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BIOFIN-EU

PROTECTING AND RESTORING BIODIVERSITY USING MAINSTREAM FINANCE

D5.1: Financial Institutions & Markets: Biodiversity Data Systems Capability

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Funded by
the European Union

Grant Agreement No.	101135476
Project Acronym	BIOFIN-EU
Project Title	Protecting and Restoring Biodiversity using Mainstream Finance
Type of action	HORIZON-RIA
Horizon Europe Call Topic	HORIZON-CL6-2023-BIODIV-01-9
Start – ending date	1 January 2024 - 31 December 2026
Project Website	biofin-project.eu
Work Package	WP5: Financial Instrument Design & Business Model Innovation
WP Lead Beneficiary	University of Limerick
Relevant Task(s)	T5.1 Stakeholder analysis to identify data bottlenecks; T5.2 Systems capability test for financial institutions
Deliverable type Dissemination level	R – Report PU: Public
Due Date of Deliverable	28 February 2025
Actual Submission Date	28 February 2025
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Document History

Date	Version	Changes	Contributor(s)
20/02/2025	V0.1	Review of first draft	Louis Powell (UM)

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Recommended citation

BIOFIN-EU; Garvey, J., Chervier, C., Corrigan, C., Clohessy, C. (2025), Biodiversity Finance: Financial Instrument Design and Business Model Innovation. BIOFIN-EU, Deliverable 5.1, pp. 1-48.

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Executive Summary

This report provides an overview of key functions within the global financial system and identifies where decision-making processes and systems can more effectively accommodate biodiversity data. The report integrates research efforts undertaken in the first year of the BIOFIN-EU project (January 2024-January 2025) and it encompasses the development of baseline knowledge gathered through literature reviews and stakeholder analyses. The analysis has been undertaken at the level of individual products (financial instruments) as well as at the organization and system-wide level.

The design of fixed income securities (bonds) and their capacity to channel mainstream finance towards protection and restoration projects is analysed in Chapter 2. The potential for improved data systems to facilitate impactful regulatory interventions is noted in the context of agricultural commodity trading is also noted in this Chapter. Chapter 3 details the procedures and decision-support tools that are used in bank lending. Specific attention is paid to financial institutions that apply 'green' criteria to their lending procedures and adoption pathways to direct finance towards protection and restoration actions are proposed. Chapter 3 also provides a short overview on asset exclusion and ranking procedures used by institutional investors in seeking to undertake nature-positive investments.

The systems within which individual investors allocate capital to savings and investment are outlined in Chapter 4 and is used to motivate upcoming research on preferences and behaviour. Chapter 5 draws on the economics of market design to understand the adoption pathways for an industrial sector to invest in Nature-based Solutions (NbS). It attends to the challenge of excess nutrients arising from intensive agriculture and how NbS are envisaged as a solution to overproduction. Public authorities and State-Owned Enterprises (SOEs) are important organisational forms that can help to redirect financial flows towards NbS. Chapter 6 provides an overview of the financial instruments that can be deployed in these settings and the implications for financial institutions and business model innovation are explored.

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Glossary of terms and abbreviations used

List of Abbreviations and Acronyms	
NbS	Nature-based Solution
WP	Work Package
OTC	Over the counter
FI	Financial institutions
NFC	Non-financial corporation

1. Introduction

The current report seeks to better understand the extent to which mainstream finance can accommodate biodiversity data within its decision-making procedures. The report considers mainstream finance as those financial flows that take place across core functions within the financial system; that is, financial intermediation (lending), investment and savings decisions by financial institutions (FIs) and individuals and corporate finance. The analysis is undertaken across product, organisational and systemic levels of the financial system and acknowledges the contested and fluid context for the report, in particular the changing political environment as well as the unresolved regulatory frameworks around corporate disclosures.

1.1. The Global Financial System

Despite overwhelming evidence of the global decline in Nature, the financial system continues to allocate economic resources in a way that intensifies the use of biodiverse ecosystems. Recent EU achievements in introducing environmental and financial regulation are an attempt to establish guardrails against the most observably destructive activity and demand higher levels of transparency among financial institutions and non-financial corporations (NFCs). However, efforts to redirect mainstream financial flows are encumbered by interacting political, economic, and informational barriers. While there is some (as yet sparse) evidence that attention on biodiversity loss and enhanced transparency on corporate impacts on biodiversity can influence investor decision-making (Garel et al., 2024), Nature remains a peripheral factor in the financial decision-making and is not typically considered in the design of lending or investment products (e.g. pension funds, ETFs, private equity) or financial marketplaces. The realpolitik of how the financial system functions is encapsulated in a recent study by Hsu et al. (2023) which shows that firms producing more toxic emissions are associated with higher subsequent stock returns and that constructing investment portfolios on this basis rewards investors.

Set against this reality, how should we best finance nature conservation and restoration projects? The intention behind reformist approaches is to improve how sustainable activity is defined (EU Taxonomy) and advance the transparency of corporate (CSRD) and financial (SFDR) activities. Financial flows are directed by networks of financial institutions and intermediaries that deploy decision-making tools and instruments that are ill-suited to integrating spatially explicit and complex risks that result from biodiversity depletion or assessing their impact on biodiversity. The current report examines data bottlenecks in the organisational structures and information systems used by financial market participants. We explore how these bottlenecks can be addressed so that financial institutions and capital owners can *substantially contribute* to Environmental Objective 6, the protection and restoration of biodiversity. In analysing the relevance of data bottlenecks and data systems, the report seeks to identify those enabling conditions that need to be addressed within the mainstream functions of lending and capital allocation.

1.2. Data Bottlenecks in Financial Institutions and Markets

Identifying the enabling conditions for the redirection of financial flows towards the protection and restoration of biodiversity requires a detailed view on the existing processes used by financial institutions and capital owners in lending and allocation decisions. The report thus focuses on operational issues for financial institutions, capital owners and how they can effectively allocate capital towards the protection and restoration of biodiversity. The term *data bottleneck* is used as a synonym for the more academic term *information problem*; when one party to a transaction holds information that is not available to the other party, and this asymmetry has an impact on the

characteristics of the transaction or post-transaction behaviours. Evaluating how biodiversity data can become decision-relevant information is particularly challenging in a financial system that is largely focused on more immediate concerns around risk and return. Conventional research methods in empirical finance frequently benefit from the availability of large volumes of data. Quantitative methods applied in conventional empirical finance are of less use when seeking to better understand the nascent topic of biodiversity finance. It is instead necessary to use a combination of often qualitative methods guided by knowledge of the financial system to identify those enabling conditions that exist and those that remain to be created if financial flows are to be redirected towards nature.

1.3. Contribution to the BIOFIN-EU objectives

The figure below locates the report as a link between the knowledge building phase of BIOFIN-EU and operational research that will seek to provide guidance on the processes and tools needed to account for the dependencies and impacts on nature. The findings and recommendations for future research in T5.3 and T5.4 are also informed by the wider research being undertaken across other BIOFIN-EU work packages.

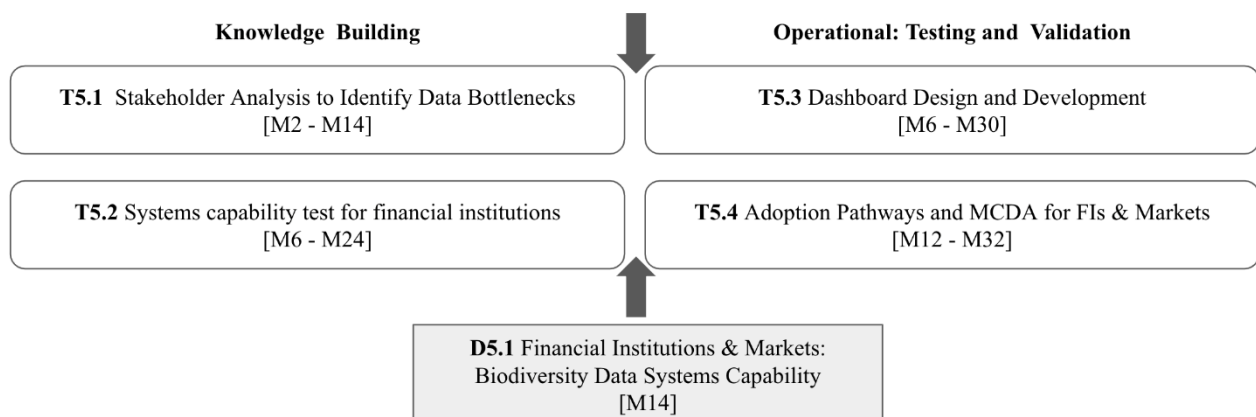


Figure 1: The current report (D5.1) is located at the end of Year 1 of the BIOFIN-EU project.

The report attends to mainstream finance and the major channels for financial intermediation and capital allocation. To structure the current report, we adopt the functional perspective to explore data bottlenecks at various *levels* of the financial system, namely at the level of financial products or instruments, at the level of the organisational and at a system level. Section 2 examines the role of financial instruments and recent approaches to using fixed income securities (bonds) in the context of restoration and protection activities. Section 3 details data bottlenecks and data systems at an organizational level in banks and fund management companies. Section 4 addresses data bottlenecks at a system level, drawing on new research into market design and technological barriers that impair the decision-making of individual and corporate investors as they relate to Environmental Objective 6 of the EU Taxonomy.

2. Financial Instruments

This section focuses on the analysis of debt-based financial instruments (bonds). A bond is a loan that the bond purchaser, or bondholder, makes to the bond issuer. Bonds constitute the dominant mechanism for the allocation of capital globally¹ and they have been used by both national and international governments, municipalities, and corporations to access capital. An investor who buys a bond is lending to the bond issuer. Like a loan, a bond pays interest periodically and repays the principal at a stated time, known as maturity.

This section concludes with a short comment on the global trade of physical commodities. The trade in commodities is streamlined through the design of global marketplaces and the efficient function of financial contracts and supply chain infrastructure. These create data bottlenecks that frequently mean that biodiversity impacts are often invisible to market participants. A research agenda is proposed to address these bottlenecks. Equity-based financial instruments and loans are considered as part of the *organisation level* research described in Section 3.

2.1. The Bond Market

The financial system can be viewed as an optimising machine that identifies and ranks investment and lending opportunities based on their risk and return characteristics (Crane et al, 1995). Against this dynamic backdrop, the functional perspective provides a framework for other domains to evaluate and critique the core functions of the financial system. Within this functional perspective, financial innovation is intended to identify and exploit inefficiency and therefore it directs the system towards 'greater economic efficiency' in which private capital flows through several channels, via instruments (e.g. equities, bonds), financial institutions and markets (Merton and Bodie, 1995, p.4). It should be noted that while innovation in how these functions are delivered, may improve efficiency (reduce costs and aid short term price discovery), there is no theoretical basis to expect that they increase welfare (Zingales, 2015). Indeed, the prioritisation of short-term gains above longer-term investments and the redirection of profits back into the financial sector can lead to reductions in welfare (Mazzucato, 2020). While the allocation of voting rights to shareholders can influence corporate decision-making on several important topics that affect firm value (e.g. capital structure, Myers (2000); executive compensation, Rajan and Zingales (2000)), its impact on mitigating the costs of corporate activity on nature remain questionable. The intention behind reformist approaches to sustainable finance is to improve how sustainable activity is defined (EU Taxonomy) and advance the transparency of corporate (CSRD) and financial (SFDR) activities. There is some (as yet sparse) evidence that attention on biodiversity loss and enhanced transparency on corporate impacts on biodiversity can influence investor decision-making (Garel et al., 2024) The functional perspective provides an operational view on how the financial system functions and is thus a useful tool to analyse the set of potential financial instruments that could be used to activate capital flows towards land-based ecological restoration. It helps us to better understand how existing financial instruments are likely to evolve if finance is to be re-directed towards the protection and restoration of biodiversity. Investing in financial instruments that directly allocate

¹ International Capital Market Association (ICMA) estimates that the overall size of the global bond markets in terms of USD equivalent notional outstanding, is approximately \$128.3tn. This consists of \$87.5tn SSA bonds (68%) and \$40.9tn corporate bonds (32%), as of August 2020 (Ref. ICMAgroup.org)

capital towards land-based ecological restoration can be part of an overall strategy that is shaped by the investors' needs and preferences. Potential investors may be corporates mandated to direct funds towards restoration in fulfilment of planning requirements (Environment Act, 2021) or an asset manager who is extending their investment strategy beyond exclusion criteria to evaluate financial instruments that invest in nature positive actions (Springer, 2020). Bonds or fixed-income instruments offer one of the most effective structures for financial instruments directed towards restoration activity. Their application in project finance as well as their clearly defined duration and the predictable nature of cash flows meet many of the expected requirements for providers of nature-based solutions as well as prospective investors.

