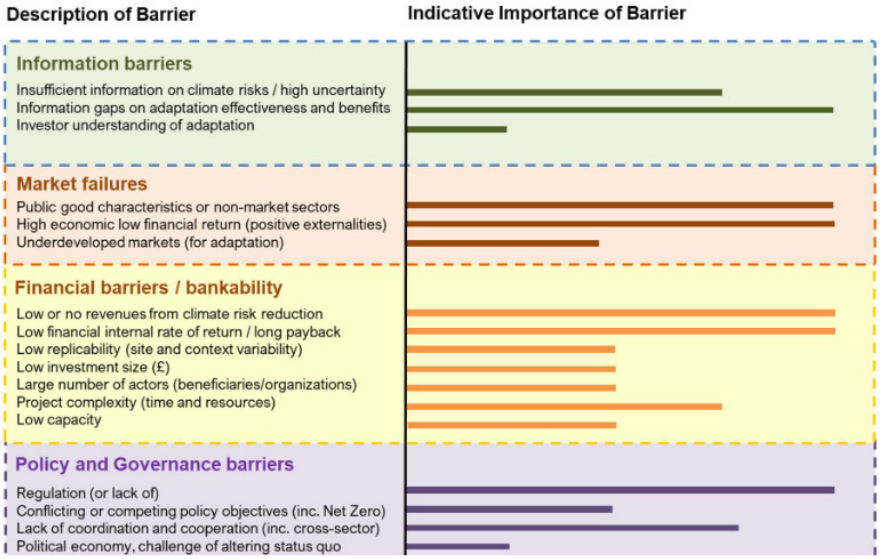
Regarding climate adaptation at scale, supranational, sovereigns and agencies (SSAs) are significant issuers in the green bond market and account for nearly 42% of the sustainable bond issuance. For instance, in May 2023, the Asian Infrastructure Investment Bank (AIIB) issued its first Climate Adaptation bond, a thematic bond under the AIIB Sustainable Development Bond Framework. The five-year bond raised AUD 500 million, and the proceeds will be allocated to projects with an estimated 20% or more significant climate adaptation finance portion of the total project financing. Separately, in October 2023, the Dutch government continued its successful issuance of sovereign green bonds by raising almost five billion Euros, with the proceeds flowing towards flood risk management, dyke building and other adaptation investments.

Examples of their implementation in the urban context include green bonds, the proceeds of which are used for adaptation purposes in infrastructure (such as the EUR 300 million Paris Climate Bond, issued in 2015 to finance the city's mitigation and adaptation projects (GIZ, 2019)). More recent examples include the series of urban adaptation green bonds in Toronto, now totalling CAD 400 million, with some of the proceeds flowing towards flood protection (City of Toronto, 2023).

3.3 Barriers to Investment

Adaptation gaps will continue to grow under current levels of implementation (IPCC, 2023). The Climate Change Committee Investment for a well-adapted UK report in February 2023 identified a range of different barriers to investing in adaptation along the following areas: market and financial, behavioural, bankability and regulatory policy, and information. However, they have different indicative levels of importance, highlighting different priorities in addressing them (Watkiss & Frontier Economics, 2022). These are summarized below:

Figure 3: Barriers to adaptation investment and their indicative importance.



Source: Watkiss and Frontier Economics, 2022

[12] https://www.dmo.gov.uk/responsibilities/local-authority-lending/concessionary-rates

Welfare economic theory can help frame adaptation investment. Market failures or distributional objectives often justify Government intervention (Cimato et al. 2010). Market failure, including information failure and externalities, is when the market does not deliver an efficient outcome (HM Treasury, 2003). Other barriers are behavioural, organisational and institutional arrangements, such as lack of public sector regulation defining roles and responsibilities for adaptation (Stern, 2006).

Most current adaptation interventions do not generate income, making it difficult to receive financing from private sector investors. This is because of the public good nature of adaptation, as many benefits do not deliver direct private returns on investment. However, if market prices align with accounting prices, revenue streams can exist for natural assets with adaptation benefits, such as protection and rewilding soils (Dasgupta, 2021).

Failure to value and price resilience deters private sector investment. Investment in adaptation and resilience can lead to value creation if the social rate of return on investment is recognised through avoided loss and damage and service disruption, optimised lifecycle costs, improved certainty of operating cash-flows, and broader social, economic and environmental co-benefits (CDRI, 2023). Even then, a long payback period and low returns may be a barrier to investment. At the same time, governments need to set targets and embed them in regulatory frameworks to ensure resilience is valued correctly; both the public and private sectors are likely to invest in it adequately (NIC, 2023).

Secondly, the value created usually benefits a broad set of stakeholders. Regulation and new financing structures are needed to capture the direct monetary benefits and broader social and environmental outcomes. The public goods nature of adaptation also implies a free-rider problem. Allocating the costs and benefits of risk and resilience amongst stakeholders is the key to incentivising the proper integration of resilience in infrastructure systems.

Lastly, a significant barrier is the need for more information or information asymmetries. This has been recognised as a barrier to deploying private finance for sustainability, particularly for natural capital and infrastructure investment opportunities (G20 Sustainable Finance Study Group, 2018; Cooper & Trémolet, 2019). For institutional investors, this lack of data is a significant barrier to aligning with their fiduciary and prudential responsibilities and understanding the financial losses that climate change can create.

4. Case Studies – Description and Approach

To showcase successful examples of adaptation and resilience financing, overcoming identified barriers to investment in the previous section, we present eight case studies of UK adaptation and resilience financing (see Table 2 below). Case studies are drawn from interviews conducted between July and October 2023 and extensive desktop analysis. (See Annex 2 for case studies methodology and complete analysis.)

Table 2: Overview of case studies.

Case study	Financial feature	Location	Stage	Main financial actor
Green Bonds	Physical Risk Assessment & Green Bonds Underwriting	England	Launched	NatWest (UK bank and insurer group), Impact Investors
Westminster Council green investment framework	Crowdfunding climate finance	London	Launched	Westminster Council, Retail Investors & Impact Investors
Investing in Greenhouses	Investing in Greenhouses for agriculture	England	Launched	Brunel Pension Partnership - pension assets (around £35bn of ten Local Government Pension Scheme funds in the UK)
Glen Dye Project	Investing in Nature Based Solutions	Scotland	Launched	Aviva Investors - Insurer & Asset Manager

Craigleith Retail Park	Revolving Fund to monetise climate benefits	Edinburgh	Appraisal	Real Estate Fund and Life Insurance Company - Nuuven and Teachers Insurance and Annunity Association of America (TIIA)
Canary Wharf Real Estate Development	Making the largest urban regeneration in Europe climate resilient	London	Completed	Sovereign wealth fund and real estate developer - Brookfield - and Qatar Investment Authority
Havant Thicket: Water Reservoir	First UK Infrastructure Bank climate resilient project	England	Launched	Development Bank and Investors - Alcala Partners and UK Infrastructure Bank
Thames Water and Tideway Tunnel	Regulation mandating Adaptation and Resilience	London	Launched	Infrastructure investors and insurance companies - Allianz, Amber Infrastructure and Dalmore Capita, Swiss Life

This paper categorises adaptation and resilience investments, drawing from official jurisdictional frameworks and widely accepted market frameworks such as the EU Sustainable Finance Taxonomy, the United Nations Office for Disaster Risk Reduction (UNDRR) Guide for Adaptation and Resilience Finance, the UNDRR and Climate Bonds Initiative white paper Designing a Climate Resilience Classification Framework, the MDB Group Joint Methodology for Tracking Climate Change Adaptation Finance (UNDRR, 2023; UNDRR, 2024; ADB, 2022).

The case studies compiled span both urban (London and Edinburgh) and rural (Scotland and England) settings. These projects, many of which are in a mature state, with a few still in the proposal stage, are primarily focused on water-related adaptation – though we also include examples related to other climate hazards. Notably, we feature major international and national institutional investors, as well as financial institutions, in our case studies, making the findings directly relevant to financial professionals beyond the UK.

According to CDRI (2023), for the valuation of ecosystem services to become standard practice in environmental policy and infrastructure investment decisions, three shifts need to happen:

- the realisation that ecosystem services have a value
- understanding and knowing how to monetise ecosystem service value
- undertaking valuation exercises to decide future land use as a requirement

Following CDRI (2023), a complete estimation and visualisation of the risk and the resilience dividend can provide a solid economic imperative for investing in infrastructure resilience.

In this paper, we focus on mobilising private sector financing and developing capital market solutions for adaptation and resilience. Our analysis of eight case studies seeks to answer three questions: What is the investment proposition for private sector financing in adaptation and resilience? What are the investment models and financing instruments? What are the drivers for investors? Key factors influencing private sector investment include the valuing and pricing of resilience, revenue streams, and business models, as well as transparency and information to investors. Additional issues are skills, capacity, and financing capabilities.

As seen also in the previous section, we developed a systematic methodology to analyse the case studies based on (1) adaptation investment, (2) revenue sources and financial instruments, and (3) investment drivers (see previous section) according to these three criteria.

Box 5: Case study assessment methodology

1. Adaptation and resilience investment

For the private sector, the principal factor in increasing investment in adaptation is the availability of revenue streams to pay back upfront investments and the short payback period needed. Appropriate revenue streams to broaden the range of investors vary across diverse types of adaptation. In looking at the financing typology (bankability of adaptation), the main factors reviewed in the case studies include (ADB, 2022; UNDRR, 2024):

- Areas of adaptation (Climate resilient themes) Adaptation actions are based on sector (i.e. water, agriculture, nature restoration and built environment) and type of measure (i.e. engineering, nature-based solutions, etc.). UNDRR and Climate Bonds Initiative on Climate Resilience focus on seven themes of resilience, including infrastructure, water sector, cities and real estate development (UNDRR, 2023).
- Types of investment (Secondary or adapted vs Primary or enabling).
    - Adapted investments: as a secondary objective, where the action is integrated into existing or planned investment flows ('climate proofed') with the adaptation financing requirement likely to be of small scale relative to the overall investment.
    - Enabling Investments: investments where adaptation is the primary objective, with the dedicated investment required for the resilience of other assets, activities, or entities (e.g. protecting infrastructure from increasing flood risk).
- Adaptation benefits and co-benefits are both economic (providing a societal perspective) and financial (presenting the private sector perspective). Economic benefits include environment and ecosystem services (see also the environmental objectives and social outcomes of the ICMA / LMA principles).

2. Financing instruments and revenue sources

Allocating the costs and benefits of risk and resilience amongst stakeholders is the key to providing incentives for properly integrating resilience into adaptive action. After clearly identifying the resilience value and stakeholders, it becomes imperative to formulate policies that quantify the socio-economic advantages of investing in resilience and facilitate investors in capturing a share of those benefits.
This section explores different revenue sources, generating private sector revenues (i.e. business models or ways of monetising adaptation benefits) and financial structures and instruments. Following CCC (2023):

- Revenue Sources to support adaptation investment can be categorised into four types, each with its own characteristics: public and philanthropic funding, user fees, other private revenues, and household expenditures.
- Financing instruments covered in the case studies include sustainability-linked financing, green bonds and blended finance.

3. Drivers of investment

Finally, our case selection aimed to cover a range of investment drivers for financial investors. Various investors and financial actors have been considered, including pension funds, insurers, asset managers, sovereign wealth funds and banks. These actors have different risk-return expectations and investment horizons. They will suit different types and stages of projects regarding adaptation.

There are several reasons for investors to finance or contribute more towards adaptation investments, including:

- Addressing physical risks of climate change: Climate risk disclosure and financial regulation are major market catalysts for correctly pricing the risks in adaptation investment.
- Positive alignment: Investors are increasingly pressured to align finance with climate resilience beyond risk management.
- Adaptation as an investment theme: There are increasing opportunities to invest in adaptation and resilience through resilient infrastructure, sustainable agriculture, data and information services, insurance, water, healthcare, and real estate.