2.2. Political and Economic Challenges in Financing Nature

Governments finance expenditure through current taxation and the issuance of public debt. Issuing debt provides national governments with a mechanism to accelerate transformative change through investment in infrastructure and mitigate the worst effects of short-term shocks. To date, no bond that explicitly uses proceeds to invest in nature conservation and restoration has been issued under the EU Green Bond Standard. Exhibiting ambition in relation to nature restoration requires the creation of a strong legal and governance framework not just in relation to the issuance, but also the way the proceeds contribute to the country's transformation agenda. Frequently, nature conservation and its effects are less straightforward to sell to voters, compared to the clear benefits of other sustainable investments. For example, the lowering of energy bills resulting from investment in improved home insulation or renewable energy. In the US, the Biden Administration explicitly linked sustainable investment with voters' concerns, even going as far as to label the public investment programme as the Inflation Reduction Act. For EU Member States, there is a need to navigate the potential political conflicts of redesigning government supports for heavily subsidised while making significant investments in nature positive activities. Overcoming the political barriers to undertake higher rates of investment in nature conservation and restoration will require attention on how nature reduces risk exposures and improves outcomes for vested interests and voters more broadly. This is likely to be the case for green bond issuance at international (EU Commission), national (EU Members State) or subnational (Municipality).

Reviews of green bond issuance reveal that both corporate and sovereign issuers have typically used proceeds from green bonds to invest in renewable energy, clean transport, and energy efficiency (Bhutta et al., 2022; Lewandowski and Smoleńska, 2023). Within the EU, after 2018 when the EU Taxonomy was first put on the table, EU member states described the use of proceeds as significantly contributing to the taxonomy and fulfilling the 'do no significant harm principle.' Lewandowski and Smoleńska (2023) note that credibility and trust in the market segment are aided by the adoption of a clear set of standards and rules, exemplified by the EU Taxonomy. Deploying green bonds for land-based ecological restoration is significantly more complex than for energy or transport projects. These complexities can be identified in the selection of restoration projects and the policy commitments that will deliver a sufficient volume of effective restoration projects so that bond proceeds are used efficiently. The availability of supportive infrastructure such as second party

opinion providers who can verify the impact of the use of proceeds is likely to be more challenging in ecological restoration than in other sectors.²

Due to these interacting challenges, financing activities that protect and restore biodiversity has thus far been reduced to smaller scale projects.

Naeem et al. (2015) cite several projects undertaken at varying scales, including Costa Rica's PES program (national scale), New York City's water supply (regional scale), down to community-scale biodiversity conservation in Cambodia. They summarise the complexity of these projects by noting issues around the identification of 'whom to compensate, what to pay (i.e. money or other forms of incentives) and how much to pay, the mechanisms of payment and verification of service delivery' (Naeem et al, 2015). Naeem et al. (2015) note that even selecting the optimal approaches to biodiversity protection and restoration are contested from within the natural sciences. From an economic perspective, there are equivalent challenges around identifying who should pay and the channels through which capital can be allocated in an optimal way.

2.3. Bonds

The architecture of a conventional bond (Figure 1) provides a useful starting point to evaluate proposed biodiversity-linked securities. Typically, the bond issuer (payor) is seeking capital to undertake a new project while the bond investors (beneficiary) in return for providing capital, receive periodic interest payments (coupons) over the life of the bond as well as the loan amount (principal) at the end of the bond's duration. Within the global bond markets, there are multiple variations of this basic bond structure based on the preferences of bond counterparties, and they typically trade in dealer-oriented over the counter (OTC) search markets that are quite different from other market structures, such as equity or commodity markets. The scale and efficiency of bond transactions rely on the smooth operation of several functions such as the clearing and settlement of payments, the management of risk and accurate price information. The current report aims to better understand how biodiversity linked finance addresses these functions to better understand how mainstream finance can be unlocked for protection and restoration activities.

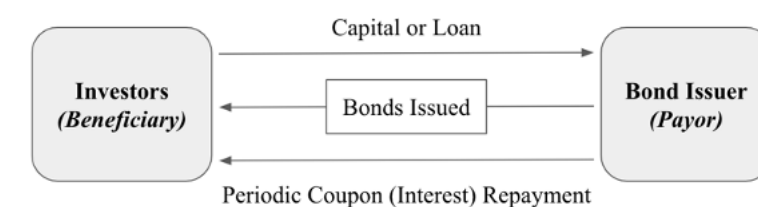


Figure 2: Conventional bond structure

2.4. The Design of Fixed Income Securities

This section provides an integrated review of financial instruments used to finance land-based ecological restoration. The design principles required to deploy biodiversity-linked financial instruments in mainstream financial markets are explored. Biodiversity linked finance is frequently

²² Global long-term fixed income issuance in 2022 was \$22.5 trillion. <https://www.sifma.org/resources/research/fact-book/>

located in two types of bond structure, namely *green bonds*, and *environmental impact bonds*. Environmental impact bonds (Figure 2) establish a close relationship between the bond investor, the borrower, and the results from an investment. In contrast to the green bond, where the investor’s return is only subject to conventional financial risk (non-repayment), the environmental impact bond includes risks for the investor that are linked to performance, in this case the creation of environmental benefits derived from ecosystems services (e.g. measured improvements in water quality, measured reductions in flood risk) (Herrera et al., 2019). The design principle resides in creating a set of financial incentives for the private market (bond investors) to optimally select and monitor contractors who will implement the restoration project in a timely and cost- effective way.

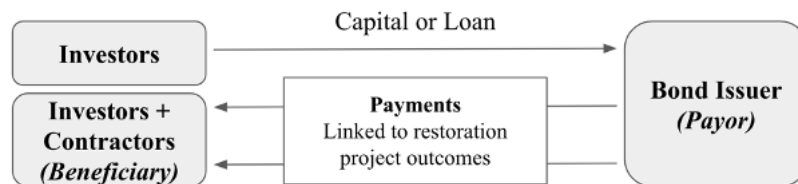


Figure 3: Basic Environmental Impact Bond Structure

A systematic review of financial instruments yields a small sample of studies, with many offering a forward-looking view on how bonds can be implemented for land-based ecological restoration. Listed in the Table 1 below, the selected studies identify challenges around the capture of nature data and the availability of economic data as key implementation challenges.

Table 1: Selected studies, study methodology (ecosystem) and geographical location.

Study #	Author(s) (Year)	Study Methodology (ecosystem)	Location
1	Ferguson et al. (2016)	Intrinsic case study (forest)	Australia
2	Hall et al. (2017)	Intrinsic case study (forest)	New Zealand
3	Madeira & Gartner (2018)	Intrinsic case study (forest)	United States
4	Herrera et al. (2019)	Instrumental case study (coastal wetland)	United States
5	Bernknopf & Broadbent (2020)	Instrumental case study, Portfolio Theory (forest)	United States
6	Moxey et al. (2021)	Instrumental case study (peatland)	United Kingdom
7	Brand et al. (2021)	Collective case study (freshwater, forest)	United States
8	Thompson (2023)	Collective case study (forest, tropical landscape, species protection)	United States, Indonesia, South Africa, Kenya

The main characteristics of the financial instruments described in these studies are summarised in Table 2. These features typically increase the idiosyncratic characteristics of the proposed instruments reducing the opportunity for adoption within mainstream finance. Study #6 proposes that landowners avail of public funding to undertake restoration and then rely on private funding to pay for the marginal gain in carbon sequestration arising from those actions. Given the uncertainty around the marginal effect on carbon sequestration, the authors recommend that the instrument should include rewards for a wider range of ecosystem services – including biodiversity risk – to reduce the financial risk for the payor (landowner). This is a significant data bottleneck that confers risks on the landowner who must incur opportunity costs in return for an unspecified return.

Environmental Impact Bonds (EIBs) (Study #2, #3, #4, #7) explicitly link the availability of bond proceeds to the ecological performance of restoration activity. In each case, the beneficiary receives

a return on their investment based on environmental outcomes, e.g. ‘these impacts could include x-number of trees per hectare after five years, y-tonnes of carbon per hectare, or a z-percentage decrease in phosphorous concentrations in freshwater samples.’ (Hall et al., 2017). The sustainable forestry bond (Study #5) applies a quantitative approach to establish financial returns for a traditional forest bond that integrates with specified ecosystems (i.e. waterfowl habitat and improved water quality arising from nitrate reduction). Measurement risk is considered only from the perspective of the investor and analysis of natural and socio-political risks are examined in a reduced form using approaches adopted from portfolio theory.

Table 2: Summary of financial instruments and their associated characteristics.

Study No.	Project Name/Instrument Type	Financial Instrument Characteristics				
		Duration	Min. Trans. Size	Payors	Beneficiaries	Financial Intermediary
1	Biodiversity Investment Scheme/ Green Bond	5 years ^b	AUD5,000+	Conventional assets/ Biodiversity manager	Retail Investors	Bank
2	Permanent Forest Bond/EIB	5 years	Not defined	New Zealand Government	Retail & Institutional Investors	Not defined
3	Forest Resilience Bond/EIB, PPP ^a	7 years	US\$50m	USFS, State Owned Enterprises, Water Utilities	Institutional Investors ^b	Not defined
4	Louisiana wetland restoration/ Environmental Impact Bond	10–15 years	US\$30m	Oil & Gas Corporates	Institutional Investors	CPRA's Financing Corporation
5	Sustainable Forestry Bond, Green Bond	Annual	Not defined	Timber Production	Institutional Investors	Not defined
6	The Peatland Code/Blended Finance	30+ years	Not defined	Landowners	UK Government + Corporate	Not defined
7	Atlanta Flood Bond/EIB ^a	5 years	US\$14m	Atlanta DWM	The Rockefeller Foundation	Not defined
8	Green Bond for Working Forests/ Green Bond ^a	5–10 years	\$150m	Public agencies/Local Communities	The Conservation Fund	Goldman Sachs
8	IFC Forests Bond/Green Bond ^a	5 years	\$152m	Local communities and landowners	Institutional Investors	Int. Finance Corporation (IFC), part of the World Bank
8	Tropical Landscape Finance Facility Sustainability Bond/Green Bond ^a	15 years	\$95m	Rubber plantation landowners	Corporate Investors (Michelin Group, France)	BNP Paribas
8	YUBA I FRB/Green Bond ^a	4 years	\$4m	State of California, Yuba Water Agency	Impact Investors	Blue Forest (NGO)

^a Bond issued.

^b Implied in the analysis.

Table 2 summarises how the selected studies address the six core functions of the global financial system identified by Crane et al. (1995). In general, the reviewed studies are vague or provide no information on the financial architecture within which these instruments function. By drawing on the functional perspective we can observe knowledge gaps in several areas. The costs of bringing the financial instruments to market are not described or benchmarked against equivalent sized financing arrangements in the mainstream market. While implementing land-based ecological restoration presents complexity, it is unclear how assessment and restoration activities are monitored during the term of the financial instrument and whether investors would continue to access and report data on ecosystems services production after maturity. From a financial perspective, important issues in relation to the clearing and settlement of trades, the need to standardise financial instruments to facilitate investment from a broader pool of investors and perhaps an expanded set of investor types (not just corporate or institutional but retail investors), increased collaboration from other stakeholders to develop insurance-type products to provide financial protection against unexpected loss of ecosystem services production (e.g. disease, wildfire). The functional perspective also highlights the need for improved analysis of how investor preferences to understand how biodiversity-linked bonds rank in the universe of investible green assets and continued attention on monitoring tools and governance frameworks to overcome incentive problems associated with financing land-based ecological restoration.

Table 3: Functional Perspective on Financial Instruments for Land-Based Ecological Restoration

<p><i>Clearing and settling payments to facilitate trade.</i></p>	<p>Not specified for US-based EIBs (S#2, #3 and #7) but assumed that a financial intermediary hold funds and distributes them based on the achievement of agreed targets (notified to it by a third party). S#6 recommends that private funds could be efficiently channeled through government agencies. No recommended payments procedure for transparent, efficient and timely payments for ecosystem services, and the associated reduction in transaction costs. S#8 (TLFF, IFC bonds) no detail is provided on the costs of financial intermediation activity facilitated by World Bank, BNP Paribas and Goldman Sachs respectively.</p> <p>No information provided on fee income paid to financial institutions (either in absolute terms or relative to benchmark costs for conventional instruments). No information provided on governance procedure for release of funds.</p>
<p>To provide a mechanism for the <i>pooling of resources</i> and subdividing of shares in various enterprises.</p>	<p>US-based EIBs (S#2, #3 and #7) does embed the 'stacking' of ecosystem services, so that multiple bond beneficiaries can enable a transaction size that is economically feasible, and benefits can be allocated to more than one counterparty (e.g. water quality/water utility, reduction in flood risk/risk management agency).</p> <p>Not considered in selected studies. Financial instruments facilitate cash flows between two entities with one entity acting as a conduit for funding those actively undertaking restoration activity.</p>
<p>To provide a way to <i>transfer economic resources</i> through time, across borders and among industries.</p>	<p>S#8 international financial transfers are facilitated by financial intermediation. The returns to beneficiaries conflate corporate benefits to investors (e.g. access to crops) and the marginal impact on ecosystem services. In all other selected studies, issuance of finance and restoration activity take place within national borders. S#6 identifies the time lag between landowners incurring costs and the availability of funds that are contingent on ES provision as problematic.</p>
<p>To provide ways of <i>managing risk</i>.</p>	<p>Financial instruments are seen as mitigating economic risks associated with environmental degradation (e.g. soil erosion/agricultural production; coastal erosion/damage to ports) The design features of some instruments additionally 'de-risk' those instruments for private finance, providing investors with opportunities for enhanced returns.</p> <p>Limited discussion on additional risk management features (e.g. how to improve certainty for landowners around securing payments linked to ES provision). The role of insurance covers against landscape level losses linked to wildfire and disease could be introduced in this context. No information is provided on how the financial instrument addresses financial risks or how these risks distributed between the payor and the beneficiary (e.g) are payments protected against inflation or foreign exchange risk (in the case of international transfers).</p>
<p>To provide <i>price information</i> to help coordinate decentralized decision-making in various sectors of the economy.</p>	<p>While price information (as it relates to carbon pricing) does help to ground the proposals around private finance flows via the Peatland Code (S#6), use of price information is not directly considered in protection and restoration activities.</p> <p>Price information is inferred, based on capital committed and the associated interest return to beneficiaries.</p> <p>No ranking criteria for beneficiaries to allocate capital - either on a risk-reward basis or based on their expected contribution to biodiversity net gain.</p>
<p>To provide ways of <i>dealing with the incentive problems</i> created when one party to a transaction has information that the other party does not.</p>	<p>S#6 references the challenges around measuring and monitoring of ES by counterparties. S#4 identifies role of third-party verifiers needed to provide objective data on progress in agreed ES measures.</p> <p>Incentive problems arising from missing or asymmetric information are addressed indirectly.</p>

2.5. Future Research Agenda

Green bonds and environmental impact bonds are financial instruments that exist alongside a universe of conventional investment opportunities; thus, it is important to examine how their non-standard features prevent adoption by participants in the mainstream financial markets. It remains unclear whether these instruments (or their variants) can support the increase in the estimated level of investment required to slow the biodiversity crisis. Indeed, there is no evidence to expect that investors will exhibit a preference for instruments where proceeds are used to undertake scientifically validated protection and restoration activities in land-based ecologies.

Existing instruments used to fund biodiversity restoration projects are not designed to be integrated into the global financial system but rather facilitate voluntary, one-off investment structures that are difficult to scale up. Research and communication on biodiversity finance must provide improved detail on financial efficiency and transparency. This includes clearly documenting fee and advisory income, identifying the counterparties that are exposed to financial risks such as inflation or currency fluctuations, and the governance structures around payment delivery. As noted by Zingales (2015) there is a responsibility on finance academics to help to 'curb the rent-seeking behaviour of finance' and this analysis will be important in establishing norms for the transaction costs associated with nature finance. Furthermore, there are a very particular set of challenges in scaling restoration activity that is not observed in other areas of green finance (e.g. renewable energy). It is important that restoration projects are locally led, and appropriate for local ecosystems. There is thus a need for new research into the financial architecture that can aggregate these efforts and incorporate a governance structure that enables capital to be available in a timely way and for it to be fungible across several projects. The current report proposes that future research should address core issues around market design, transaction costs and incentive problems that are currently impeding the flow of capital towards the protection and restoration of nature. Developing and testing this architecture can support more ambitious and clearly articulated policies that re-direct mainstream finance towards nature restoration.

A future research agenda should aim to better understand how biodiversity objectives can be integrated into mainstream fixed income securities such as sovereign bonds and thus become available for conventional investment. Attention should focus on *the enabling conditions* necessary to clear and settle payments for nature protection and restoration. This includes opening up new pathways for landowners to be compensated for undertaking protection and restoration activities (e.g. in many EU countries farmers cannot receive payments from State agencies other than the Department of Agriculture).

Addressing *transactions costs* through standardisation and unified channels for the measurement and sharing of nature information. The development of ecosystem accounts provides the opportunity to direct science-based targeted funding towards those ecosystems that are degraded. National efforts at producing ecosystem accounts are not yet reflected in the design of financial instruments.

2.6. Commodity Trading: Informational Barriers in Global Markets

Understanding the financial drivers that underlie the evolution of marketplaces provides an important context for evaluating whether biodiversity data can be accommodated in direct trading activity and the motivating forces for their consideration. Marketplaces rely on trading commission that is associated with transaction volume and their success relies on their capacity to match the requirements of potential buyers and sellers (Seddon, 2019). To achieve this, transactions adopt standard features that facilitate the requirements of both commercial and speculative market participants. This supports trade volume and thus contributes to efficient price discovery (Chordia, Roll and Subrahmanyam, 2011). The emergence of a financial instrument such as a futures contract, potentially holds lessons for applications in biodiversity finance. Former CME President, EP Harris describes the early phase in the development of a financial instrument as follows.

Beginning in the early fifties and until the present time, Exchange members have vigorously researched, tested, and promoted many new contracts for futures trading. Most have been agricultural commodities, but some non-agricultural commodities were also formulated. Some have succeeded and some have failed, but fear of failure has not impeded progress. The commodities which have fallen by the wayside in futures trading include onions, scrap iron, frozen shrimp, frozen broilers, hides, and apples. Successful markets have been established in frozen pork bellies, Idaho potatoes, live hogs, strictly fresh eggs, and the most exciting current futures — live beef cattle.

Harris, 1970, p.52

The success of live beef cattle as a futures contract relied on the creation of clear rules around their trade and delivery as well as policy enablers – for example, agricultural subsidies, which help to maintain a sufficient volume and stable supply of the underlying asset, live beef cattle (Laborde et al., 2021). As noted by Paulson (2024), the financialization of live beef cattle demonstrates how a commodity becomes ‘more physically abstract over time’ yet the physical effects on land degradation and water quality are well understood (Cesoniene, Dapkiene and Sileikiene, 2019).

2.7. Commodity Data Systems and Ecosystem Accounting

The case of Brazil highlights how predominantly public monitoring tools are being utilised to enforce the national Forest Code and reduce deforestation, while also serving as a resource for financial actors to inform business decisions, such as lending and purchasing. The 2012 Forest Code mandates

that landowners in the Amazon biome conserve 80% of their property as native vegetation, while those in the Cerrado biome are required to conserve 20–35%. To ensure compliance with the Forest Code, the National Rural Environmental Registry System (CAR) was established in 2016 as a spatially explicit tool mapping all rural properties in Brazil. Registration involves geo-referencing property boundaries and conducting field visits for verification. While this process imposes significant costs on state governments, third-party donor agencies have provided critical financial support. Compliance with the Forest Code is verified by overlaying CAR data with forest cover maps produced by the Brazilian Space Agency's PRODES system. Properties identified as non-compliant or engaging in unlawful deforestation are fined by Brazil's "environmental police" IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) and added to a public list of embargoed properties. Under Federal Decree 6514/2008, economic activities in embargoed areas, including the production, purchase, and sale of goods, are strictly prohibited. Furthermore, the Central Bank of Brazil requires producers to present a 'license, certificate, or equivalent proof of environmental compliance' to qualify for public loans. Public banks, which provide rural loans at lower interest rates, remain the primary lenders in Brazil's agricultural sector.

Box 2. Redirecting financial flows

The Forest Code stipulated that, as of 2017, Brazilian banks are prohibited from extending credit to producers who have not registered their lands in CAR (this is not linked to compliance). Finally, the National Monetary Council (CMN) issued Resolution No. 5,021/2022, which increases the credit limit by 10% for producers whose CAR registrations have been reviewed and whose properties are either compliant with the law or undergoing environmental regularization (Jung et al., 2017)

In 2006, major global commodity traders such as ADM, Bunge, and Cargill—responsible for purchasing approximately 90% of soy produced in the Brazilian Amazon—agreed to a moratorium on deforestation for soybean production in the Amazon biome. Initially signed for two years and subsequently renewed multiple times, the Soy Moratorium prohibits traders from purchasing soybeans grown on properties cleared after July 2006 (later updated to July 2008). To ensure compliance, the initiative utilizes a monitoring system that overlays MODIS satellite imagery with annual deforestation polygons generated by the Brazilian Space Agency's PRODES maps to identify crop production on newly deforested land. Suspected areas undergo further investigation through manual interpretation of Landsat images and, in earlier years, aerial flyovers. Field visits identify the responsible producer or farm, a process now simplified by the CAR system. Non-compliant producers are listed and shared with traders adhering to the moratorium. In 2009, a similar initiative was introduced for the beef supply chain, involving meat-packing companies. Like the Soy Moratorium, it relies on PRODES deforestation data and CAR to identify non-compliant properties (Massoca et al., 2017).

The Brazilian case shows how data systems can be used to mandate constraints on the financial system and support the protection of biodiverse landscapes. Future research should examine how existing and emerging datasets on ecosystem accounts can be used in private market settings through enhanced regulation and contracting.

3. Financial Institutions

The EU Sustainable Finance agenda requires financial institutions (FIs) to become more transparent in how they align with nature-positive strategies. Recent analysis by the ECB acknowledges that biodiversity and nature loss pose risks to essential economic activities and the overall financial system. EU:DG FISMA (2024) proposes a flexible methodological framework that can be deployed by FIs to assess and manage biodiversity and nature-related risks. The implementation of such a framework and the subsequent integration of nature-related risks into decision-making processes will require significant innovative capability and new expertise. The importance of nature's location specificity and the necessity to involve stakeholders beyond the counterparties to a financial transaction creates exceptional demands on FIs data systems. It would be thus unsurprising if FIs adopt a conservative approach and undertake minimal investment in this endeavour until they are mandated to do so. Ambitious approaches to mainstreaming nature in decision-making processes also presents risks to FIs, including how data is managed, potential inequalities in access to finance as well as exposure to charges of overreach and financialization, defined by Fairhead et al (2012) as the "drawing into financial circulation aspects of life that previously lay outside it."

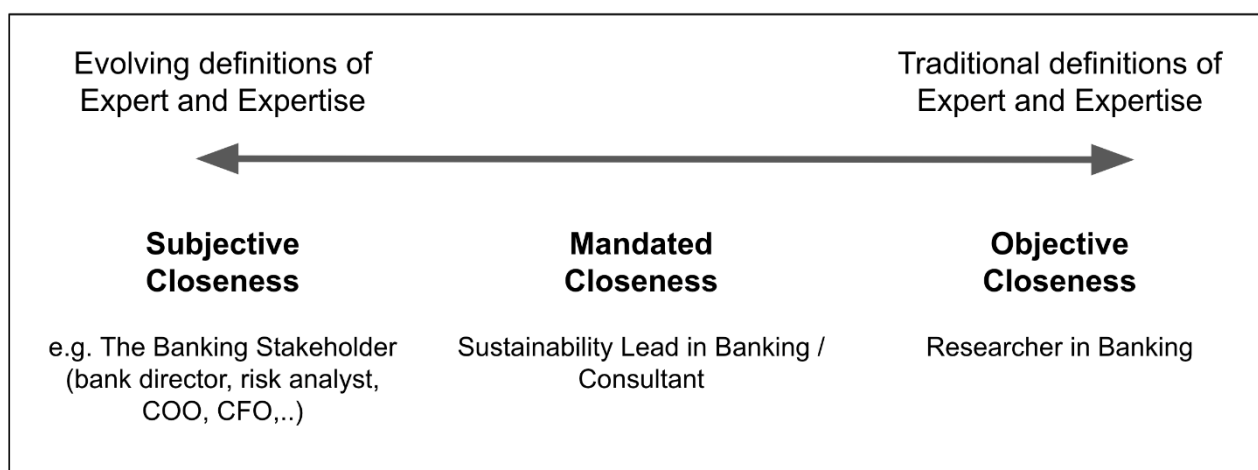
The introduction of the EU Taxonomy, CSDR and SFDR provide the parameters for the research described here. In 2024, banks disclosed their Taxonomy alignment and Green Asset Ratio alongside their Taxonomy eligibility for the first time. To align with the EU Taxonomy, loan proceeds must *substantially contribute* to one of six environmental objectives and *Do No Significant Harm* to any of the other environmental objectives listed in the Taxonomy. Greater transparency arising from the CSRD and SFDR is expected to result in FIs seeking out opportunities to increase their level of Taxonomy-aligned assets (loans or investments).