Figure 4: Case Studies – Key insights – Complete Table

ABOUT THE CASE STUDY			1. FINANCING TYPOLOGY			2. FINANCING AND REVENUES SOURCES		3. DRIVERS OF INVESTMENT	
Case study	**Location**	**Stage**	**Theme**	**Benefits**	**Type of Investment**	**Type of Financing Instrument**	**Main Revenue Source**	**Main Actor**	**Investment Strategies Characteristics**
Physical Risk Assessment & Green Bonds Underwriting - NatWest	England	Launched	Climate Mitigation and Adaptation	Water management & flooding	N.A.	Public Financing: Green Bonds	General Tax base	NatWest (UK bank and insurer group), Impact Investors	Addressing Physical Climate Risk, after BoE CBES stress testing.
Crowdfunding climate finance: Westminster Council green investment framework	London	Launched	Climate Mitigation and Adaptation	Efficient buildings and Clean Energy Green and Resilient city	N.A.	Public Financing: Green Bonds	General Tax Base	Retail Investor and Impact investors	Local Inclusion and Financing: Supporting local council taking climate action and earning a financial return.
Investing in Greenhouses for agriculture - Brunel Pension Fund	England	Launched	Sustainable Agriculture	Increase domestic tomato production by 10% Reduce greenhouse gas emissions by 75% Minimize water consumption	Enabling	Private Financing: Equity	Contracted Revenues	Brunel Pension Partnership - pension assets (around £35bn of ten Local Government Pension Scheme funds in the UK)	Asset Class Performance & Positive Alignment: This project is part of the pension funds private markets and real assets portfolio and aligned with Brunel Net Zero Commitments.
Investing in Nature Based Solutions - Aviva - Glen Dye Project	Scotland	Launched	Nature & Biodiversity/Green Infrastructure	Carbon capture and peatland restoration at national scale Adaptation benefits: woodland recreation, on-site water management, controlling flood risk in the area.	Enabling	Private Financing: Equity	Carbon Credits	Aviva Investors – Insurer & Asset Manager	Asset Class Performance & Positive Alignment: Targeting risk-adjusted returns – 8% IRR net of fees over rolling 5-year periods in an innovative fund structure while investing in NBS.
Revolving Fund to monetize climate benefits for a sustainable drainage systems - Nuuven and TIIA - Craigleith Retail Park	Edinburgh	Appraisal	Real Estate/Green Infrastructure	Maximise site amenity and value Support water management and climate adaptation	Adapted	Private Financing: Equity	Cost Reduction and Co-benefits monetization	Real Estate Fund and Life Insurance Company - Nuuven and Teachers Insurance and Annuity Association of America (TIIA)	Addressing Physical Risk & Positive Alignment: Support Nuveen's ESG credentials & GRESB score through outcomes associated with water efficiency, community engagement and tenant engagement.
Making the largest urban regeneration in Europe climate resilient - Canary Wharf - Brookfield and QIA	London	Completed	Real Estate/Green Infrastructure	Biodiversity targets with climate adaptation metrics (heating island impact)	Adapted	Private Financing: Equity & Green Bonds	Household Expenditure - Property Appreciation	Sovereign wealth fund and real estate developer – Brookfield - and Qatar Investment Authority	Positive Alignment: Biodiversity and climate adaptation key elements of sustainability certification of real estate development (i.e. BREEM). The sustainability of the overall project has been instrumental to private equity investments and the issuance of Green Bonds.
First UK Infrastructure Bank climate resilient project - Havant Thicket: Water Reservoir	England	Launched	Water sector	Water Security: Enhancing the resilience of water supply systems in Southern England	Enabling	Private Financing: Blended Finance	User Fees - Regulated Asset Based Mechanism	Development Bank and nvestors - Alcala Partners and UK Infrastructure Bank	Positive Alignment: This is considered to be the first UKIB "climate resilient" project. UKIB conducted an environmental assessment, using its ESG +R (environmental, social, resilience and governance) considerations framework.
Regulation mandating Adaptation and Resilience: Thames Water and Tideway Tunnel	London	Launched	Water sector	Water Security: Improving water quality which delivers health benefits Enhances the sewer network's resilience to climate change and population growth for at least the next 100 years	Enabling	Private Financing: Equity & Green Bond	User Fees - Regulated Asset Based Mechanism	Infrastructure investors and insurance companies Allianz, Amber Infrastructure and Dalmore Capita, Swiss Life	Asset Class Performance: A fully index-linked revenue stream and yielding investment through both construction and operating periods.

5. Case Studies – Key Insights Analysis

5.1 Adaptation Investment

In looking at the adaptation investment, the main factors reviewed in the case studies include (ADB, 2022; UNDRR, 2024):

i. Areas of adaptation (Climate resilient themes): adaptation actions are based on sector (i.e. water, agriculture, nature restoration and built environment) and type of measure (engineering, nature-based solutions etc.);
ii. Types of investment (Secondary or adapted vs primary or enabling);
iii. Adaptation benefits and co-benefits are both economic (providing a societal/social perspective) and financial (presenting the private sector perspective) benefits

5.1.1 Adaptation Areas – Climate Resilient Themes[13]

Several case studies contribute to climate adaptation by dealing with water scarcity, an increasing threat to the UK and the world. UK South East region, categorised as "seriously water-stressed" by the Environment Agency, necessitates actions to secure water resilience, including the construction of new reservoirs. The Thicket Water Reservoir case study (4) is the UK's first significant new water storage reservoir since the 1980s. Seen as a "critical step" to enhance water security in the South East of England, it will generate significant environmental benefits for local communities and wildlife. The initial need for the reservoir project was driven by the requirement for Southern Water to significantly reduce its abstraction on the Rivers Test and Itchen, as set out by the Environment Agency to meet the Habitats Directive and Water Framework Directive requirements. The project value represents the first adaptation project for the UK Infrastructure Bank, aligning with UK government plans.

Adaptation for water security can be associated with other sectors, such as sustainable agriculture. The Greenhouses case study (2) aims to increase domestic tomato production by 10%, reduce greenhouse gas emissions by 75%, and minimise water consumption. The farming method implemented in the greenhouses requires less water than traditional farming practices. The closed-loop water circulation system eliminates wastage, ensuring efficient water usage and conservation. These efficient measures significantly decreased water usage, which is crucial for sustainability, especially in regions facing water scarcity.

Green infrastructure in urban & rural adaptation and social inclusion. Actions to enhance green infrastructure take place on various scales – from urban and single neighbourhoods to the broader rural landscape. At municipal and local levels, these multiple objectives are constrained by a lack of resources and financing. In London, Westminster›s Green Investment Case study (8) provides the council with the investment needed to address the climate emergency. It also allows residents to support their local council in taking climate action while earning a financial return. For Thicket Water Reservoir (4), public consultation and environmental impact assessments have influenced the climate proofing elements of the design including – for example – redesigned vehicle access, new wetlands areas; replanting/improving 110 hectares of woodland; new footpaths and improved specifications; and greening of soft landscaping.

5.1.2 Type of Investment

Adaptation as the main enabling investment objective. In a few case studies, adaptation and resilience are the main consideration, requiring dedicated investment. Due to the capital-intensive nature of large water, wastewater treatment and desalination plants, targeted investment in projects in the water sector often requires significant additional new investment. For the Tideway case study (5), the adaptation benefits are gained from enhancing the sewer network's resilience to climate change. This project provides multiple benefits, including improved safety standards in the industry and economic benefits.

Adaptation as a secondary investment objective. Several case studies with solid adaptation co-benefits are delivered as secondary objectives and integral to mitigation and/or nature objectives. Adaptation as a secondary objective often requires little investment compared to total project costs.

[13] The case studies cover a portion of the 61 risks identified in the UKCCRA3 climate analysis. That said, they can be considered as a proxy for investors interest and help identify areas for government actions.

The Greenhouses case study (2) shows how adaptation benefits are delivered through ecosystem restoration that, in turn, reduces water scarcity through on-site water management and controls flood risk in the area. The Glen Dye case study (3) – a private equity project for nature restoration (i.e. tree planting and peat bog restoration) – is a further example of a dual- and multi-beneficial project.

Nature-based solutions are often too small to replicate and scale to attract financial investment. The local-specific nature of the investment makes it difficult for private finance to replicate and scale projects tailor-made for a local project's conditions. Aggregating smaller projects into a single investment portfolio, as proposed with the Craigleith Retail Park (6) project, while in theory can reduce transaction costs, making them bankable for investors, has proven challenging to implement due to added governance complexity and increased project development costs.

5.1.3 Adaptation Benefits and Co-benefits

Ecosystem services benefits and beneficiaries will depend on adaptation areas and sectors. For example, Blue-Green Infrastructure (BGI) provides various ecosystem services, such as water purification, air quality, space for recreation, water regulation, temperature regulation and carbon sequestration. Ecosystem services can be measured by providing an input to economic appraisal through 'Natural Capital Accounting,' which considers the stock of natural capital that generates this flow of ecosystem services. Portsmouth Water used a natural capital accounting approach to evaluate the net environmental gain of the Havant Thicket reservoir, with a habitat and biodiversity mitigation and compensation programme. It concluded that overall, there would be a substantial net gain, with a focus on recreation, health, well-being, and water provision, particularly in drought years. Canary Wharf's real estate development (7) undertook an ecosystem valuation as part of its Biodiversity Plan to demonstrate the intrinsic value of natural capital and identify the most effective investment forms in green infrastructure: street trees, accessible amenity space, or biodiverse roofs.

Despite some projects delivering ecosystem benefits, financial benefits from adaptation projects are often the main driver for investment from the private sector. Private sector cost savings, such as avoided climate losses, are often insufficient to justify the necessary investment. For Craigleith Retail Park Case Study (6), while there are some public benefits from reduced water treatment costs, biodiversity, air quality and carbon storage (which underpinned the rationale for the blended finance approach and public support), the most significant benefits arise from the real estate scheme which is likely to be realised by the investors in the form of the uplift of property values and rental increase. The Glen Dye site in Scotland (3) enhances woodland recreation and on-site water management and contributes to controlling flood risk in the area. While not the primary criterion for investment, its societal and environmental advantages enhance its investment appeal.

Institutional investors, particularly those with a long-term horizon, are playing a crucial role in driving engagement with adaptation. In the Greenhouses case study (2), local government pension funds have been instrumental in the first investment in sustainable UK farming projects, deploying the largest heat pumps ever in the UK. This demonstrates the significant influence and power that institutional investors have in shaping the future of adaptation projects.

5.2 Financing and Revenue Sources

This section explores different revenue sources, generating private sector revenues (i.e. business models or ways of monetising adaptation benefits) and financial structures and instruments. Following CCC (2023):

- Revenue Sources to support adaptation investment can be categorised into four types each with its own characteristics: public and philanthropic funding, user fees, other private revenues, and household expenditure.
- Financing instruments covered in the case studies include sustainability-linked financing, green bonds and blended finance.

5.2.1 Revenue Sources and Investment Models

Income stream – User charges for a resilient water sector

The importance of broader revenue streams and the role of regulation for infrastructure. User fee revenue, supporting investment in general resilience, is used in regulated infrastructure sectors (e.g., electricity or water systems). For example, Thames Water's 15 million wastewater customers are paying for

the Thames Tideway Tunnel (5) through their bills, as approved and determined by Ofwat.
Both Tideway and Portsmouth case studies successfully mobilised private finance, demonstrating the viability and attractiveness of the investment model proposed for investors. Tideway (5) attracted £1.3 billion in private equity investment from a consortium of infrastructure investors and insurance companies, including Allianz, Amber Infrastructure, and Dalmore Capital, benefiting 2.7 million UK pensioners. Portsmouth Water mobilised £165m private finance out of a total investment of £339 million from Ancala Partners (an equity fund focusing on proprietary investments in critical mid-market infrastructure).

Innovation in water revenue models

Innovation observed in the case studies includes the use of a regulated asset-based (RAB) model also under construction and the introduction of more competition. The Tideway sewer tunnel project (5) uses private equity, green bonds and UK Government funds in a regulated asset-based (RAB) model. As a regulated utility company by Ofwat, Tideway has collected inflation-linked revenue from Thames Water's wastewater customers since construction. Ofwat is introducing more competition in infrastructure delivery and financing to the water sector through its Direct Procurement for Customers model[14]. Portsmouth Water for the Thicket Reservoir (4) has agreed on a unique long-term bulk supply agreement with neighbouring water company Southern Water, with the support of Ofwat, to enable the reliable delivery of 21 million litres of water daily. This project is the first example of the Direct Procurement for Customers regulation – a process for water companies to competitively tender for a third party to design, build, finance, operate and maintain infrastructure.