In this context, understanding where data bottlenecks are likely to emerge for financial institutions requires analysis of the current procedures and capabilities of FIs. Important considerations relating to the commodification of nature must remain as a critical backdrop to the current research. The EU Taxonomy and associated disclosure rules reflect a neoliberal philosophy that supports political and economic institutions that are robustly liberal and capitalist while supplemented by a constitutionally limited democracy and a modest welfare state. Thus, FIs will maintain priorities in relation to return on capital, risk appetite and market share ahead of other central values. Harvey's (2005) observation that market exchange is "an ethic in itself, capable of acting as a guide to all human action and substituting for all previously held ethical beliefs" is assumed to hold true. While FIs may be willing to deploy innovative approaches to green lending (and there is evidence that this is the case), they will only do so when the risk-return characteristics are attractive. The protection and restoration of biodiversity presents complexities around pricing and monitoring as well as linking outcomes to default risk that can be difficult to resolve. As long as these complexities persist they are likely to promote a retrenchment towards neoliberal agenda where FIs are more likely to identify their role as a service provider that is responsive to market preferences or pointing to the absence or unreliability of data as a key barrier to innovation.

The following section outlines preliminary findings across these interconnected issues. Data is drawn from banking and asset management workshops as well as semi-structured interviews with a wide range of banking professionals and policy experts. A Delphi study is used to provide structured approach to eliciting an expert view on how the EU Taxonomy (EUT) is expected to influence new lending procedures and decision-making. This complements a detailed examination of current green lending practices that helps us to identify the capabilities and limits of banks current data systems and decision processes.

3.1 Bank Lending and Biodiversity Data: An Expert Stakeholder Analysis

To better understand how bank lending procedures might evolve as a consequence of the EU Taxonomy and related disclosure requirements from both financial and non-financial companies, a Delphi study was designed to elicit views from experts in banking operations. The preliminary stage distributed a survey to nineteen banking experts.³ The selection and categorisation of the Delphi panel members was defined by their subjective, mandated, or objective closeness to banking operations an approach adapted from Needham and de Loë (1990). Stakeholders with subjective closeness category are selected for their direct, experiential knowledge in banking operations. This included executives from retail and corporate banking as well as senior executives with expertise in core banking functions such as risk management. Mandated closeness includes those with a professional, legal, regulatory, or policy relationship in the area of analysis, specifically those involved in sustainability agenda within a financial institution. Banking and policy experts from academic and those with a research brief within major financial agencies comprised the third category, that is, those with an objective closeness to sustainable banking practices and policy.



Adapted from Needham and de Loë, 1990

Figure 4: Delphi expert panel on banking and sustainable lending.

Panel members were asked questions on the expected impact of the EU Taxonomy and related disclosure requirements on the lending market. The questions examined the capacity of the Taxonomy to influence lending procedures and loan product design as they related to the protection and restoration of biodiversity. In this context, several questions in this preliminary phase sought to understand expert views more fully on the banking function and issues of control, transparency and equity that may arise when linking biodiversity status to a financial product such as a loan. A critical view of the relation between financialisation and neoliberalism is outside the scope of the current report but remains an important context that requires further examination.

³ Results from the first-round survey (reported in brief in the current report), will be used to inform a second-round survey as well as a comprehensive workshop which will be used to identify changes in lending procedures so that data bottlenecks can be directly addressed.

Table 4: Delphi Panel Composition by Role and Closeness to Area of Analysis

Subjective Closeness		Mandated Closeness		Objective Closeness	
Label	Role	Label	Role	Label	Role
P1	Senior Director, Corporate Banking	P5	Sustainability Manager	P13	Research Fellow, Expert European Banking Policy
P2	Chief Financial Officer	P7	Deputy Manager, Corporate & Sustainability Division	P14	Research Fellow, National Central Bank
P3	Senior Bank Executive, Director of Risk	P8	Climate Finance Expert, Financial Institution	P15	Associate Professor, Banking and Monetary Policy
P4	Chief Retail Banking Officer	P17	Sustainability Researcher within Green Bank	P16	Professor of Sustainability Science
P6	Lending Manager	P18	Banking Expert, Economic Consultancy		
P9	Senior Director, Corporate Banking				
P10	Chief Operating Officer, Financial Services				
P11	Bank Director, Investment Markets				
P12	Managing Director, Corporate Banking				
P19	Director of Group Risk Management				

The survey comprised of ten broad questions that prompted experts to characterise how the EU Taxonomy might re-shape bank lending operations. Responses were sought on the likely impact of the EU Taxonomy on lending patterns, investment in protection and restoration efforts and how banks are likely to engage with clients. These questions were framed around the availability and reliability of biodiversity data with experts asked to provide responses to both quantitative (Likert-scale) and qualitative (open text) responses. The responses below are not a definitive study, but rather an attempt to gather some baseline information that will guide potential adoption pathways for biodiversity data in loan availability and loan product design.

High levels of dissensus are observable in the responses across the expert panel. Notably, those with a subjective and mandated closeness to the area of analysis (that is, those experts working within the banking system) envisage an unchanged set of priorities for banks. Their responses confirm that the market remains the dominant paradigm, with lending procedures and the design of loan products only expected to change as a response to customer demand. While experts with an objective closeness to banking also confirm the centrality of market forces, they propose solutions

that are either external to the market (the role of the State in allocating resources) or place controls on the market (the need to enhance the Taxonomy). The expectation that competitive forces within the financial system continuing to erode biodiverse landscapes is noted, *'finding cut-off values for (allowable) deforestation (...) makes no sense as it is the aggregate value of forest loss in a particular region that will determine if we transgress important tipping points for ecosystems capacity to sequester carbon. [The taxonomy] failed to capture such things, and I therefore am not sure how well it will actually support a more sustainable trajectory - P16'*.

Table 5: Summary of qualitative responses to question on how the EU Taxonomy is likely to initiate innovation in the banking market and expand financialization. Question wording, *'How likely is it that the EU Taxonomy will lead to new lending opportunities for banks within the next five years?'*

Subjective Closeness	Mandated Closeness	Objective Closeness
Taxonomies have rarely had significant influence on banking at the front end. (P2)	Currently (EUT) is seen as a regulatory disclosure instead of an identifier for new 'green' products. (P5)	What we need is policies (industrial, command & control...) along with government investments, which will steer private investments towards the new priorities. Believing that a taxonomy will do the job (without questioning structural issues such as the need to reform EU fiscal rules) fits within a neoliberal framework... (P13)
Banks lend to people and companies that pay them back. A taxonomy will not change that. (P3)	As more businesses seek financing that meets (EUT) criteria, banks will have an opportunity to develop new products and services tailored specifically for green investments. (P7)	..if effective the EUT should at least have an impact on the direction of lending, i.e., lending to sectors that may not be prominent among banks borrowers at the moment. (P15)
There is always demand for new lending in new areas as old areas close down. (P9)	(The EUT) does not currently comprehensively tackle the issue of biodiversity, since important sectors like forestry and agriculture are not well-integrated (P17)	I am doubtful that the EUT has any transformative capacity ... it focuses largely on being able to categorize and thus separating what is green, from that which is not. However, as developed I find it largely fails to even do a good job of that. (P16)
Society demands and governments policies will be more important drivers than the EU taxonomy (P11)	... banks can anticipate rising demand for loans that meet sustainable thresholds, especially with regulatory support and incentives favouring Taxonomy-compliant activities. (P18)	
All substantial change requires investment which in turn requires financing. Tailored loan offerings will support the initiatives / transition. (P19)		

Of those that responded to the question, *how likely is it that EU Taxonomy will result in reduced lending opportunities for banks within the next five years?*, eleven members (73%) of the expert panel believed that it is extremely unlikely or moderately unlikely, while 27% (four) believed that it was neither likely nor unlikely. Qualitative answers to this question from those with a mandated closeness to sustainable finance noted that;

'the taxonomy does not have a very stimulating effect. Banks are just reclassifying their existing portfolios. Moreover, the taxonomy is focussed on 'green investments', so 'brown' or 'grey' investments are not sufficiently disincentivised by the taxonomy (P17)'

and

'I don't think this will factor into lending within five years (P7).'

Experts leading core banking functions (subjective closeness) are ambiguous about the expected pressures on banking activity suggesting that *'banks with larger exposure to fossil fuels and other 'brown' sectors may need to divest / manage out stranded assets (P9)'*. They also describe how even despite pressure to become sustainable the flow of capital towards polluting sectors would be maintained under the current system, observing that *'it may be that some lending moves from banks to non-banks should reputational risks increase (P3)'*. Responses demonstrate that lending patterns have not yet been impacted from the introduction of the EU Taxonomy and disclosure rules and more importantly, there is no expectation among experts that it is likely to change in the immediate future.

The availability and reliability of biodiversity data is envisaged as a key enabler of decision-making across several domains including private finance. The current report is seeking to better understand how data systems and decision-making can best accommodate biodiversity data in the future. The conflicting views on biodiversity data and its relevance can be observed in the respective comments of experts with subjective, mandated, and objective closeness to bank lending (Table 6). While supervisory authorities, such as the European Central Bank acknowledge nature-related financial risks (Elderson, 2023), these risks do not yet inform banking operations. At the level of individual loans, there is no evidence that banks adjust lending terms and conditions to account for dependency on a deteriorating ecosystem. Indeed, the expectation is that if such risks are linked to default risk, finance may not be withheld. Rather increased default risk may be managed in conventional ways, such as increasing collateral requirements (Bester, 1994; Blazy and Weill, 2013). Elsas and Krahen (1999) show that the use of collateralisation increases workout probabilities.

Similarly, if loan proceeds are directed towards intensifying 'brown' activities on a biodiverse landscape, the ultimate financial impacts (e.g. food inflation, lost tourism revenues, ..) are unlikely to be connected to the performance of that loan. Even among those with a mandated closeness to sustainable lending there is no clear pathway or incentive to integrating biodiversity data (Table 6). Experts with objective closeness state that there is sufficient data for banks to take action. Financial institutions see themselves as responders to market demand and seeking more sophisticated information on biodiversity impacts will be a requirement in the future.

Table 6: Summary of qualitative responses that extract’s detail on experts’ view on ‘The availability and reliability of biodiversity data hinders a bank’s capacity to innovate and design ‘nature-positive’ loan products.’

Subjective Closeness	Mandated Closeness	Objective Closeness
Banks simply would not be able to accurately align such data with default risk which remains the primary concern. (P3)		...we should stop thinking that issues such as data gap are the problem. Bankers ...understand that policies are almost non-existent, so why would they invest where it is needed? (P13)
data collection and interpretation remains challenging, ... this will take some time to effectively capture. Common standards need to be established across the industry to support product development and innovation (P1)	financial institutions may be reluctant to invest in initiatives that lack clear evidence of their environmental impact (P7)	There is enough reliable data available for biodiversity to be taken into consideration ... the idea that we need more data to take action is in my opinion false. (P18)
I haven't seen anything meaningful on this to date (P19)	The definition of 'nature-positive' is currently unclear, meaning that also the availability of biodiversity data does not contribute to achieving that target. (P17)	The lack of scientifically grounded definitions and assessment criteria for what can/should be considered nature positive businesses further hinders this ambition (P16)
In the absence of this data set, the bank will be passively responsive to business and consumer demand in this space (P2)		

There is an expectation that greater precision in disclosure rules will result in a type of ‘beauty context’ among financial institutions seeking to portray themselves as sustainable to both clients and shareholders. The responsibility is on current and prospective borrowers to provide data relevant to disclosures and for the bank to disclose this data. Experts were asked to whether data bottlenecks existed between the impacts of how loan proceeds were used and how this information was made available to them by borrowers and captured in bank disclosures (Table 7). Some consensus emerged among the panel who noted that information available from disclosure data is likely to communicate little about the physical impacts arising from the use of loan proceeds. This finding aligns with empirical results from 101 European systemic banks produced by Giannetti et al (2023). Among their findings the note that ‘firms with a larger carbon footprint that obtain loans from banks with more extensive environmental disclosures do not end up decreasing their emissions or commit to voluntary emission targets.’

Table 7: Summary of qualitative responses that extract’s detail on experts’ view on ‘The availability and reliability of biodiversity data creates a gap between banks sustainability-linked disclosures and the impact of their loans on biodiversity.’

Subjective Closeness	Mandated Closeness	Objective Closeness
We're way off this level yet (P3)	...(the) EU Disclosures frameworks are still nascent on the topic of biodiversity.	Bankers cannot resolve a transition that is not happening...(P13)
	This means that there is a gap between our impact and the disclosures. Lack of data is also a problem (P17)	
The easier it is for borrowers to monitor, assess and record the impact of biodiversity improvements the more likely it is that biodiversity measures will form part of sustainability linked disclosures and targets for borrowers and banks. (P6)		..we lack a consistent way of assessing the alignment between policy ambitions and targets, the targets of lenders, and the targets and actual achievements (thru reduced harm or nature positive impacts) of the businesses in which they invest. ... a key barrier to this is the system of non-financial accounting, the lack of asset level reporting (until recently). However, despite the ESRS coming into effect my assessment is that the quality and reliability of the data that ESRS (and GRI and TNFD) will provide will still be fairly poor (P16)
	This is also dependant on the portfolio as some lending would be easier to collect data and some sectors would be capturing this data already, e.g. agri. (P5)	
	biodiversity considerations often take a backseat to more immediate commercial priorities... there is often a disconnect between what banks report regarding their sustainability efforts and the real-world implications of their financing activities. (P7)	
		Biodiversity data are tricky to construct and interpret, and banks may not have the necessary expertise in-house to do so. (P15)

A subsequent question on the capacity of banks to help clients mitigate the impact of their business on biodiversity showed that view of experts leading bank divisions was that this would not happen (Table 8). It is a function that is envisaged as outside the scope of banking and not in their commercial interests. This was a point of dissensus across the expert panel as those with an objective closeness to sustainable finance pointed to banks’ ‘strong position’ to demand data and that very often this data does not need to be ‘super reliable.’

Table 8: Summary of qualitative responses that extract’s detail on experts’ view on ‘The availability and reliability of biodiversity data compromises banks’ ability to work with clients to mitigate the impact of their business on biodiversity’.

Subjective Closeness	Mandated Closeness	Objective Closeness
<p>Even with data, Banks do not have skillsets for this. (P3)</p>	<p>Yes, this is a problem. On a client level, we need easy ways to collect biodiversity data without burdening our clients. (P17)</p>	<p>This (question) makes banks out to be passive users of data from companies, but in my discussions with banks I see them as having a fairly strong position to demand/ask companies to disclose certain information, in order that they can a) both understand and assess the nature-related risks associated with the client, but also to b) guide the client in their strategy to mitigate harm (as is more common that nature positive at the moment). (P16)</p>
<p>such partnerships require a foundation of trust and transparency regarding data sources and methodologies used in assessments. If there are discrepancies or doubts about the validity of the information being shared, it could further complicate efforts for banks to engage meaningfully with clients on biodiversity issues. (P7)</p>	<p>We can still take nature positive actions and collaborate with clients to mitigate risk. Need to be careful to do no significant harm but there are clear actions that could be taken across sectors. (P5)</p>	
<p>I don't think this is ..a result of a lack of biodiversity data specifically; it is more that Biodiversity is not necessarily seen as something that is as immediately relevant from a Double Materiality perspective and therefore if it is not a priority for a banks' clients (or the regulator) it will not be a priority for the bank. (P6)</p>		<p>Banks may not need super reliable biodiversity data to do so. There is already a huge documentation on how, e.g., mining or pesticides use are highly detrimental to biodiversity. So banks could decide to use these as proxy for assessing biodiversity risks. (P15)</p>
		<p>...there is sufficient biodiversity data available for banks to start engaging with clients effectively right now. Working proactively with clients under current data constraints is essential for banks to support an immediate transition toward biodiversity-positive practices (P18)</p>

The qualitative responses summarised here must be interpreted with caution as they form part of a more extensive Delphi survey to be undertaken in the coming months. There is an observable consensus among participants that the EU Taxonomy and disclosure rules are not likely to redirect financial flows from economic activities that negatively impact ecosystems and towards activities that protect and restore biodiversity. Those with an operational experience of bank functions (subjective closeness) note that; this is not the bank's responsibility, it's not a priority for the regulator, action by a single bank would have little impact on redirecting financial flows as other lenders would make capital available, there is no way to link ecosystem decline to the risk of an individual loan and banks don't have the capacity to do this. These results are perhaps unsurprising and are consistent with the ECBs findings in relation to climate risk factors. The ECB note that these factors 'have not yet been fully considered in banks' internal credit risk stress-testing models.' (ECB, 2022). Those with objective closeness provide alternative reasons as they note there is sufficient and relatively easy measures that can be used by banks to constrain lending to 'brown' sectors. They point to the need for consistent standards across the banking sector but also note the need for stronger regulation over how banks make loans.

The expert panel do not expect that existing disclosure requirements or more sophisticated risk analysis will be effective in redirecting capital flows towards the protection and restoration of biodiversity. While progressive banks may develop and introduce exclusion criteria in relation to brown sectors, these appear unlikely to become a part of mainstream banking. In addition, the incentives for banks to work with clients to undertake protection and restoration activity are weak since the near-term impacts of this activity cannot easily be linked to a lower default risk.

Though the current study uses a small sample, the results align with qualitative insights into banks' current and future plans with respect to climate related risks reported by the European Central Bank (2022). The report notes that for 61% of banks, future actions on climate risks were not associated with concrete targets. Also, while some banks refer to overarching objectives (e.g. the Net Zero Banking Alliance), these were not linked to measurable key performance indicators. In the context of climate risks, global investment in fossil fuels have remained virtually unchanged over the past decade (IEA, 2024). In the context of corporate lending, more recent analysis shows that the poor environmental performance has little impact on bank lending decisions, where they may keep the size of their loans unchanged or even increase their loans issued (Luneva and Sarkisyan, 2024).

3.2 Lessons from Green Lending

The following section provides a short overview of green lending procedures as well as the current status of green lending. Current green loan procedures can be distinguished from conventional loans as they require banks to capture non-financial data. They may provide a template that can be expanded to require borrowers to use some or all proceeds to protect and restore biodiversity. Loan procedures were described by participants in a banking workshop held in Dublin on 27th June 2024. Participants were leading green loan arrangements or piloting sector-specific green loans (e.g. agricultural loans). The majority of green loans are available at preferential rates relative to equivalent conventional loans. In some cases, these preferential rates are supported by European Investment Bank through their European Investment Fund (for example, [the Growth and Sustainability Loan Scheme](#) for SMEs). The EIB Green Loan Eligibility Checker has been designed as a simple tool to verify that a loan meets the EIB criteria as a green loan. The dashboard doesn't assess all eligibility criteria; however, it is typically used by loan officers within banks to verify certain conditions of a loan are met. It is a valuable tool for mid-size banks who may not have developed

internal systems or training for loan officers when lending to SMEs and sole traders. Prospective borrowers can access the Checker to pre-assess their application for green loans rates.

3.2.1 Procedures used in green lending

Green lending introduces non-financial information that is not directly linked to the performance of the loan but is required to verify the loan meets criteria specified by the lender. It is the responsibility of the borrower to provide evidence to the lender that loan proceeds will be used in a way that meets the lenders criteria for sustainability. These criteria may include a reduction in emissions (purchase of an electric car, minimum home energy rating) or undertaking sustainability measures (evidence of participation and score in an industry-led sustainability scheme).

Table 9: Green Loans: Use of Proceeds and Verification

Borrower Type	Use of proceeds	Verification	Example
Individual	Purchase of electric vehicle	Upload of purchase document with information on car, dealership, and date	Green Personal Loan (link here)*
Business e.g. Agricultural Loan	Participation in industry-led sustainability scheme	Scores on sustainability scheme and measure of farms carbon footprint. Restrictions apply to how loan proceeds are used.	Enviroflex (link here)

*In the Irish market, Allied Irish Banks is offering a green loan at 6.4% APR and a standard equivalent loan at 8.95% APR.

Green lending does not incur transaction costs that are higher than conventional loans. In the context of aligning loans with the Taxonomy (specifically Environmental Objective 6), banks have no easy way to verify that the prospective borrower is significantly contributing to the protection and restoration of biodiversity. To illustrate this an agriculture loan scenario is provided in Box 1. This representative scenario can be extended to other borrower types (household, SME, corporate) where the financial case to lend is strong, but use of proceeds is likely to lead to significant harm to biodiversity.

Box 1. Loan Scenario - Agriculture

An intensive and commercially successful dairy farmer (the borrower) is seeking a loan to expand production. Global demand for dairy products projected to increase in the coming years. The borrower has a long-standing relationship with the bank and is in a strong financial position. Publicly available ecosystem accounts, shows that the local area has experienced declining water quality.

Loan proceeds are intended for the purchase of land previously owned by a neighbouring farmer. The land under consideration was farmed extensively and it comprises of high-nature value habitats including, scrubland, wide hedgerows, and semi-natural grasslands. The bank is familiar with increasing regulatory pressure on the dairy sector to improve the management of nutrients and reduce intensification.

The emergence of this loan scenario is a consequence of public policy and the most effective and efficient approach to protecting nature is to pre-empt this scenario emerging through policy and

public finance measures. The measures may include strict planning requirements in relation to clearing hedgerows and scrubland, incentivising landowners to maintain and enhance habitats through results-based payment schemes, the application of conservation easements or the public purchase of high nature value land areas. In the absence of these measures, loan scenarios like that described above are more likely to emerge. As noted by Hans Stegeman, chief economist at Triodos Bank, “For too long, policymakers have placed excessive hope in private finance to resolve issues they hesitate to address through regulation or public policy.”⁴

The evidence suggests that the loan application described above would not be rejected based on nature-related financial risks or the impact of loan proceeds on biodiversity. The financial strength of the borrower and the commercial prospects for the proposed use of funds, will support loan approval. Once the loan is approved, the bank will not undertake ex-post monitoring of how the loan proceeds are used.

How can biodiversity data and supporting data systems be deployed to progress lending policy and procedures towards Taxonomy alignment? Simplified procedures used in current green lending shows that minimising transaction costs and streamlining decision-making is a priority for financial institutions. In the context of biodiversity impacts, the development and implementation of exclusion criteria for new loans is operationally feasible. Location specific data on the use of proceeds can be integrated with ecosystem accounts that describe the extent and condition of ecosystems such as grasslands, rivers or lakes (see [link](#)).

Loan Exclusion

Bank X does not finance livestock agricultural activity where loan proceeds will be used to increase production in catchment areas with moderate, poor, or bad ecological status as reported in the National System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA-EA).

Table 10: Lending decision-making and data system requirements

Data System Requirements	Loan Decision	
	Reject	Conditional Approval
Low	I Bank applies exclusion criteria	
Low		II Bank requires industry standard
Moderate		III Bank requires part of loan proceeds to be used to make a <i>significant contribution</i>

⁴ <https://www.theguardian.com/commentisfree/2025/jan/15/woke-capital-net-zero-banking-alliance>

There are several current examples, where banks rely on industry sectors to provide information on sustainability standards. These standards are used by banks to make discounted lending available to borrowers. There are low barriers to extending this approach to constrain financial flows to activities in areas of declining ecosystems. In this case, Loan approval is conditional on evidence the borrower is adhering to high sustainability standards including sustainable grassland management as well as nutrient storage.

Industry-Aligned Loan Approval

Bank X does not finance livestock agricultural activity where loan proceeds will be used to increase production in catchment areas with moderate, poor, or bad ecological status as reported in the National System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA-EA) unless the farmer can demonstrate they are a participant in a recognised Sustainability Programme.

For a loan to be Taxonomy aligned, the borrower must provide evidence that the use of proceeds will significantly contribute to the protection and restoration of nature and Do No Significant Harm to any of the other Taxonomy objectives. This will require some part of the proceeds to be dedicated to investment in a Nature-based solution (NbS) and be subject to ex-post monitoring.

Taxonomy-Aligned Loan Approval

Bank X does not finance livestock agricultural activity where loan proceeds will be used to increase production in catchment areas with moderate, poor, or bad ecological status as reported in the National System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA-EA) unless the farmer can demonstrate a clear intent to protect and restore biodiversity through investment in Taxonomy qualifying river and lake measures.

To be effective, this would require third-party assessment to guide appropriate interventions as well as monitoring data linked to a more flexible financial contract where the discounted interest rate is contingent on the installation and maintenance of the NbS. In the loan scenario used here, qualifying NbS include river or lake related measures such as riparian or floodplain vegetation development or floodplain restoration, for example re-connection of a river or lake with its floodplain or re-meandering river courses by creating a new meandering course. Under current banking conditions this latter choice would have cost implications for the borrower and implications for the banks competitive position. Section 1.7 expands this potential use case and the supporting technologies that could help to reduce transaction costs associated with implementation and data management.