Carbon credits for adaptation and nature-based solutions

Carbon and ecosystem credits can support adaptation actions[15]. Climate resilience benefits can often be realised as a co-benefit to a broader environmental benefit (such as the resilience of an ecosystem and carbon storage). These actions are supported by revenues monetised in carbon markets and may not be directly linked to climate risk reduction. Carbon credits are featured in several of the case studies. The Glen Dye case study (3) has several adaptation benefits – returns for Aviva's Climate Transition Fund are generated from carbon credits. The Glen Dye site in Scotland aims to address climate change by targeting carbon sequestration through peatland restoration. In the short term, the Glen Dye project involves low-level investments, such as tree planting, which generates carbon credits. These credits can be retained within the Climate Transition Fund, offering financial benefits and supporting the fund's long-term growth objectives. As the investment matures, it will yield returns from timber sales and the sale of carbon credits, making it a sustainable venture for Aviva Investors' clients, typically pension and insurance asset owners. The Glen Dye project highlights the need for commercial and governmental involvement to generate income and support adaptation initiatives.

Landscape management and regulation are significant in developing carbon markets and nature restoration projects. In Scotland, the New Markets for Land and Nature report looks at land management and finance, addressing the tensions of land ownership, control, governance and potentially higher land prices due to increased demands (Adaptation Scotland, 2023 & Scottish Land Commission, 2023). UK and international regulations and standards – such as the UK Forestry Standard and the COP26 Glasgow Leaders Declaration on Forestry and Land Use – are used to verify the sustainability of forest management and wood products. This regulatory environment has enabled the Glen Dye financing approach (4).

Value capture through property appreciation – using nature in real estate

Urban green space, adaptation, and property value. Buildings associated with open spaces can add to the aesthetic setting of an area, increasing attractiveness to residents and businesses and increasing the property value[16]. Beyond recreation and physical health benefits, they can reduce climate hazards, such as flood management. The property premium will reflect the scale of the benefits and other spatial factors, such as proximity, population density and availability of substitutes. As shown in the case studies Craigleith Retail Park (6) and Canary Wharf Real Estate (7), the increase in property value can be captured through monetisation.

[14] https://www.ofwat.gov.uk/regulated-companies/markets/direct-procurement/direct-procurement-for-customers/
[15] Companies or organisations can purchase ecosystem credits through traded platforms to comply with or achieve environmental regulations or outcomes; farmers or landowners supply by carrying out activities to achieve those outcomes (CCC 2023).
[16] Case studies of five open space sites in the London Borough of Barnet suggested property value premiums of 10-15% to over 2000 residential properties and of 3% to over 50 commercial properties nearby (Eftec, 2017).

Biodiversity and climate adaptation can be delivered through BNG in real estate. The Canary Wharf Real Estate Biodiversity plan's objective was to embed the biodiversity 'net gains' principle within management and planning decision-making across the Estate. This included integrating biodiversity within climate change adaptation and resilience measures, reducing the urban heat island effect, increasing stormwater retention capacity, and introducing drought-tolerant planting[17]. The sustainability of the overall project has been instrumental to private equity investments and the issuance of green bonds for investors in Canary Wharf plc, Brookfield and Qatar Investment Authority (a significant asset manager and sovereign wealth fund).

5.2.2 Financial Instruments

Revolving Fund for Wastewater treatment and stormwater drainage

Wastewater treatment and stormwater drainage improvements are adaptation benefits. Improvements were developed in the Craigleith Retail case study (6) through a proposal for a revolving fund that monetises savings as well as increased property values and rental yields. While the financial benefits were low, the project demonstrated the financial viability of blended finance for urban nature-based solutions, providing adaptation benefits. The project laid the groundwork for similar future projects in privately-owned assets.

Sustainability-linked instruments and green bonds

Green bonds are getting increased attention. They are a regular part of an investor's portfolio, opening opportunities for retail investors, banks, and financial advisors on the sell side at national and international levels. However, the NatWest Group case study (1) shows how only a tiny proportion of green bonds are used for adaptation and resilience financing. In 2022, the issuance of green bonds in the UK was USD 18.4 bn, of which only USD 0.21bn went towards adaptation and resilience (CBI, 2023).

Sustainability-linked bonds and loans for investing in resilient buildings and water efficiency are becoming mainstream instruments. For example, Great Portland Estates plc was the first UK real estate investment trust to issue an innovative £450 million ESG-linked Revolving Credit Facility; three ESG-linked KPIs aligned with the company sustainability strategy (including Biodiversity net gain and embodied carbon KPI)[18]. A few case studies have aligned their debt financing with their company's sustainable mission. Tideway (5) has issued £2.3 billion of sustainable debt through 18 green bonds, a sustainability-linked revolving credit facility with KPIs linked to legacy targets and two green US private placements. The financing package for Thicket Water Reservoir (4) includes £205 million of innovative ESG performance-linked financing.

Blended Finance

Public finance and blended finance can be used strategically to crowd in private finance for adaptation. They can be used to facilitate private investment and finance for adaptative action. In the Craigleith Retail Park case study (6), Scottish Water provides public funding to encourage and promote the co-investment of returnable finance from private asset owners. The Thicket Reservoir (4) represents the first adaptation project for the UK Infrastructure Bank (UKIB) that provided £50 million of financing to bridge the gap between investors' risk and investment appetite and traditional public funding.

Crowdfunding for Local Financing

Crowdfunding at municipal and local levels can address constraints caused by a lack of resources and financing. In London, Westminster's Green Investment Case study (8) provides the council with the investment needed to address the climate emergency. It allows residents to support their local council in climate action while earning a financial return. Westminster's Green Investment allowed the council to quickly access the cheapest form of debt available, reducing the prevalence of some financing barriers - like rates of return, revenue streams and payback period.

[17] https://group.canarywharf.com/wp-content/uploads/2021/04/canary-wharf-esg-biodiversity-action-plan-2018-2028-summary.pdf
[18] Financial Times 6 February 2020 GPE signs innovative £450 million ESG-linked Revolving Credit Facility.

5.3 Drivers of Investment

This section looks at the investment drivers for financial investors in the case studies. Drivers can be related to three areas:

i. addressing physical climate risk;
ii. positive alignment with climate resilience objectives; and
iii. adaptation and resilience as an investment theme.

5.3.1 Addressing Physical Risks of Climate Change

Managing the impact of physical climate risks is part of investors' fiduciary duties. This is also reflected in the Craigleith Retail Park case study (6), where both the asset owner, Nuveen, and its parent company, Teachers Insurance and Annuity Association of America (TIAA), are committed to implementing TCFD recommendations and to obtaining a Global Real Estate Sustainability Benchmark (GRESB) rating. As such, they were driven to understand better the financial materiality of the physical effects of climate change (England, Watkiss & Hunt, 2023). However, this attention from investors has not translated into adaptation investment decisions due to a lack of data and limited downscaling of global climate models. Investors might also underestimate portfolio-level risks due to asset risk consideration and reports under the TCFD framework omitting the potential impact of several compounding climate hazards (e.g. heatwaves and overheating, beyond flooding).

Secondary and indirect impacts from physical climate change have major implications for financial institutions. Understanding how lending may become more vulnerable in various climate scenarios is essential for banks with significant retail lending. To achieve this, they need to consider numerous channels by which transition or physical risk could affect households. For example, affecting a household's disposable income could effectively impact their capacity to repay loans. Therefore, they need to consider this both at a macro level (e.g., impacts from unemployment and house prices) and on a granular level (e.g., across both geographies and borrower characteristics). As seen in the case study on NatWest Group plc (1), the British banking and insurance holding company participated in the Bank of England's 2021 Climate Biennial Exploratory Scenario (CBES) and its requirement for physical risk assessment. As the UK's largest physical climate risk emanates from flooding, NatWest Group focused their assessment on this area, recognising that customers, such as farmers whose businesses will be affected by these climate impacts in the future, will likely alter their borrowing needs.

5.3.2 Positive Alignment of Resilience Objectives

Investors' net zero strategies aligned can also bring adaptation benefits. Investing in climate resilience can be complementary to investing in the low-carbon transition. Investors with transition-related goals can find synergies with other objectives, such as adaptation and nature. For example, this can include investing in power grid stability, batteries, energy-efficient heating, ventilation, and air conditioning as the grid decarbonises. In the Glen Dye case study (3), the project contributes to Scottish and UK forestry planting targets. This forms part of Aviva Investors' Climate Transition Fund and commitment to achieving net zero across its Real Assets platform by 2040. The project materially reduces carbon impact primarily through decarbonising the built environment but also via nature-based solutions and adaptation measures, including afforestation.

New operational frameworks for financial institutions, including Environment, Social, Governance and Resilience (ESG+R) components are developing. Standards, certifications and ESG performance indicators can help lower perceived risks for private investors, therefore unlocking additional financing and funding streams (ICSI, 2022). However, there are limitations in how current frameworks capture the resilience dimension. The UK Infrastructure Bank conducted an environmental assessment for the Thicket Water Reservoir (4) using its ESG+R framework. This framework was developed internally by the UKIB team based on best practices from both private and public markets. It is designed to guide UKIB's management of any materially significant ESG+R risks and opportunities in their portfolio.

5.3.3 Adaptation and Resilience as an Investment Theme

Adaptation and resilience opportunities can include a mix of more mature assets, such as infrastructure and timber, and newer assets, like nature-based solutions. Timber assets are instrumental in the energy transition. They also present significant adaptation benefits, offering long-term, asset-backed return generation with a hedge against rising carbon credit prices. In the Glen Dye Case

study (3), the asset manager and insurer, Aviva plc, invests directly in nature-based solutions, including afforestation and sustainable forestry activities. These solutions capture emissions and deliver carbon removals and adaptation benefits.

Pension funds are looking for diversification in private markets. Investors focus on investments with asset backing, contractually fixed or otherwise secure cash flows (with some inflation linking), and limited economic or operating exposure. In the Tideway Water case study (5), a fully index-linked revenue stream and yielding investment through construction and operating periods was one of the main drivers for investors. For the Greenhouses case study (2), predictable cash flows of bioenergy assets from rentals were supplemented by government funding (UK Renewable Heat Incentive payments[19]), offering attractive risk-adjusted returns and portfolio diversification. The project is part of the Brunel pension fund's private markets and real assets portfolio.[20]

Different investment vehicles are used to secure the adaptation investment. In the Glen Dye Case study (3), Aviva invests in an innovative fund structure, targeting risk-adjusted returns of 8% IRR net of fees over rolling 5-year periods. Brunel's pension fund was invested in its project through Greencoat Renewable Income LP (GRI), a closed-ended private markets fund part of its Secured Income Portfolio. Local Government Pension Funds (LGPS) pooling also offers Brunel scale advantages with co-investment opportunities and cost reduction with lower fees, as well as expertise on funds and secondary products.

6. Conclusions

Private sector financing in adaptation and resilience in the UK is still limited. Encouragingly, there is potential for innovative financing mechanisms, but significant barriers exist across the financial ecosystem. Addressing these barriers will require substantial Government interventions to mature and transform the market. Although case studies do not cover the complete set of climate change risks in the UK, they can be considered a good proxy for investors' interest and the need for government action on signalling and enabling conditions. Insights reveal that while many adaptation benefits are public and demanding for private actors to capture, public funding and regulation can complement private capital in blended finance structures.

The analysis also underscores the interconnectedness of adaptation with nature, suggesting that, in some cases, lessons from nature and biodiversity markets can inform approaches to adaptation financing. As the case studies illustrate, whilst private investments in nature are possible, scaling and replicating them requires concerted efforts.

The investment proposition for adaptation and resilience

Property and water sectors offer increasing opportunities to use private sources of finance, including household investors and commercial banks, for adaptation and resilience. Several case studies contribute to climate adaptation by dealing with water scarcity, an issue increasingly threatening the UK and directly associated with other sectors, such as sustainable agriculture. However, many other hazards, such as overheating, are not being addressed. Green infrastructure in urban adaptation is also a significant investment theme, highlighting a primary need for more resources and financing at the municipal and local levels.

Climate-proofing investment offers opportunities for resilience through asset maintenance and renewals. In only a few case studies, adaptation and resilience are the primary considerations requiring dedicated investment. The capital-intensive nature of extensive water and wastewater treatment and desalination plants necessitates substantial additional investment for targeted projects in the water sector. Most case studies show substantial adaptation co-benefits, usually delivered as secondary objectives and integral to mitigation and nature objectives. This is the case, particularly for nature-based solutions that are often too small to replicate and scale to attract financial investment.

[19] The Non-Domestic Renewable Heat Incentive (NDRHI) is a government environmental programme designed to increase the uptake of renewable heat to help reduce carbon emissions and meet the UK's renewable energy targets. The Department for Energy Security and Net Zero closed the NDRHI scheme in Great Britain to new applicants on 31 March 2021

[20] Source: Brunel Pension Partnership Limited Annual Report & Financial Statements 2022

Adaptation, often overlooked in financial valuation, requires the establishment of a market for its outcomes. The benefits of ecosystem services, which are contingent on the adaptation areas and sectors, can be effectively measured through 'Natural Capital Accounting.' This approach takes into account the stock of natural capital that generates the flow of these services. While financial benefits from adaptation projects are a key driver for private sector investment, it's essential to address methodological and data issues, such as site- and context-specificity, long periods, and high levels of uncertainty, to ensure the accuracy of these measurements.

Investment models and financial instruments

The case studies have shown innovation in investment models across sectors. For the water sector, innovation is in using regulated asset-based systems for the construction of assets beyond the operation phase or introducing more competition through the Direct Procurement for Customers model (DPC), a model that allows customers to directly procure goods or services from a supplier. Carbon and ecosystem credits can support adaptation actions for nature protection and restoration – with revenues not directly linked to climate risk reduction – monetised in carbon markets. In real estate, adaptation actions shown in the case studies benefit owners and occupants, contributing to property appreciation. Further demonstrations and financial quantification of how integrating natural capital and resilience measures in design and planning for real estate could promote a more comprehensive understanding and create further incentives for investors and asset owners to invest in adaptation.

The findings underscore the urgent need to facilitate innovative financing for adaptation measures and projects. Case study findings and estimates for the UK reveal a stark reality: a tiny proportion of green bonds are currently used for adaptation and resilience financing. While sustainability-linked bonds and loans in resilient buildings and water efficiency are rapidly growing, the inclusion of climate resilience is still limited. A revolving fund for wastewater treatment and stormwater drainage improvements cannot only monetise savings but also increase property values and rental yields. As the physical impacts of the climate and nature crises escalate, insurance will become increasingly critical to protect the resilience of the most vulnerable parts of the population. Beyond public schemes such as Flood Re, crowdfunding at municipal and local levels can address constraints due to lacking resources and financing. Blended finance can also be used to facilitate private investment and finance for adaptation action.

Drivers of investment

Physical risk is currently under-estimated by investors. Managing the impact of physical climate risks is part of investors' fiduciary duties. However, investors might underestimate risks at the portfolio level due to asset risk consideration and reporting under the TCFD framework, not considering the potential impact of several compounding climate hazards (e.g. heatwaves and overheating, beyond flooding) or secondary and indirect impacts. Case studies also highlighted indirect impacts on banks' loan books (i.e. on agriculture loans) of the UK's most significant physical climate risk – flooding.

New operational frameworks (ESG + R), including resilience outcomes, are required. An essential component of climate change adaptation is climate risk disclosure and assessment, with key frameworks being the EU Taxonomy, TCFD requirements or the forthcoming UK Green Taxonomy. Shortcomings of current initiatives are the focus on process rather than outcomes and the lack of granularity at the sector level. At the same time, as highlighted in the case studies, new operational frameworks, including resilience for financial institutions—Environment, Social, Governance and Resilience (ESG+R)—can help lower perceived risks for private investors, therefore unlocking additional financing and funding streams.

Pension funds are looking for diversification in the private markets. The case studies show that investors focus on investments with asset backing, contractually fixed or otherwise secure cash flows (with some inflation linking), and limited economic or operating exposure. Different investment vehicles are used to secure the adaptation investment, targeting risk-adjusted returns of less than 10% IRR net of fees in closed-ended private market funds. Co-investment opportunities offer scale advantages with cost reduction, lower fees, and expertise in funds and secondary products.

Glossary

Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. (IPCC 2022).
Adaptation financing gap	Adaptation depends on both access to finance (the upfront capital) and the availability of revenues to repay the finance over time (CCC, 2023). The United Nations Environment Programme publishes an annual report on the status of this gap. For 2022, please find it here: https://www.unep.org/resources/adaptation-gap-report-2022.
Blended Finance	Blended finance is a catch-all term that covers financial products or structures that combine different funding sources aimed at lowering the risk profile of specific companies or projects and ultimately attracting private capital (UK Treasury 2023 Green Financer Strategy).
Climate proofing	Climate proofing refers to a process that integrates climate change mitigation and adaptation measures into the development of infrastructure projects (European Commission, 2021)
Green infrastructure (also Blue Green Infrastructure)	A strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, such as water purification, air quality, space for recreation and climate mitigation and adaptation while also enhancing biodiversity (EU, n.d.). Green infrastructure can include green spaces, but also schemes that are alternatives to engineered (grey) infrastructure such as sustainable drainage systems or green flood control management. It can include green infrastructure in new developments, upgrading of existing green infrastructure and retrofitting of new green infrastructure.
Greenium (green premium)	Pricing benefits are based on the logic that investors are willing to pay extra or accept lower yields in exchange for sustainable impact (UNDP, 2022).
Land value capture	Land value capture is a policy approach that enables communities to recover and reinvest land value increases that result from public investment and government actions. Land value capture is rooted in the notion that public action should generate public benefit (OECD, n.d.)
Nature-based solutions	Actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature (IUCN, n.d.).

Physical risk	Physical risks are risks associated with the impacts of climate change, such as the risks stemming from extreme weather events and changing climate patterns. Transition risks are those associated with the pace and extent to which an organisation manages and adapts to the internal and external pace of change to reduce greenhouse gas emissions and transition to renewable energy (US EPA, 2023).
Resilience	The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC 2022).
Revolving fund	An amount of money that exists to finance something, but from which any loans must be replaced so that the full amount is available again (Cambridge Dictionary, n.d.).
Sustainable drainage systems	Sustainable drainage systems (SuDS) are drainage solutions that provide an alternative to the direct channelling of surface water through networks of pipes and sewers to nearby watercourses. By mimicking natural drainage regimes, SuDS aim to reduce surface water flooding, improve water quality and enhance the amenity and biodiversity value of the environment (BGS Research, n.d.).
Transition risk	Transition risks are those associated with the pace and extent to which an organisation manages and adapts to the internal and external pace of change to reduce greenhouse gas emissions and transition to renewable energy (US EPA, 2023).
Voluntary carbon markets	Voluntary carbon markets allow carbon emitters to offset their emissions by purchasing carbon credits emitted by projects targeted at removing or reducing greenhouse gases from the atmosphere (EEX, n.d.).

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Annex 1: Policies and Regulations Related to Climate Adaptation and Nature

Table 3: Policies and regulations related to climate adaptation and nature.

Policy or regulation	Jurisdiction	About
UK Green Finance Strategy (2023)	UK-wide	The Strategy sets out how the UK Government will pursue its ambition to become the world's first net zero-aligned Financial Centre – equipping the market with the information and tools necessary to drive the transition.
Sustainability Disclosure Requirements Framework (includes ISSB/TCFD reporting)	UK-wide	A comprehensive regulatory framework that mandates companies and financial institutions to disclose their impacts, and addresses key aspects like comprehensive reporting standards, explicit product labelling, and firm-level accountability
UK Green Taxonomy (in development)	UK-wide	It will provide a common framework, setting the bar for investments that can be defined as environmentally sustainable, helping to tackle 'greenwashing,' improve understanding of environmental impact to help companies and investors make informed green choices, support investment in sustainable projects and boost efforts to tackle climate change.
Transition Plan Taskforce guidance (2023)	UK-wide	Launched to develop the gold standard for private sector climate transition plans. The TPT's work takes place within the broader landscape of UK regulation and legislation around sustainability disclosures. It will inform the UK's future Sustainability Disclosure Requirements Framework
UK Nature Markets Framework (2023)	UK-wide	This nature markets framework sets out how government will guide and support the development of nature markets capable of supporting elevated investment levels and the government's vision to hardwire integrity and principles into the market framework to build trust and confidence so markets can grow at pace with ambition.
BSI Nature-Investment Standards	UK-wide	A new stakeholder-driven standards programme to boost confidence in nature markets and increase private sector investment into nature recovery.
Carbon Codes	UK-wide	The UK Saltmarsh Carbon Code will enable UK saltmarsh carbon to be marketed and traded as carbon offsets, whilst providing assurances to buyers that the climate benefits being sold are real, quantifiable, additional, and permanent. The Peatland Code is a voluntary standard for UK peatland projects, whereby investors in restoration projects can make carbon savings[21]. The Woodland Carbon Code is a voluntary code, designed to help individuals and businesses wishing to contribute to tree planting to help offset the carbon they emit, with contracts lasting between 35 – 100 years.

[21] https://ahdb.org.uk/news/understanding-regulated-carbon-markets

Natural Environment Investment Readiness Fund (NEIRF)	England	The Fund of up to £10 million provides grants of up to £100,000 to more than 75 environmental groups, local authorities, businesses, and other organisations to help them develop nature projects in England to a point where they can attract private investment.
Biodiversity Net Gain (2023)	England	A way of creating and improving natural habitats. BNG makes sure development has a measurable positive impact ('net gain') on biodiversity, compared to what was there before development. Becoming mandatory in England. Developers must deliver a biodiversity net gain of 10%.

Adapted from Adaptation Scotland (2023)

Annex 2: Case Studies

Methodology

The case studies were based on a mixed-method approach, including an extensive review of the literature and relevant policy documents. Qualitative data was collected from interviews (n=8) held with the interviewees and their associates. This enabled the collection of insights by leading practitioners and academics which are presented below.

Table 4: Interviewees

Organisation type	Grouping and interviewee coding	Number of interview participants	Country
Bank (1)	Investors & enablers (IV)	2	UK
Institutional Investor / Pension Fund (1)	IV	1	UK
Asset Management (1)	IV	1	UK
Government (3)	Government & enablers (G)	4	UK
GLA (2)	G	1	UK

A systematic literature and policy documentation review of the UK's adaptation planning, and green/climate finance was performed (see Annex I). Together this data set afforded an understanding of how adaptation funding and financing is conceptualised in the UK. The second dataset is from qualitative analysis of semi-structured interviews with the relevant actors (n=8), government and enablers (n=5), and investors (n=3)).

Case Study 1: NatWest Group – Physical Risk Assessment and Green Bonds

Key Takeaways

- The green bond issued for adaptation Dutch water and local authorities (flood protection) has an acceptable risk and return profile and is an example of a green bond issuance for adaptation which could be replicated in the UK.

Bank of England's Climate Biennial Exploratory Scenario exercise[22]

NatWest Group plc – a British banking and insurance holding company – was one of the participants of the 2021 Climate Biennial Exploratory Scenario (CBES) that was held by the Bank of England and focused on physical risk assessment. This assessment was aimed to explore the financial risks posed by climate change for the largest UK banks and insurers, given the Bank's objectives of ensuring the macroeconomy, the financial system and the Bank of England itself are resilient to the risks from climate change. The CBES includes three scenarios exploring both transition and physical risks, to different degrees: "Early Action," "Late Action" and "No Additional Action."

For banks with significant retail lending, understanding how lending may become more vulnerable in various climate scenarios is important. To achieve this, they would need to consider numerous channels by which transition or physical risk could affect households. For example, if they affect households' disposable income it can also impact their capacity to repay loans. They would need to consider this both at a macro level (e.g., impacts from unemployment and house prices) as well as on a granular level (e.g., across both geographies and borrower characteristics).

As the UK's largest climate physical risk comes from flooding, NatWest Group focused their assessment on this area. NatWest recognised that customers, such as farmers whose businesses will be affected by climate impacts in the future, will likely alter their borrowing needs.

Overall, the exercise has shown that UK banks and insurers are making good progress in some aspects of their climate risk management, but still need to do much more to understand and manage their exposure to climate risks. The lack of available data on corporates' current emissions and future transition plans is a collective issue affecting all participating firms.