3.3 The BIOFIN Dashboard: Lending Use Case

3.3.1 Overview

The Dashboard aims to support financial flows towards economic activities that contribute substantially to the protection and restoration of biodiversity and ecosystems. It will be designed to be deployed in a limited, but important set of financial decision-making settings. It is expected that the Dashboard will minimise transaction costs for counterparties engaged in financial contracting while facilitating feasible collection and processing of high integrity, science-based data.

3.3.2 Bank Lending

To align with the EU Taxonomy, loan proceeds must be used to substantially contribute to one of six environmental objectives and Do No Significant Harm to any of the other environmental objectives listed in the Taxonomy.¹ In the context of biodiversity data that is relevant to

Environmental Objective 6 of the Taxonomy, banks have no easy way to identify and gather biodiversity data from prospective borrowers. This problem is particularly the case for lending to Small and Medium Sized Enterprises (SMEs), project finance or loans made through Special Purpose Vehicles (SPVs).² Furthermore, in developing and delivering loan products, banks have no easy way to nudge prospective borrowers towards investing in qualifying activities. To be successful, this activity must be designed to fit within a loan approval process that takes place in a competitive banking market. This motivates our first use case which focuses on new lending to unlisted SMEs (farmers).⁷ The use case initially focuses on how the Dashboard can help to reduce the costs associated with contract completion and information sharing between a prospective borrower and a lender. Extensions of the use case will test how the Dashboard can support information sharing on the impacts of qualifying activities to improve financial contracting and reporting.

Table 11: Key definitions in lending use case. The terminology is consistent with that used in Annex IV of the EU Taxonomy. [Link here.](#)

Counterparty	Description
Borrower	Individual or organisation that is borrower funds where some or all of the proceeds of the loan are dedicated to a qualifying activity.
Lender	Financial institutions lending funds where some or all of the proceeds of the loan are dedicated to a qualifying activity
Operator	Individual or organization that carries out the qualifying activity.
Third Party Certifier	Competent authority that verifies the initial description of the conservation area and the management plan.
Qualifying activity	The activity contributes to at least one of the following: (a) maintaining good condition of ecosystems, species, habitats or of habitats of species; (b) re-establishing or restoring ecosystems, habitats, or habitats of species towards or to good condition, including through increasing their area or range.

Dashboard functions during loan approval:

- provides an easy way for the Borrower to share details on the use of proceeds (location, planned use of proceeds).
- matches the Borrower with an Operator with expertise in delivering qualifying activities at that location, and
- provides an easy way for the Borrower to upload evidence that they are undertaking a qualifying activity.
- provides an easy way for the Third-Party Certifier to verify that the activity qualifies

Dashboard functions post-loan approval:

- provides the Lender with integrated information on the loan including loan type, location, use of proceeds, details on the qualifying activity
- Provides an easy way for the Borrower to obtain and upload evidence of impact of qualifying activities. This monitoring activity would be undertaken by the Operator as part of the original contract. [This function will be developed in second phase of testing.]

Example

A conventional bank provides agricultural lending to individual farmers. It designs a green loan that provides financial support for qualifying activities that substantially contribute to the protection and restoration of nature. The green loan makes a preferential rate available on the full loan amount, if x% of the total loan proceeds are directed towards a qualifying activity. For illustrative purposes we categorise two LIFE IP projects as examples of Operators with the expertise to undertake assessment and implement qualifying activities (Waters of Life, Wild Atlantic Nature).

Table 12: Operator and specialism in qualifying activity*

Wild Atlantic Nature	river or lake related measures <i>installation of ditches for rewetting, removal of drainage installations, replacement with installations that control the discharge, or setting back of dykes to enable flooding</i>
Waters of Life	river or lake related measures <i>riparian or floodplain vegetation development or floodplain restoration, including re-connection of a river or lake with its floodplain or off-channel/lateral connectivity improvement to restore the retention capacity of the floodplain and its ecosystem’s function; re-meandering river courses by creating a new meandering course or reconnecting cut-off meanders or reconnecting a lake or group of lakes to a river;</i>

Wild Atlantic Nature and Waters of Life are EU funded LIFE IP projects. They are envisaged here as ‘operators’ with the technical and operational capability to assess and implement qualifying activities on a contractual basis and in receipt of private finance.

Loan Application During the loan application process, the Dashboard allows prospective borrowers to identify how loan proceeds will be used at their location and to view pressures on local ecosystems. A matching process is facilitated so that the borrower can connect with an operator with expertise in undertaking qualifying activities relating to those ecosystems.

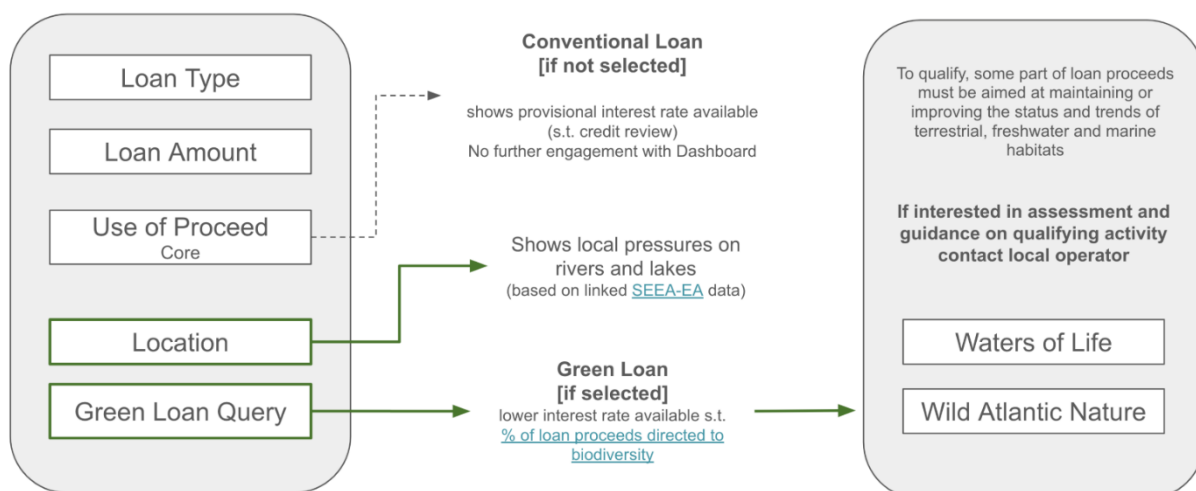


Figure 5: Dashboard Borrower Interface (Loan Application) allows a prospective borrower to select an operator to undertake an assessment and provide guidance on qualifying activity.

Loan Approval Following contact from the Borrower, the Operator undertakes an assessment of the farm (area for conservation) and provides a management plan as per Section 2 and 3 of [Annex IV](#) of the Taxonomy. If the Borrower agrees to proceed, a contract between the Borrower and Operator is concluded. The Borrower uploads the contract to the Dashboard, and this is verified by a Third-Party Certifier.

Post-Loan Monitoring and Reporting The bank uses the Dashboard to support the audit and reporting functions. Internal bank users with compliance and reporting tasks can use the dashboard to link individual loans with location specific detail on use of proceeds and qualifying activities. Additional features such as post-approval monitoring where the Borrower can provide information on progress arising from qualifying activities, for example scorecard data provided by the Operator.

3.3.3 How does the Dashboard align with existing data systems and methods?

Conventional retail lending is characterised by streamlined processes that minimise effort for prospective borrowers and ensures that banks can easily receive and verify key information. Green loans typically require the borrower to incorporate additional information to the loan approval process.³ The application of the Dashboard in the current use case aims to maintain loan processing efficiency while incorporating necessary additional features in relation to biodiversity actions and data management.

The Dashboard allows a prospective Borrower to identify the use of proceeds and the location of core activity (e.g. purchase of farm equipment, maintenance of agricultural buildings). Dashboard integration with spatially explicit information on the extent and condition of ecosystems enables a prompt for the prospective Borrower to invest some part of loan proceeds in a qualifying activity. They are alerted to local Operators who can assess the area of conservation and design a management plan. Green loan approval is confirmed once the contract to undertake the qualifying activity are uploaded to the Dashboard.

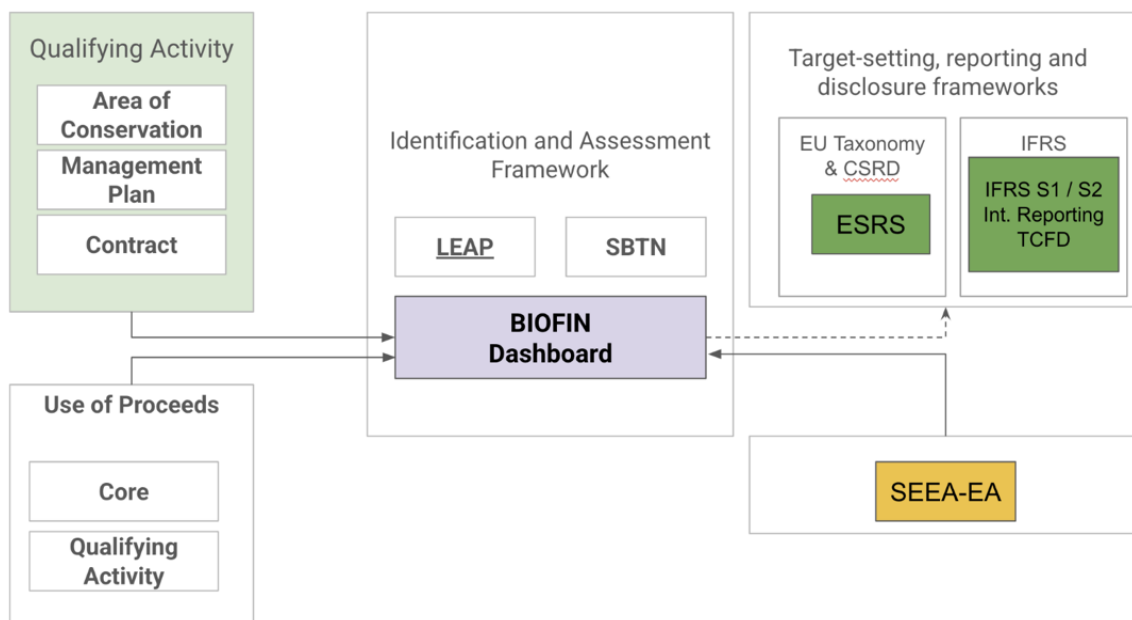


Figure 6: The Dashboard reduces costs associated with delivering and reporting on Taxonomy-aligned new loans. The extent and condition of ecosystems provided are publicly available

The SEEA-EA (Ecosystem Accounting) can be used for target setting and measurement within private entities (as per the Align approach). SEEA-EA comprises five ecosystem accounts, namely extent, condition, services (physical and monetary), and asset and while there is variation in approaches to ecosystem accounting, EU countries are reporting the extent and condition of ecosystems. Integrating this spatially explicit data into the Dashboard facilitates decision-making and designing loan products that are responsive to changes in the condition of ecosystems. In the current use case,

the Dashboard makes it easier for a Lender to promote qualifying activities to a prospective Borrower at a location where rivers and lakes are in poor condition. The methodology aligns with ESRS and IFRS reporting requirements / standards. For this reason, we show SEEA-EA informing the reporting & disclosure frameworks in the above visual.

At the time of writing (February 2025), the minimum viable product (MVP) for the Dashboard is under development. The use case and MVP will be evaluated by retail lenders over the coming weeks.

3.3.4 Institutional Investors

Asset management encompasses the management of both physical and financial assets. Primary information was gathered from stakeholders in asset management including several semi-structured interviews and an online workshop (29/10/2024) with institutional investors and managers of physical assets. In the context of using and deploying biodiversity data in investment settings, it is clear that the universe of biodiversity-linked assets is very small, and this is in itself a challenge for financial institutions seeking to efficiently allocate capital.