Green Gilt Underwriting

The green bond market is now well-established, resulting in USD 2,159 billion of green (and USD 710 billion of sustainability) bonds outstanding globally (Climate Bonds Initiative, 2023). A key benefit associated with the issuance of green bonds is the 'greenium,' a lower yield compared to a similar conventional bond and subject to credit quality. However, oversubscription rates continue to prevail for green issuances, frequently larger than for conventional bonds, while providing outperformance during volatile markets. Investors continue to establish dedicated green, climate or decarbonisation funds that specifically support the transition and decarbonisation of the real economy[23].

When it comes to climate adaptation at scale, supranational, sovereigns and agencies (SSAs) are major issuers in the green bond market and account for nearly 42% of the sustainable bond issuance[24]. For instance, in May 2023, the Asian Infrastructure Investment Bank issued its first Climate Adaptation bond, a thematic bond issued under the AIIB Sustainable Development Bond Framework. The five-year bond raised AUD 500 million, and the proceeds will be allocated to projects that have an estimated climate adaptation finance portion of 20% or greater of the total project financing[25]. Separately, in October 2023, the Dutch government continued its successful issuance of sovereign green bonds by raising almost EUR 5 billion, with the proceeds flowing towards flood risk management, dyke building and other adaptation investments[26].

[22] https://www.bankofengland.co.uk/stress-testing/2022/results-of-the-2021-climate-biennial-exploratory-scenario
[23] Information from NatWest
[24] https://www.environmental-finance.com/content/downloads/sovereigns-supranationals-and-agencies-%28ssa%29-in-the-sustainable-bond-market.html
[25] https://www.aiib.org/en/news-events/news/2023/AIIB-Issues-First-Climate-Adaptation-Bond-Targeting-Resilient-Infrastructure.html
[26] https://english.dsta.nl/documents/publication/2023/05/26/green-bond-report-2022 & https://english.dsta.nl/news/news/2023/10/17/new-20-year-green-dsl-2044-raises-€-4.98-billion

The UK Government also uses green bonds to fund adaptation. In the summer of 2021, the UK Debt Management Office published its Green Financing Framework to describe how the UK Government plans to finance expenditures through the issuance of sovereign green bonds (green gilts) needed to tackle climate change. As set out in the Framework, the money raised by the green gilts will be used to finance expenditures in clean transportation, energy efficiency, renewable energy, pollution prevention and control, living and natural resources, and climate change adaptation. These green gilts are sold to institutional investors and provide a fixed rate of return until their expiry.

The UK's inaugural green gilt is a 12-year bond, maturing on 31st July 2033. This inaugural 12-year green gilt was launched via syndication in September 2021. A second green gilt was launched in October 2021, also via syndication. Green gilt issuance for the financial year 2021-22 raised a total of £16.1 billion (cash)[27]. In October 2021, NatWest acted as Joint Lead Manager on the UK Debt Management Office's second green gilt, the longest-dated sovereign green bond currently outstanding in the market, globally. Investor orders for the £6 billion green gilt, which matures in July 2053, making it the longest-dated sovereign green bond currently outstanding in the market, rose to over £74 billion. The bond, which will finance projects such as offshore windfarms, zero-emission buses, and schemes to decarbonise homes and buildings, carries a coupon of 1.5%. The yield on the green gilt was set one basis point lower than that on the referenced 2052 non-green gilt[28].

The proportion of allocation of the green gilt issuances towards adaptation amounted to 13% in 2021-2022, flowing towards flood and coastal erosion risk management programmes. Funding for flood defences is allocated and managed across a six-year flood investment programme, to develop around 2,000 new flood defence systems and reduce national flood risk by 11% over the current programme, which runs from 2021 to 2027[29].

NatWest as Underwriter for €500million Nederlandsche Waterschapsbank green bonds[30]
In November 2022, NatWest Bank acted as a joint bookrunner for a five-year green 'Water Bond' by the Nederlandse Waterschapsbank (NWB Bank), a bank of and for the Dutch public sector, 100% owned by the Dutch state and local authorities. NWB Bank uses the proceeds from Water Bonds to provide loans to the Dutch water authorities (who are responsible for flood protection, water management and water quality), for whom climate change adaptation has become one of their key tasks. NWB's Water Bonds are considered 'Dark Green' by the Norway-based Center for International Climate Research (CICERO), meaning they are consistent with the aim of creating a low-carbon and climate-resilient future[31].

NWB Bank sought to issue a five-year Water (green) Bond – its first for 2022 – and turned to NatWest to support the transaction as a joint bookrunner. NWB Bank opted for a deal size of €500 million and set the final coupon at 2.75%. The proceeds will go towards flood protection across the Netherlands, as mentioned above, with the green indicator (=impact metric) being "[kilometres] of regional flood defences that meet safety standards"[32].

The risk profile of such investment is the same as a conventional bond because the credit rating is the same and there is no difference in pay-out. When it comes to returns for the €500m bond, the coupon was 2.75%.

[27] https://www.dmo.gov.uk/responsibilities/green-gilts/
[28] https://www.natwest.com/corporates/about-us/case-studies/uk-government-s-second-green-gilt-raises-further-6-billion-for-decarbonisation-projects.html
[29] https://assets.publishing.service.gov.uk/media/5f1adc7dd3bf7f596b135ac8/flood-coastal-erosion-policy-statement.pdf, https://www.dmo.gov.uk/media/yxtnpt5l/pr260922.pdf & https://assets.publishing.service.gov.uk/media/651446cdb1bad4000d4fd916/HMT-UK_Green_Financing_Allocation_Impact_Report_2023_Accessible.pdf
[30] Case study based on information from NatWest, https://www.natwest.com/corporates/about-us/case-studies/supporting-nederlandse-waterschapsbank-with-its-first-water-bond-of-the-year.html and the following document: https://www.smithschool.ox.ac.uk/sites/default/files/2023-01/Case-studies-in-adaptation-finance.pdf
[31] https://nwbbank.com/en/investor-relations/water-bonds
[32] https://nwbbank.com/application/files/1316/8674/0640/Waterbond_Report_2022.pdf

Case Study 2: Brunel Pension Partnership – The Greenhouses

Key Takeaways

- The Greenhouses is a project that demonstrates that adaptation benefits (such as reduced water scarcity through reduced water consumption) are often delivered as an integral part of mitigation and/or nature projects.
- Predictable cash flows of bioenergy assets from rentals and Government funding (UK Renewable Heat Incentive payments) offer attractive risk-adjusted returns and portfolio diversification as part of the pension fund's private markets and real assets portfolio.
- Such multi-benefit adaptation/mitigation projects could be financed more widely by other asset owners across the UK.

Picture: One of the greenhouses in Norfolk, UK

Brunel Pension Partnership (Brunel), formed in 2017, manages the investment of the pension assets (around £35bn) of ten Local Government Pension Scheme funds in the UK. Brunel recognises its role as an investor in tackling climate change, and is committed to reaching net zero by 2050 and developing a climate policy by 2030 to guide its investment approach.

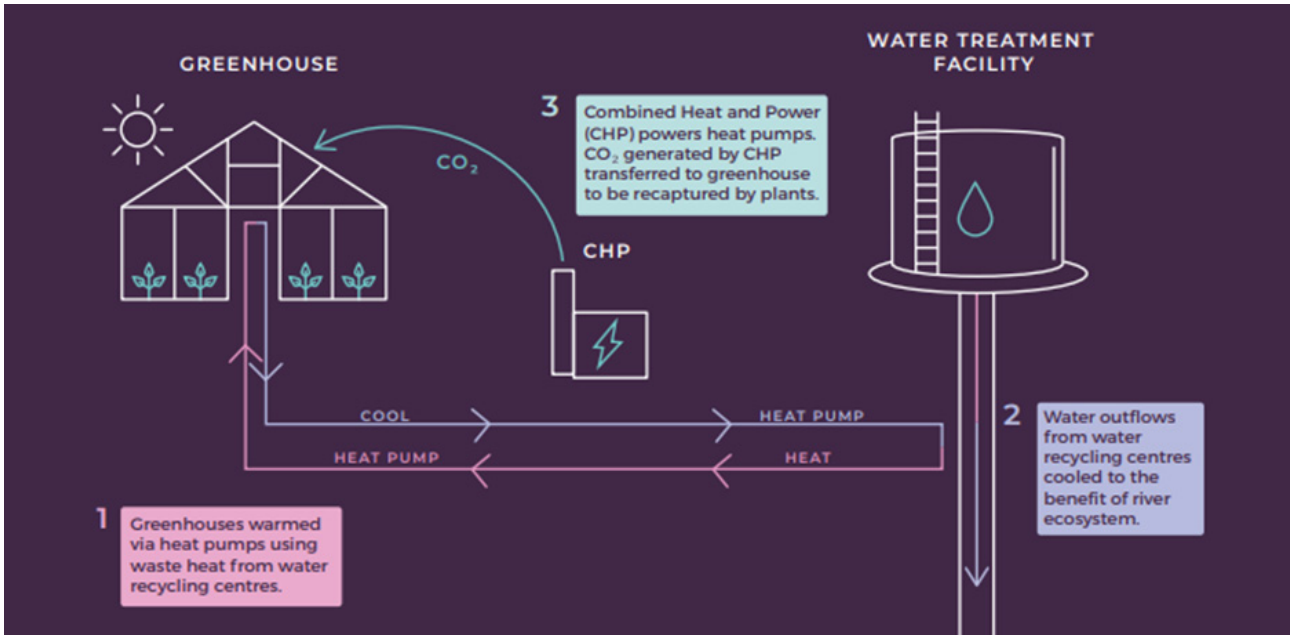
On behalf of its clients, Brunel chose Greencoat Capital's "GRI" fund for its Secured Income Portfolio. As part of this fund Brunel, along with others, invested £120 million in the project led by Oasthouse Ventures[33] (a pioneering company in sustainable agriculture) to build large-scale vertical greenhouses using waste heat created by the nearby sewage treatment plant. At inception, Brunel and their clients benefitted from long-term fixed price inflating contracted revenue; Government-backed CPI linked non-domestic Renewable Heat Incentive (RHI) tariff and long-term leases with leading agricultural growers[34].

The project involved constructing greenhouses spanning an area equivalent to forty-seven football pitches in Norfolk and Suffolk. The greenhouses are majority heated through heat exchange from nearby sewage treatment plants. Inside the energy centre at the nearby water treatment plant, once the water has been processed and heat exchanged, clean water is released which is 6 degrees above ambient temperature. The energy centre uses heat pumps to boost this to 50 degrees Celsius. This water is then used to heat the greenhouse. The cooled water is then released and is better for local ecosystems. The heat pumps are powered by electricity generated from gas-fired combined heat and power plants. The CO^2 produced in this process is stored in a giant cylinder and used to feed the plants.

[33] https://www.brunelpensionpartnership.org/2020/10/23/investing-in-giant-greenhouses-to-cut-emissions-and-create-jobs/

[34] The Non-Domestic Renewable Heat Incentive (NDRHI) is a government environmental programme designed to increase the uptake of renewable heat to help reduce carbon emissions and meet the UK's renewable energy targets. The Department for Energy Security and Net Zero (formerly the Department for Business, Energy and Industrial Strategy) closed the NDRHI scheme in Great Britain to new applicants on 31 March 2021

In addition, rainwater is collected from the roof. Last year, this provided all the water needed for the plants. There are hives on site which provide for the bees that pollinate the plants.



Picture: Treated water, warmer greenhouses: The energy loop[35]

The aim was to increase domestic tomato production by 10%, reduce greenhouse gas emissions by 75%, and minimise water consumption. This project contributes to climate adaptation by indirectly dealing with water scarcity, an issue increasingly threatening the UK. The farming method implemented in the greenhouses requires less water than traditional farming practices, and the closed-loop water circulation system eliminates wastage, ensuring efficient water usage and conservation. These efficient measures significantly decrease water usage, which is crucial for sustainability, especially in regions facing water scarcity.

The implementation of the greenhouses led to other significant benefits for the environment, economy, and local communities. The project created 137 permanent jobs in Norfolk and Suffolk, with an additional 117 seasonal worker roles. By boosting domestic tomato production, the UK became less reliant on imports, reducing the need for transporting food across long distances and cutting associated carbon emissions. The farming method (aided by screens) reduced pesticide usage, making the production process more environmentally friendly.