“The team made an attempt to design a biodiversity ETF⁵ but the set of eligible assets that could be included were too small.” (Participant 1, Asset Management)

In the context of available financial instruments, the relevance of biodiversity information to the investment decision was noted;

Sovereign green bonds are the most common pro-environmental asset class because sovereigns own large land areas...The focus is on carbon sequestration (afforestation, rewetting,..), while there may be biodiversity impacts they are currently unmeasured and do not influence decision-criteria. (Participant 2, Asset Management)

The absence of biodiversity data is also cited by a manager of forestry assets who notes that they have taken actions to protect habitats within their forestry management and planning, not in the expectation that it will influence the value of the asset but just that it was the right thing to do. In considering financial assets (e.g. equity), there are limitations associated with the analytical tools available to asset managers. A global asset manager that is seeking to implement nature-positive investment set out the following sequence that they have developed to evaluate prospective investments. Asset selection process;

- apply exclusion criteria (avoid),
- analyse a company’s global pressure on biodiversity (minimise) and
- establish whether a company is having a positive impact on biodiversity e.g. identifying revenue arising from specific nature-positive activities such as improving water quality (restore)

⁵ An exchange traded fund (ETF) is designed to provide a low-cost way for retail investors to invest in a group of assets characterised by theme

In applying its exclusion criteria, the asset manager analyses the company according to pre-determined key performance indicators (KPIs) such as; does company make a major contribution to climate change (exclusion of fossil fuel companies)?, how does the company contribute to the usage of water or change in land use? A second level analysis focuses on controversies in relation to the company's activities in locations where there are pressures on biodiversity. Metrics such as mean species abundance (MSA) are used to indicate biodiversity pressures at specific locations.

3.3.5 Research Agenda

Within the investment management industry there are multiple interacting challenges in implementing a nature-positive investment strategy. Competitive market pressures and an adverse political environment remain dominant. However, it is clear that even for motivated and highly resourced analysts, there are poorly understood issues around the selection and relevance of biodiversity data. There is an opportunity to develop guidelines for the use of biodiversity indicators across asset class and sector.

4. Individual Investors

A broad variety of investment vehicles are available to non-professional, individual investors. The largest proportion of investment capital is directed towards those vehicles that are passively managed and as far as possible reduce transaction costs for capital owners while providing them with easily defined profile in terms of expected returns and risk over a defined future time-period.

The European Fund and Asset Management Association (EFAMA) reports that €18.6 trillion was held in mutual funds across Europe in 2023. UCITS (Undertakings for Collective investment in Transferable Securities) funds are regulated and widely recognised across the EU, and they are the dominant vehicle in the market as they provide diversification and regulatory protections. In recent years, Exchange-Traded Funds (ETFs) have seen significant growth reaching €1.5 trillion assets under management (AUM) in 2023. Passive investing through ETFs is increasingly popular, particularly among younger investors. Pension products, including personal pension plans and employer-sponsored schemes, are widely used. In 2023, 35% of EU households held pension-related investments, according to the ECB. Pension products, including personal pension plans and employer-sponsored schemes, are widely used.

While these investment vehicles and the systems that have been developed are efficient from a financial perspective, their design and delivery have effects on transparency and investor's agency over how their capital is deployed. The BIOFIN project is exploring how individual investors can more effectively allocate their capital to investment vehicles that protect and enhance nature. Our primary research question is: how do individual investors interpret, access, and participate in nature-positive investment? A systematic review was undertaken and categorised according to the themes that support or prevent investors choices in these domains. These themes are included; governance and technologies; behavioural biases and preferences; organisational forms and regulatory instruments and labelling. The results are expected to increase our understanding about the design of investment vehicles and how this impacts nature-positive investment. Moreover, they will inform us about how future research should attend to each of these themes if the private financial flows are to be re-directed towards the protection and restoration of nature.

4.1 Individual Investors and Nature Positive Investment

The actions of individual investors can significantly influence market trends and drive demand for sustainable and socially responsible investment products, complementing the large-scale impact of institutional investors (Pasquino & Lucarelli, 2024). Individual investors' capital flows are affected by the design of organisational structures, government tax and pensions policies, technological tools, and financial services regulation. Within this operating environment, factors such as financial literacy, income, and household characteristics as well as behavioural biases impact on savings and investment activity (Abdulrasool, et al., 2023).

Increasingly, individual investors are choosing to make their own investment decisions, typically through online brokerage platforms or in retirement accounts (pensions), leading to a huge increase in individual investor participation in financial markets. For example, in Germany, the retail investor base grew to a 19-year high in 2020 as 2.7 million individuals began investing for the first time (Jesus, et al., 2022). Rapid advancements in financial technology have further accelerated individual participation in financial markets and changed the way retail investors interact with financial instruments. The number of people globally using smartphones to trade securities increased from 36 million in 2017 to 130 million in 2021. In the same period, more than 20% of all trades made by

individual investors were executed on a handheld device (Brière & Thomadakis, 2024). The development of online trading platforms has allowed individual investors quicker and easier access to financial markets. Coupled with the rise of social media and online forums facilitating the dissemination of information to retail investors, access to financial markets has become much more democratised in recent years. Furthermore, the use of technology such as robo-advisors is allowing retail investors a more tailored approach to investment decision making and helping to close the ‘value-action gap,’ whereby investment decisions do not fully align with individual preferences. This is particularly relevant for robo-advisor clients who express preferences for environmentally sustainable investment products. In a sample study of 27,000 Nordic robo-advisor clients, 33.69% chose to actually invest more sustainably in line with their expressed preferences (Faradynawati & Söderberg, 2022). Therefore, understanding their motivations and finding ways to influence their behaviours is important for large-scale re-directions of financial flows towards nature-based solutions.

Biases in individual investor behaviour, such as overconfidence or conservatism can amplify market noise and prompt institutional investors to use individual sentiment as a contrarian indicator to adapt their approach (Baker, 2007). Indeed, while retail investors tend to underperform as a result of such biased behaviour, their returns are also negatively affected by externalised barriers in the market such as high transaction costs and poor-quality information (Barber, 2000). This traditionally gave more sophisticated players, such as large institutional investors, scope to adjust their strategies and exploit the resulting arbitrage opportunities. However, behavioural interventions or “nudges” can be effective non-price tools for disrupting people’s behaviour across a variety of fields, in a less invasive and more inexpensive manner than, for example, tariffs, embargos, taxes or bans (Andor & Fels, 2018). Softer interventions, informed by research in behavioural economics, are being increasingly employed in environmental policy to target observed cognitive biases, such as loss aversion, and achieve sustainability goals (Homar & Cvelbar, 2021). Given the impact such interventions could have on several policies, this research seeks to understand the effect non-financial measures could play in mobilising retail investors towards nature-based financial solutions. A systematic literature review (in progress) aims to establish the extent and gaps in the knowledge around nature positive investment barriers individuals face.⁶

4.2 Investor Preferences, Investment Rules, and Impact

Under defined-contribution plans, employees are responsible for how much they save and where they direct their savings. The suite of savings vehicles available to employees are typically designed to be responsive to their risk preferences as well as their proximity to retirement age. In providing a systematic way to curate and market savings products, the pensions system may thus be limiting employee’s freedom to allocate some part of their available resources to support the protection and restoration of biodiversity. Redirecting financial flows can be facilitated through activating the pro-environmental preferences of investors more effectively and adjusting the governance procedures of fund administrators to require them to direct some part of their investment towards specific outcomes.

⁶ Clohessy et al. (under review) Individual Investors and Nature Positive Investment: A Systematic Review Protocol. PLOS ONE.

At a global level, the funds industry is dominated by three US based funds companies, Blackrock, Vanguard, and State Street Global Advisors. They manage an estimated USD20.7 trn and exercise around 23% of the votes in the S&P 500 single class companies. In an effort to navigate the contested US political environment, Blackrock introduced voting choice programmes which allow individual investors to participate in the proxy voting process (Blackrock, 2022). This innovation allows Blackrock to move to a more neutral position in corporate governance, while facilitating individual investors to vote according to their priorities. In the absence of improved data sharing on corporate impacts on biodiversity, these voter choice programmes will have little impact on corporate strategy.

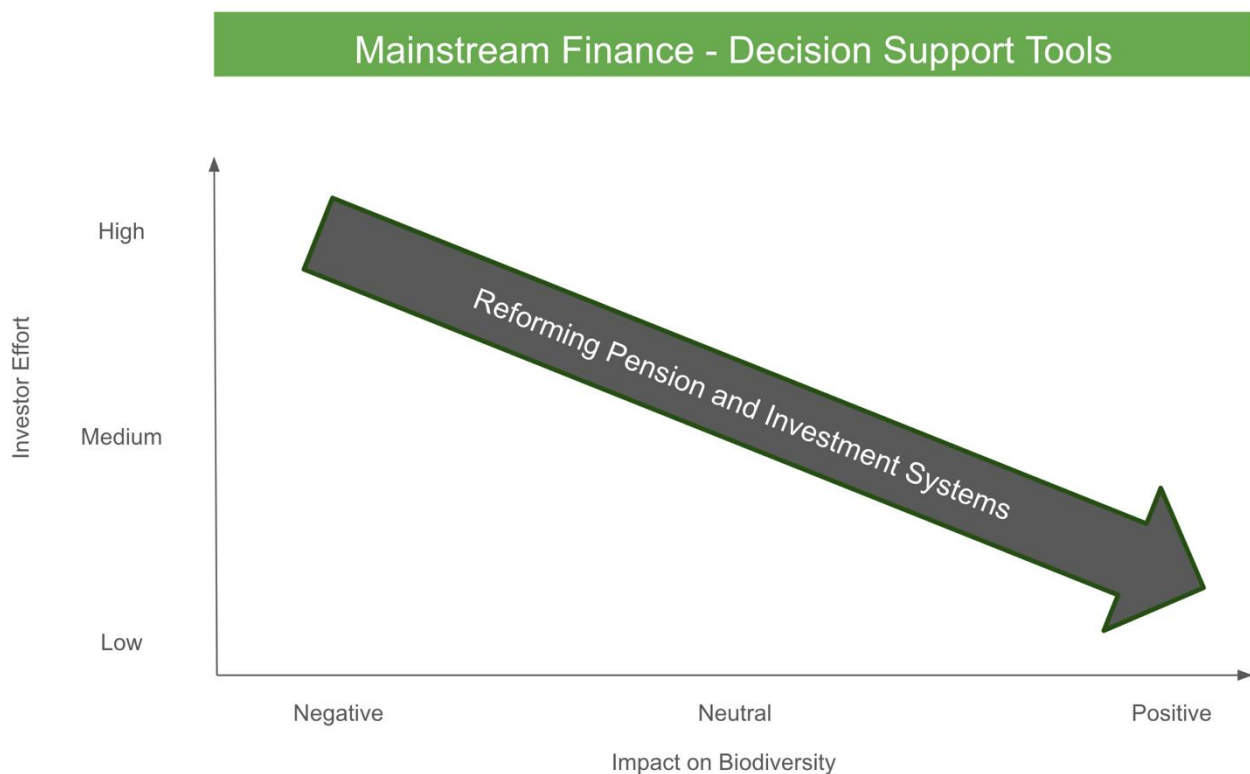


Figure 7: Reforming pension and investment systems. Addressing investment rules and activating individual investors may help to redirect financial flows. Mandating local investment (e.g. LGPS Review, 2024) will increase transparency and improve governance, potentially making capital available for Nature-based Solutions. Improving the impact of voter choice programmes (e.g. Blackrock Programme) requires improved data sharing on the corporate impacts on biodiverse landscapes.

Pension system reform also has the potential to positively impact investment in local, nature positive initiatives. For example, the pension investment review directs administrators of Local Government Pension Funds (LGPS) to work with local, mayoral, and strategic authorities to identify local investment opportunities, and to have regard for local growth plans and priorities when setting their investment strategy. LGPS asset pools would be required to carry out due diligence on local investment proposals, to make the decision to invest in these opportunities where they deem it to be in the interest of the fund and its members, and to manage such local investments (Pension Investment Review, 2024). These innovative rules offer the prospect to redirect mainstream finance towards the local Nature-based Solutions while prioritising the long-term welfare of pension fund holders. Examining enhanced governance of pension funds and the market design requirements to improve matching of fund flows with Nature-based Solutions as well as monitoring impacts of

investment are essential. Research in Year 2 of the BIOFIN-EU project will examine the barriers and opportunities to activating investor preferences (both institutional and individual).

5. Corporate Strategy and Market Design

An assessment of the exposure of industrial sectors and sub-sectors to physical and transition risks was undertaken by a Czielski et al. (2024). Agriculture and farming is a critical area for the EU as it has both a high impact as well as a high dependency on nature related risks. This has informed the redirection of public flows through the Common Agricultural Policy in recent years, however, there has been now wide-ranging empirical analysis to assess whether private financial flows from financial institutions or corporate finance have been influenced by biodiversity risks.