Brunel invested in this project through Greencoat Renewable Income LP (GRI), part of its Secured Income Portfolio. GRI is a closed-ended private markets fund and offers institutional investors the opportunity to invest, through one vehicle, in a diversified portfolio of UK renewable infrastructure assets delivering predictable sterling cashflows with significant inflation protection. Investments include solar, wind and bioenergy, with selected other green infrastructure opportunities like renewable heat.

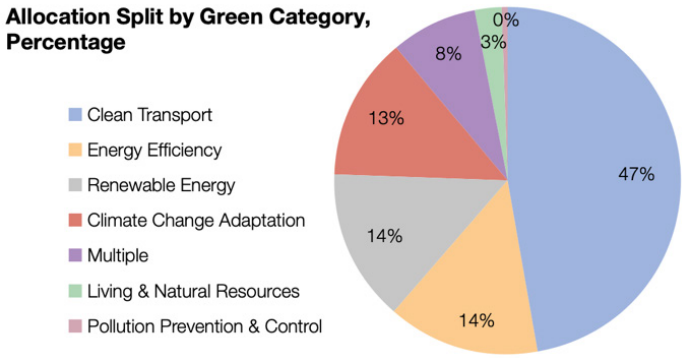
GRI is part of two long-lease property funds with strong sustainability credentials (in particular, GRESB scores and BREEAM ratings) from the Brunel Secured Income portfolio allocation. The objective is to provide a higher yield than index-linked gilts and corporate bonds, with the added benefit of this yield rising with inflation or being subject to fixed uplifts over time[36]. The focus is on investments with asset backing (contractually fixed or otherwise), secure cash flows (with some inflation linking), and limited economic or operating exposure. Investment is made in relatively lower-risk equity (e.g. without excessive leverage), or in long-dated debt instruments (largely private direct lending).

[35] https://www.brunelpensionpartnership.org/wp-content/uploads/2023/03/Brunel-Climate-Stocktake-Report-1.pdf
[36] Brunel Pension Partnership Limited Annual Report & Financial Statements 2022

Case Study 3: Aviva Investors - Glen Dye Project[37]

Key Takeaways

- This private equity project for tree planting and peat bog restoration is a further example of a dual/ multi-benefit project. Returns are generated from carbon credits. It was funded through the company's Climate Transition Fund.
- The adaptation benefits are delivered through ecosystem restoration that, in turn, reduces water scarcity through on-site water management, and control of flood risk in the area. Such nature-based adaptation projects generating carbon credits are being funded elsewhere in the UK and could be scaled further.



In 2019, Aviva Investors, a leading insurance and pension fund-backed asset manager, partnered with Scottish forestry fund manager Par Equity to acquire the 6300-hectare Glen Dye site in Scotland. The project's main objective was to rejuvenate the landscape by planting trees and restoring degraded peat bogs, thereby removing carbon from the atmosphere. Part of Aviva Investors' Climate Transition Fund, the project aims to address climate change by targeting carbon sequestration through peatland restoration. The fund aims to deliver an overall GBP return (net of fees) of 8% per annum on a rolling five-year basis. With over 70% of Scotland's peatlands damaged and releasing carbon, the initiative plays a crucial role in restoring these ecosystems, benefiting both the environment and local communities. Though the primary focus of Aviva's Climate Transition Fund is on clean energy, green buildings and broader climate solutions, the Glen Dye project also brings adaptation benefits. It enhances woodland recreation, and on-site water management, and contributes to controlling flood risk in the area. While not the main criterion for investment, its societal and environmental advantages enhance its appeal.

In the short term, the Glen Dye project involves low-level investments, such as tree planting, which generate carbon credits. These credits can be retained within the Climate Transition Fund, offering financial benefits and supporting the fund's long-term growth objectives. As the investment matures, it will yield returns from timber sales and the sale of carbon credits, making it a sustainable venture for Aviva Investors' clients (typically pension and insurance asset owners). The Glen Dye project highlights the need for both commercial and governmental involvement to generate income and support adaptation initiatives.

By investing in carbon removals of this nature, asset owners can benefit from a supply of high-quality carbon credits which, if retired and sold, generate a return on investment as well as create a hedge against future carbon prices. Projects based in the UK also benefit from a comparatively-safe legal and climate risk environment, versus similar schemes in emerging markets.

Aviva Investors' Climate Transition Fund is targeting risk-adjusted returns - 8% IRR net of fees over rolling five-year periods in this innovative fund structure – while contributing to both Scottish and UK forestry planting targets. It also forms part of its commitment to achieving net zero across the entirety of its Real Assets platform by 2040. In March 2021, Aviva plc announced its plan to become a net zero carbon emissions company by 2040, one of the most demanding targets of any major insurance company in the world.

[37] Case study based on https://www.avivainvestors.com/en-gb/about/company-news/2021/12/ai-par-equity-scottish-woodlands-natural-capital-project/ and Edward V. Dixon

Case Study 4: Portsmouth Water and UK Infrastructure Bank – Havant Thicket Reservoir[38]

Key Takeaways

- Adding a resilient angle to the ESG considerations is key; UKIB's approach is innovative and pioneering and should be used as a foundation. This multi-investor project used blended finance for reservoir infrastructure in a severely water-stressed part of the UK.
- The UKIB are mandated to help the UK tackle climate change and will continue to facilitate the financing of further adaptation-focused projects, such as this one.

The UK Infrastructure Bank is the government-owned policy bank launched in June 2021, providing £22 billion of infrastructure finance and partnering with the private sector and local government to finance a green industrial revolution and drive growth across the country[39].

The Havant Thicket water project involves the construction of the first reservoir in the UK in 30 years and is aimed at enhancing the resilience of water supply systems in Southern England. Portsmouth Water, in collaboration with the UK Infrastructure Bank (UKIB), secured a total investment of £339 million, with UKIB providing £50 million through Senior Debt.

The UK government recognises the growing significance of water sector resilience due to climate change and population growth. The South East region, categorised as "seriously water stressed" by the Environment Agency, necessitates actions to secure water resilience, including the construction of new reservoirs. Thus, this water project aligns with UKIB's priority sectors, emphasising climate resilience.

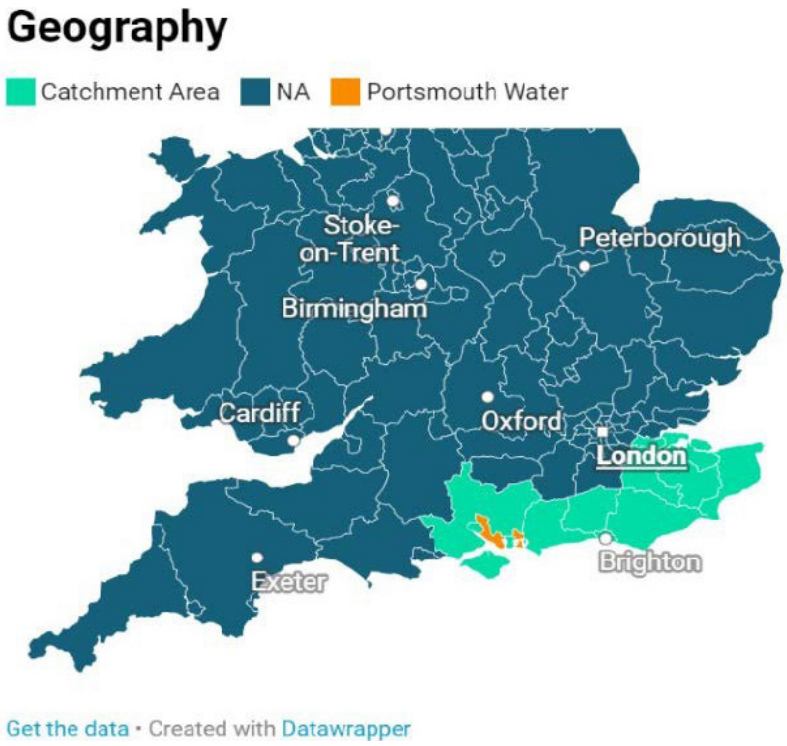


Figure: Geography of the project

The project is worth £340m, and will span 160 hectares between Leigh Park, Havant, and Rowlands Castle in East Hampshire. It mobilised £165m in private finance, which demonstrates its viability and attractiveness to investors. The banks giving their support to the environmentally-driven scheme include existing lenders ING, Lloyds Bank, NatWest, abrdn, Assured Guaranty, Pension Insurance Corporation and Siemens Financial Services (through Siemens Bank). This is in addition to the equity commitment of £150m from existing shareholders, Ancala Partners. This project is the first example of the forthcoming Direct

[38] This case study is based on https://www.ukib.org.uk/uk-infrastructure-bank-invest-ps50m-first-uk-reservoir-be-built-1980s and information from Peter Knott, Iliana Lazarova, Sefret Cela

[39] https://www.ukib.org.uk/about-us

Procurement for Customers regulation[40], a process for water companies to competitively tender for a third-party to design, build, finance, operate and maintain infrastructure.

The Bank's funding will enable Portsmouth Water to start construction of the reservoir which will, once completed, allow the water company to provide up to 21 million litres of water to neighbouring Southern Water Services to help bolster its supply - particularly important in times of drought. By increasing the water supply by up to 21 million litres per day, the project directly benefits 160,000 customers within the catchment area. Additionally, 84 jobs have been created through this and emissions saved to 138 200 tCO^2e.

Public consultation and environmental impact assessments have influenced the design, including redesigned vehicle access; new wetlands areas; replanting/improving 110 hectares of woodland; new footpaths and improved specifications; and greening of soft landscaping. UKIB also conducted an environmental assessment, using its ESRG (environmental, social, resilience and governance) considerations framework[41]. This framework was developed internally by the UKIB team based on best practices from both private and public markets and is meant to guide UKIB in managing any materially important ESRG risks and opportunities in their portfolio.

Case Study 5: Thames Water - Tideway - Thames Super Sewer Tunnel

Key Takeaways

- This sewer tunnel project uses private equity, green bonds and the UK Government in a regulated asset-based (RAB) model. Tideway collects inflation-linked revenue from Thames Water's wastewater customers. Enhancing the sewer network's resilience to climate change is an adaptation benefit.
- Multiple benefits are provided by this project, including improved safety standards in the industry and economic benefits. The RAB model could be used for many other adaptation projects involving multiple parties across the UK or in other infrastructure projects, such as nuclear plants.

The Tideway Tunnel, now 90% complete, is a 25-kilometre sewer tunnel set for completion in 2025 spanning through London. London relies on a 150-year-old sewer system built for a population less than half its current size which leads to millions of tonnes of raw sewage spills – untreated – into the Thames each year. The tunnel is expected to capture around 95% of the current overflow volume, reducing individual overflow from more than fifty events to fewer than four per year. Apart from improving water quality which delivers health benefits, the tunnel also enhances the sewer network's resilience to climate change and population growth for at least the next 100 years. Tideway's broader objectives include boosting the river economy, increasing job opportunities, and raising safety standards. The Legacy Plan consists of 54 commitments in areas of the environment, health & safety, economy, and people. It has been estimated to generate a social value of £1.72 for every £1 invested in the legacy programme.

Tideway's delivery model involves collaborations with key stakeholders to align its risk profile with that of a regulated water company. A support package provided by the UK Government during construction provides contingent public financial support under specific circumstances, providing Tideway more certainty than its peers. The company benefits from a fixed weighted-average cost of capital (WACC) until 2030.

[40] https://www.ofwat.gov.uk/regulated-companies/markets/direct-procurement/direct-procurement-for-customers/
[41] https://www.ukib.org.uk/sites/default/files/2023-05/UKIB-ESRG-Framework-2023.pdf & https://www.ukib.org.uk/climate-resilience-focus

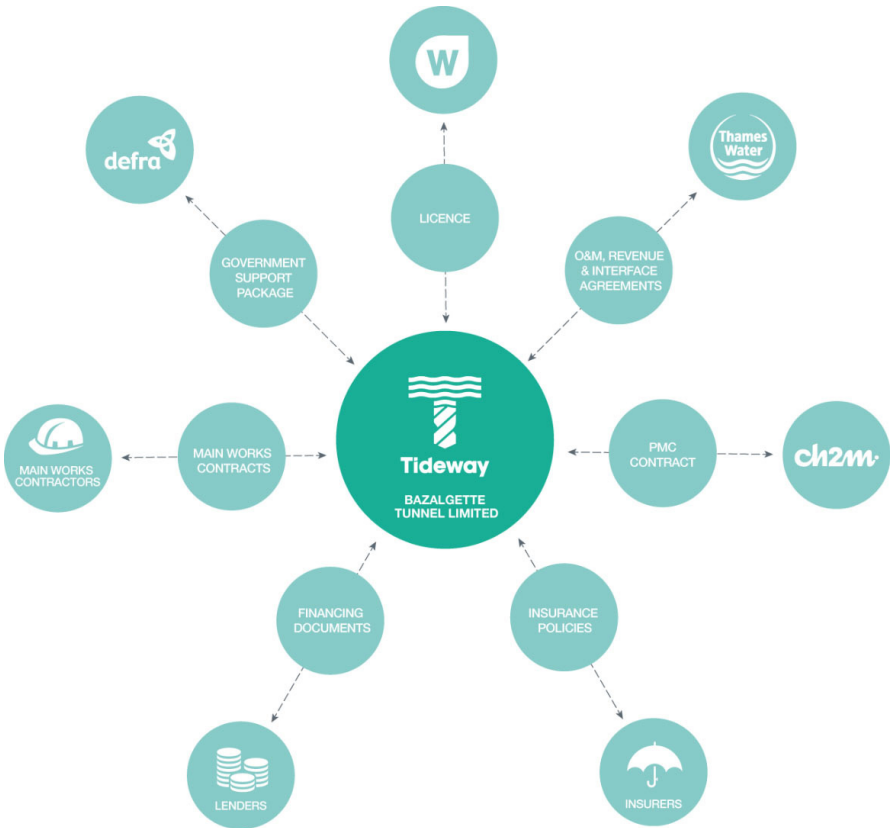


Figure: Tideway's delivery model

As a regulated utility company by Ofwat, Tideway has collected inflation-linked revenue from Thames Water's wastewater customers since its beginning. Thames Water's 15 million wastewater customers are paying for the Thames Tideway Tunnel through their bills, with the process for setting customer bills determined by Ofwat. For instance, in 2019/20 the bill includes £19 for the tunnel, and this will eventually rise to no more than £25 a year, before inflation. This model, a variant of the regulated asset-based (RAB) model, enables investors to share in some of the project's construction and operating risks with consumers, lowering the cost of capital, and resulting in risk-sharing between investors and consumers. The strong creditor protections, a stable regulatory regime (allowing for predictable cash flows and further enhancements), having a revenue stream from day one, and the government support package have all underpinned Tideway's strong credit rating and supported its financing strategy, as well as the successful overall delivery of the project. The benefits of the Tideway delivery model have been widely recognised. There are compelling arguments in favour of it being replicated elsewhere, such as in nuclear projects.

The tunnel's cost to complete is £4.5 billion. Tideway employed an "equity-first approach" and attracted £1.3 billion in private equity investment by a consortium of infrastructure investors and insurance companies, including Allianz, Amber Infrastructure and Dalmore Capital, benefiting 2.7 million UK pensioners. Additionally, Thames Water provided £1.1 billion for the preparatory construction works and the cost of the integration of the Tideway tunnel in their sewerage network.

Tideway has aligned its debt financing with the company's sustainable mission. It has issued £2.3 billion of sustainable debt through eighteen green bonds, a sustainability-linked revolving credit facility with KPIs linked to Legacy targets, and two green US private placements. The green bond issuance made Tideway the largest corporate issuer of green bonds in sterling at the time in 2017, contributing to the growth of the UK sustainable debt market. Tideway's activities fall into the ICMA Green Bond Principles[42] use of proceeds for 'pollution, prevention and control' and 'sustainable water and wastewater management.'
Once completed, Thames Water will operate the tunnel as an integral part of the London sewerage network, while Tideway will be responsible for its day-to-day maintenance and inspection.

Sources: Tideway documents; Elina Beale, Head of Treasury at Tideway

[42] https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles_June-2022-280622.pdf

Case Study 6: Craigleith Retail Park – Blended Financial Instruments for NbS in Edinburgh

Key Takeaways

- This case study developed a proposal for a revolving fund that monetises savings in wastewater treatment and stormwater drainage, as well as increased property values and rental yields.
- While the financial benefits were not exceptionally high, the project demonstrated the financial viability of blended finance for urban nature-based solutions (NbS) and laid the groundwork for future similar projects in privately-owned assets.

Craigleith Retail Park is a small retail park located to the west of Edinburgh City Centre. It is 182,180 square feet and receives over 30,000 visitors weekly. The site, which includes the land and buildings, is owned by Nuveen Real Estate (who are owned by the Teachers Insurance Annuity Association (TIAA)). Nuveen has over USD 1.1 trillion under management, with the Craigleith site sitting as part of their overall real estate portfolio. In this instance, the fund in which the asset sits is capitalised by external investors.

Scottish Water and the wider partnership ecosystem of public sector actors provided financial support to Nuveen to develop a new concept design for the site, seeking to reduce the impacts on the drainage system, as well as realise the wider benefits of blue-green infrastructure. In terms of the finance case study, the starting point for this has been different from many adaptation studies, as the site is in private sector ownership and the car park is reaching the end of its asset.

As part of the Adaptation Scotland programme, Sniffer on behalf of Edinburgh City Council commissioned Paul Watkiss Associates (PWA) to undertake an urban adaptation finance case study. The £15k case study explored the potential for financing a nature-based solution (NbS) to address surface water flooding alongside resurfacing a car park, rather than standard resurfacing work, at Craigleith Retail park in Edinburgh using an innovative, blended public-private instrument. The work explored and prioritised a range of potential sources and revenue streams, leveraging both public and private finance and investment and quantified the economic benefits and potential revenue streams from the proposed design. PWA also investigated the role of current climate-related financial disclosure commitments and considerations of the asset owner in strengthening the strategic case for financing.

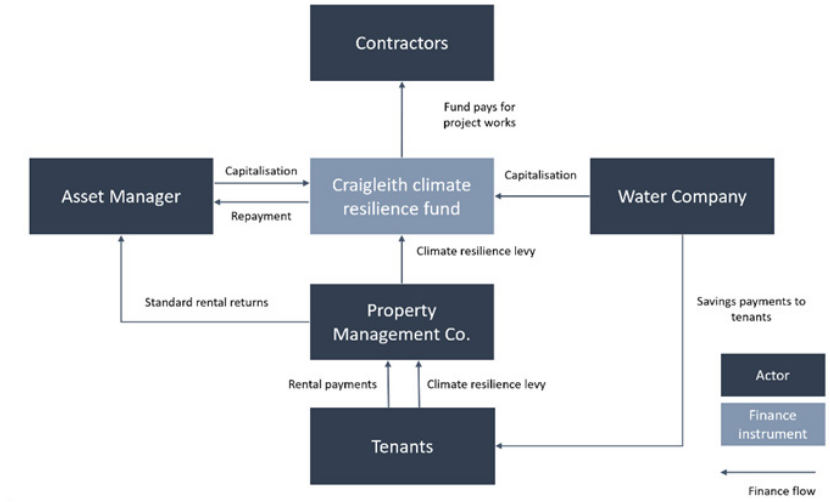


Figure: Craigleith Climate Resilience Fund Overview. Source: England, Watkiss and Hunt, 2023

These tasks were used to develop a proposal for a revolving fund, which monetises the savings in waste-water treatment and stormwater drainage, along with the co-benefits of increased property values and rental yields. The proposal was developed into an Outline Business Case in line with the Treasury Green Book Case, setting out the strategic, economic, financial, commercial and management cases, and undertaking a Cost-Benefit appraisal. It also undertook appraisal from a private sector perspective (IRR and NPV). Whilst the appraisal showed the financial benefits are not high, the planned intervention would deliver

a range of additional benefits compared to the business-as-usual option of resurfacing the car park, and the scheme had a positive Net Present Value over a 30-year investment period. Although the project has not been taken forward, the work has proven the financial viability for blended finance for urban NbS, and laid the foundations for further rollout of similar NbS projects in privately-owned assets.

Source: England, Watkiss and Hunt, 2023.

Case Study 7: Canary Wharf Real Estate: Making Urban Development More Climate Resilient[43]

Key Takeaways

- Brookfield Corporation and Qatar Investment Authority (a major asset manager and sovereign wealth fund, respectively) are the investors in Canary Wharf Estates the largest urban regeneration project ever undertaken in Europe.
- Canary Wharf's real estate development undertook an ecosystem valuation as part of its Biodiversity Plan to demonstrate the intrinsic value of natural capital and identify the most effective forms of investment in green infrastructure: street trees, accessible amenity space, or biodiverse roofs.

Canary Wharf Group plc (owned by Brookfield Property Partners and Qatar Investment Authority - thereafter 'CWG') is the holding company for the real estate developer 'CWG', which has overseen the Canary Wharf Estates (the Estate), the largest urban regeneration project ever undertaken in Europe. As of year-end 2021, it had a portfolio fair valuation of £8.5 billion, owned 37 properties and delivered over 20 million sq. ft. of sustainably-certified space (BREEAM and Code for Sustainable Homes).

To better understand the ecological value of the Estate, CWG published a 'Biodiversity Action Plan 2018-2028' (BAP) in 2018. In April 2022, CWG announced a partnership with the Eden Project, to create a model of how biodiversity can thrive in urban environments. Under the partnership, parks and gardens will be expanded, new terrestrial and marine plants will be added, and waterside access improved[44].

The three key objectives for the Estate as per the Biodiversity Action Plan (hereinafter "BAP")[45] are:

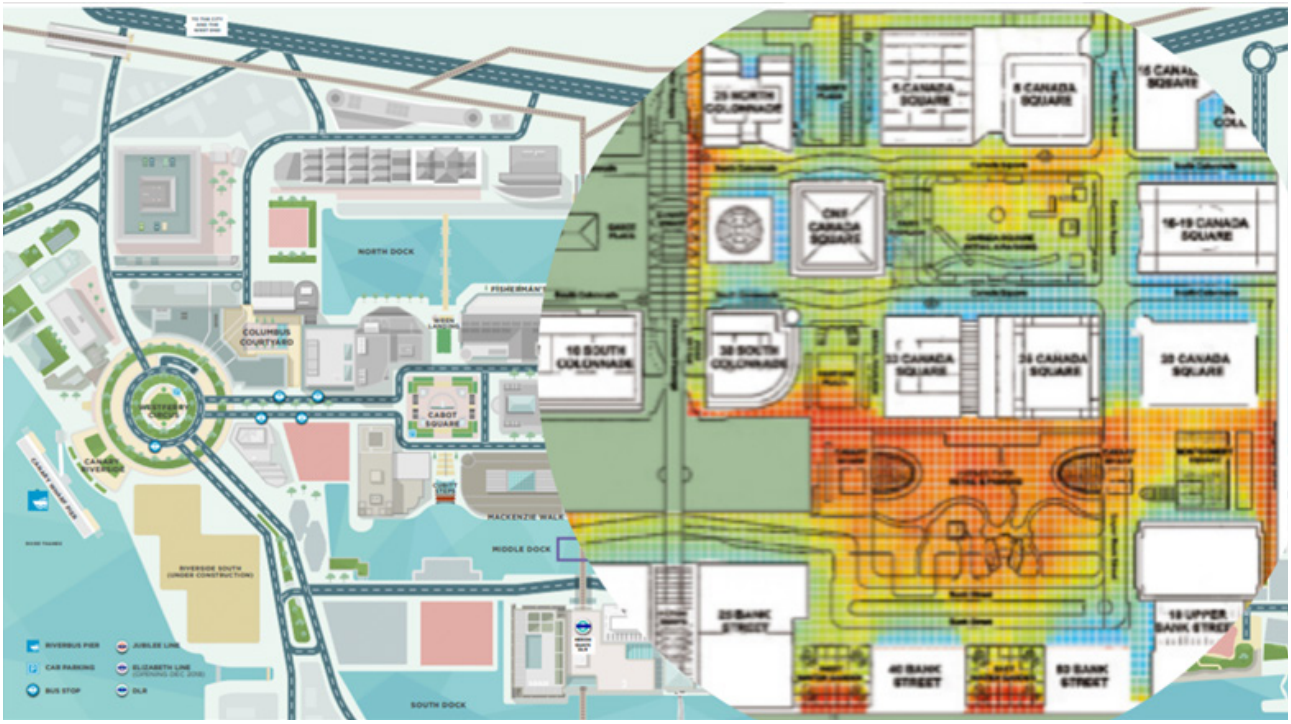
- Objective 1: Embed the biodiversity 'net gains' principle within management and planning decision-making across the Estate;
- Objective 2: Develop and apply actions for climate change resilience; and
- Objective 3: Improve ecosystem service value and in particular health, well-being, and productivity of Estate users.

Biodiversity net gain is an approach to development that leaves biodiversity in a better state than before. This will be calculated through the application of metrics to establish changes in biodiversity value, comparing pre- and post-development conditions. Progressive green infrastructure design standards are provided to help achieve this target, with an overall 75% increase in green infrastructure targeted over the lifetime of the BAP. This approach is integrated into the London Plan published in March 2021 and the update to the National Planning Policy Framework published in September 2023[46].

Climate change resilience was one of the main objectives of the BAP. A 3D model was used to analyse the conditions of the Estate and to predict climatic conditions over the next 60 years, including future Urban Heat Island (UHI) effect at ground and roof levels of key buildings. This gives an accurate long-term view of the different climatic conditions across the site and serves as a reference for decision makers considering the wider recommendations of the design principles. In areas where high heat stress is indicated, informed decisions regarding drought resistant planting and climate change resilient species can be made and implemented. This also ensures that the well-being of visitors to the Estate is not compromised by the changing climate conditions.

[43] This case study expands on findings from Holtedahl, P., Köberle, A. and Koci, I. (2023) Corporate action on biodiversity - an exploration of drivers, Centre for Climate Finance & Investment Imperial College Business School.
[44] Canary Wharf Group and Eden Project partner to boost urban biodiversity - edie
[45] https://group.canarywharf.com/wp-content/uploads/2021/04/canary-wharf-esg-biodiversity-action-plan-2018-2028-summary.pdf for the Ecosystem Service Valuation in financial terms, refer to the full BAP report.
[46] the_london_plan_2021.pdf. The spatial development strategy for greater London; National Planning Policy Framework - Guidance - GOV.UK (www.gov.uk)

The image below shows the Urban Heat Island model of Canary Wharf:



CWG recognises the significant role that sustainable finance plays in channelling investments towards sustainable activities and has issued its inaugural £906.3 million green bond in April 2021. To broaden its sustainable finance scope, CWG has decided to establish this Sustainability-Linked Financing Framework[47] developed by the Loan Market Association (LMA) and the International Capital Markets Association's (ICMA) Principles[48].

As pointed out in Holtedahl, P., Köberle, A. and Koci, I. (2023) Canary Wharf's voluntary undertaking of the BAP was driven by adaptation considerations and stakeholder relations, potentially resulting in loyal tenants making revenue streams more resilient. According to the same study there is a need to nudge or incentivize investors and real estate developers to replicate Canary Wharf's biodiversity actions elsewhere.

Case Study 8: Westminster Green Investment Scheme to Support Local Green Projects and Tackle Climate Change

Key takeaways

- Westminster's Green Investment provides the council with the investment needed to address the climate emergency and provides residents with the opportunity to support their local council in taking climate action, while also earning a financial return
- The Westminster Green Finance Framework aligns with the International Capital Market Association (ICMA) Green Loan/Bond Principles, the UK Government Green Gilt, Green NS&I Bond programmes, and objectives of the forthcoming UK Green Taxonomy.
- Westminster's Green Investment uses Green Loan Authority Security (commonly known as a Community Municipal Investment)
- The total cost of money for Westminster was 30 basis points below the PWLB Certainty rate, making it the cheapest form of debt available to the council. The funds were raised in 9 days.
- Green Municipal investments can become a more widespread and regular part of an investor's portfolio.

[47] Sustainability-linked Financing Framework August 2022: canary-wharf-group-sustainability-linked-financing-framework-aug-2022.pdf (canarywharf.com)
[48] https://www.lsta.org/content/sustainability-linked-loan-principles-sllp/ 14 ICMA SLBPs (June 2020) and June 2022 'Illustrative KPIs registry' – https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/sustainability-linked-bond-principles-slbp/

Westminster City Council (the "Council") is one of 33 unitary London boroughs within the Greater London area covering just over eight square miles and is situated on the north bank of the River Thames. The council released the Climate Emergency Action Plan in November 2021 in response to high carbon emissions and severe air pollution in the UK.

One of the main priorities of the Climate Plan is to enhance the natural environment and ensure the city is resilient to climate change impacts. Westminster's area includes parks and green spaces, comprising some 200 open spaces (both public and private) across the city. These areas play a significant role in acting as a carbon "sink" to remove carbon emissions from the atmosphere while at the same time supporting biodiversity and improving air quality and resilience.

Some of the main actions for nature and climate resiliency included in the Climate Plan are:

- maintain, plant and protect trees to support a long-term increase in tree canopy cover, targeting a 10% increase of existing cover by 2050, in line with Greater London Authority targets;
- inspire residents, communities, and organisations to increase tree planting on private land in support of the 'Queen's Green Canopy' campaign for the Platinum Jubilee in 2022;
- by 2023, assess Westminster's green and open spaces to inform a Green Infrastructure Strategy;
- by 2023, develop a Climate Adaptation Plan (based on an understanding of climate-related risks and local and national climate adaptation activity) to protect Westminster's vulnerable people, businesses, services, assets, and green spaces from changes in climate and extreme weather events.

In March 2023 the Council, in partnership with ethical crowdfunding platform Abundance Investment, launched the Westminster Green Investment, an initiative that allows residents to invest in green initiatives within the local community. This supports the council's goal of becoming a net zero Council by 2030 and a net zero city by 2040[49].

The Westminster Green Investment (Tranche 1) raised £1 million. The ambition is to integrate citizen investment into Westminster's ongoing capital raising, so that an increasing proportion of the council's finance is sourced from residents over time. Residents and businesses can invest from as little as £5, and Tranche 1 pays 4.2% interest per year, across five years. The investment provides investors with regular payments consisting of both capital and interest every six months. Each payment encompasses both an interest component and a partial repayment of the initial investment made by the investors.

The rate and fees provided a total cost of capital 30 basis points below the PWLB Certainty rate the council's main source of borrowing. It is also 10 basis points below the rate offered by the UK Infrastructure Bank. Future Tranches will have different rates based on the market at the time. Investors have the option to donate their interest back to the council to fund additional green initiatives or hold it in an Innovative Finance ISA, which offers tax free returns.

Green Bond / Loan Principles – Green Finance Framework[50]

The model is prepared in compliance with the Green Loan/Bond Principles. To comply with these principles, the council published a Green Finance Framework. This sets out how the council intends to manage its green finance programme as well as the projects funded by the finance raised[51]. Funds raised from the Westminster Green Investment can only be used to help deliver Eligible Green Projects stipulated within this framework.

The instrument used in the programme is a Green Local Authority Security (GLAS) which can either be a crowdfunding bond or a P2P Loan Agreements. This mechanism is also known as a Community Municipal Investment.

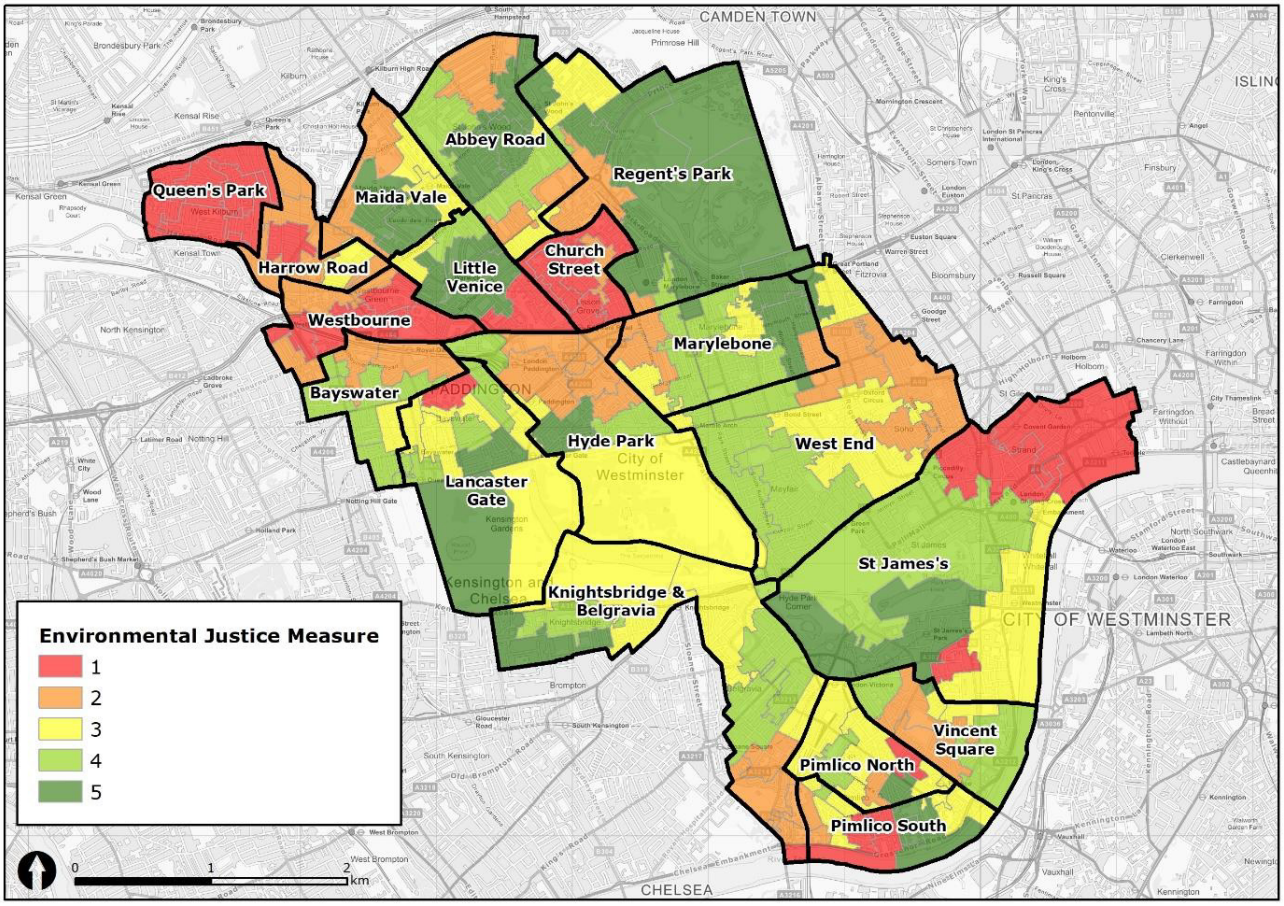
The Framework GLAS aligns with the International Capital Market Association (ICMA) 2021 Green Bond Principles (GBP) and Loan Markets Association (LMA) 2020 Green Loan Principles (GLP). They also follow the principles underpinning the UK Government's Green Gilt and Green N&SI saving bond products. These documents may be amended to align with the UK Government Green Taxonomy when it is published.

[49] https://www.westminster.gov.uk/news/new-green-investment-scheme-launched-westminster-support-local-green-projects-and-tackle-climate
[50] https://www.greenfinanceinstitute.com/wp-content/uploads/2023/10/GFI-LOCAL-CLIMATE-BOND-TOOLKIT.pdf
[51] https://assets.abundanceinvestment.com/docs/projects/green-finance-framework-docs/2023_03_09_GreenFinanceFramework_WestminsterCouncil.pdf

Abundance Investment Ltd provides templates for all the documents required to establish and issue a programme of GLASs, minimising the cost of issuance and time to execute a tranche. Once the Framework is established, it is estimated that a GLAS can be launched in under 30 minutes. Abundance will also ensure that the projects are funded by the Use of Proceeds spent on Eligible Green Projects.

Among eligible projects in relation to Climate Change Adaptation, the Framework includes:

- Schemes that deliver clean energy production, mobility and heating as well as energy efficiency.
- Schemes that deliver flood protection, resilience, and other risk mitigation programmes.
- Schemes that deliver heat protection, resilience, and other risk mitigation programmes.
- Engineering activities and technical consultancy dedicated to adaptation to climate change.



Picture: Environmental Justice Measure[52]

[52] https://www.westminster.gov.uk/about-council/data/environmental-justice-measure