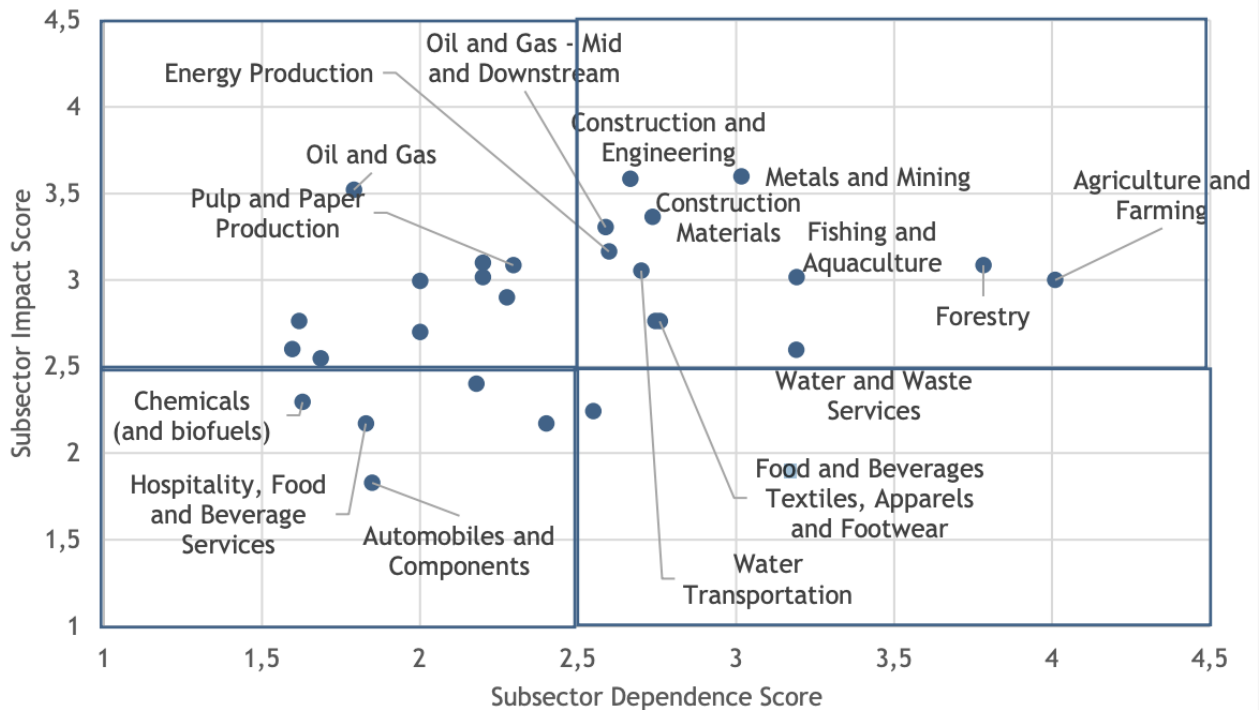


Figure 8: (Sub)sector dependence and impact score (Czielski et al., 2024)

Livestock farming accounts for approximately 14.5% of total anthropogenic greenhouse gas (GHG) emissions globally, with methane (CH₄) from enteric fermentation and nitrous oxide (N₂O) from manure management as the primary sources in dairy production (Gerber et al., 2013; Rivera and Chará, 2021). Additionally, land use change—primarily the conversion of natural habitats to agricultural land—is the leading driver of biodiversity loss (Cabernard et al., 2024). Extensive livestock systems drive deforestation and land degradation, while intensive systems contribute to nutrient overloads and pollution due to waste mismanagement (Gerber et al., 2013). Rising demand for animal products due to an ever-growing population is only amplifying these pressures (Crist et al., 2017). Agriculture must reconcile food production with biodiversity and ecosystem services provision—one of the most pressing challenges of the 21st century (Dudley and Alexander, 2017).

In the European Union (EU), these pressures are highlighted by conflicting and interacting policy agendas. The Common Agricultural Policy (CAP) prioritises productivity and competitiveness, driving agricultural intensification to meet the growing demand (O'Donoghue and Hennessey, 2015; Britt et al., 2018). For example, in Ireland, the abolition of EU milk quotas in 2015 led to herd growth, higher cow yields and new dairy farms (Läpple et al., 2022). While this expansion bolstered economic growth, it placed substantial pressure on land use, water quality and biodiversity, highlighting the environmental trade-offs inherent in intensification. Simultaneously, environmental directives such as the Nitrates Directive (ND) and the Water Framework Directive (WFD) aim to mitigate pollution and protect aquatic ecosystems, placing constraints on nutrient

management and land use. Financial and reporting regulations—including the EU Sustainable Finance Taxonomy (EUSFT), the Corporate Sustainability Reporting Directive (CSRD) and the Sustainable Finance Disclosure Regulation (SFDR)—further reshape operational and strategic choices for agribusinesses, requiring them to navigate competing demands for productivity, sustainability, and regulatory compliance.

Agribusinesses have implemented strategies to balance economic and environmental goals in response to these pressures. Companies like Kerry Group and Glanbia have divested high-impact assets to cooperative structures, reducing exposure to stringent reporting requirements under the CSRD ([Brennan, 2024](#); [O'Brien, 2024](#)). Similarly, herd reduction has been proposed as a short-term strategy to lower emissions by reducing animal numbers while increasing productivity over the longer term ([Lötjönen et al., 2020](#)). While these approaches provide immediate relief, they fail to address systemic inefficiencies or capitalise on opportunities for long-term sustainability.

The increasing size and spatial concentration of dairy farms have amplified the environmental impacts of intensive livestock farming, particularly in regions with nutrient surpluses (Lauer et al., 2018). Improper manure handling contributes to regulatory scrutiny and heightened costs, necessitating effective mitigation strategies such as detailed manure management plans or improved nutrient recycling practices ([Skaggs et al., 2018](#)). Beyond traditional approaches, manure can also serve as a renewable energy feedstock, presenting an opportunity to address environmental challenges while creating economic value. While high costs and uncertain economic returns have limited widespread adoption, anaerobic digestion (AD) offers a particularly promising solution. Converting manure into biomethane, a renewable energy source and nutrient-rich digestate; AD and broader biorefinery strategies enables a circular bioeconomy approach that reduces emissions and transforms waste into value-added resources ([Skaggs et al., 2018](#); DAFM & DECC, 2024).

5.1 Implementing Nature-based Solutions in Industrial Agriculture

Irish agriculture is the largest national emitter of GHGs. Agriculture plays a crucial role in the country's decarbonisation efforts (European Commission, 2023). The Draft National Biomethane Strategy aims to produce 5.7 TWh of biomethane annually by 2030, underscoring the urgency of decarbonising hard-to-abate sectors such as agriculture and transport (DAFM & DECC, 2024). This initiative emphasises the critical role of AD in embracing circular business models, presenting significant opportunities for the dairy industry to enhance both sustainability and economic resilience. However, Ireland's biomethane sector remains underdeveloped relative to other EU countries, highlighting the need to leverage the country's Agri-centric economy to address these challenges.

This study applies Roth's ([2008](#), [2018](#)) market design framework to examine Ireland's enabling conditions for biomethane market development. Specifically, it explores how a circular bioeconomy can support the dairy sector's decarbonisation efforts while mitigating its impact on freshwater ecosystems. Roth's guiding principles—thickness (attracting participants), congestion management (streamlining transactions), safety (reducing uncertainties) and addressing repugnance (ensuring social acceptance)—provide a structured approach to creating a well-functioning biomethane market (Roth, 2008). This framework emphasises establishing the necessary rules, customs, and infrastructure to facilitate the supply of nutrients into anaerobic digesters and the demand for outputs, such as renewable energy or biofertilisers (Roth, 2018).

A modified Delphi approach engaged experts from academia, dairy processing, financial services, and industry stakeholders in this forward-looking study. This deliberate focus on upstream

stakeholders reflects their pivotal role in shaping market structures and aligning regulations. While farmers are integral to feedstock supply and biofertiliser use, they face barriers such as high costs and limited technical expertise, necessitating support from agribusinesses to implement wider systemic changes ([O'Connor et al., 2021](#)).

The Delphi process comprised two surveys and a concluding workshop. The first survey identified key drivers, barriers, and best practices for biomethane market development. The second survey refined these findings and prioritised barriers using [Tuni et al.'s \(2023\)](#) risk classification framework, which categorises risks into market, supply, financial, technical and policy/regulatory domains. Transitioning from linear to circular business models brings inherent uncertainties, especially in early-stage markets. The framework offers a lens to systematically address these risks, ensuring a comprehensive understanding of the challenges faced by circular economy initiatives. Finally, the workshop provided a platform for participants to validate the findings and collaboratively develop actionable strategies for scaling biomethane production while addressing sectoral risks.

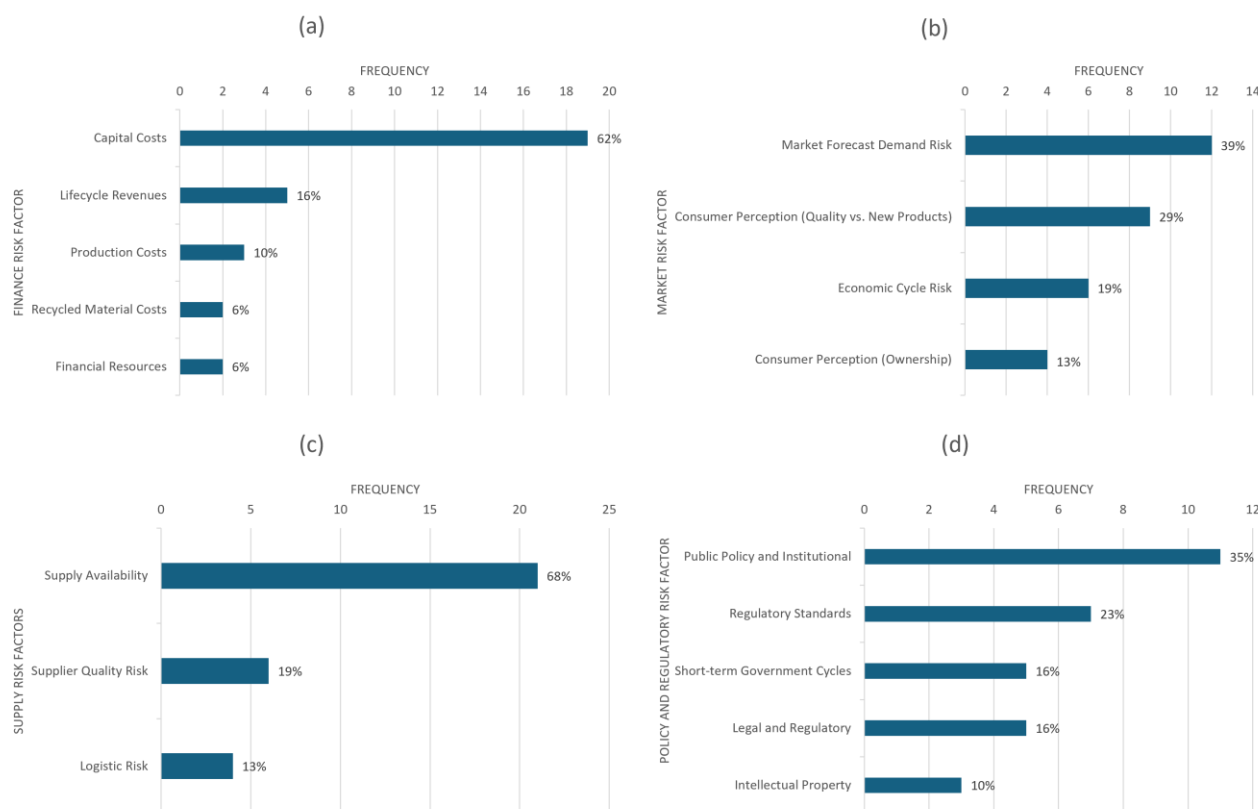


Figure 9: Presents a summary of the key risks identified during Round 2 of the Delphi process, categorised into (a) financial, (b) market, (c) supply, and (d) policy & regulatory domains. (N=31)

The Delphi process revealed critical pathways for scaling biomethane production and integrating digestate into agricultural systems, addressing the dual challenges of energy production and sustainable nutrient management. Key drivers identified included policy support, financial incentives, and infrastructure investment, such as demonstration facilities. Clear regulatory frameworks and reliable feedstock availability were also highlighted as essential enablers. However, the market potential for digestate—the nutrient-rich secondary output of anaerobic digestion—remains underexplored. Digestate offers substantial opportunities to replace chemical fertilisers, restore soil health and safeguard water quality. Its practical use aligns with NbS principles ([Cohen-Shacham et al., 2016](#)), providing environmental benefits extending beyond energy production and reducing greenhouse gas emissions.

This dual focus on biomethane and digestate underscores the importance of coordinated policy support and innovative market structures to enable AD's success across the dairy value chain. The findings emphasise the potential for agribusinesses to transition from linear to circular business models (CBMs), with AD offering a viable pathway to achieve this. However, the successful integration of AD within a circular bioeconomy framework requires a collaborative approach. Experts highlighted the necessity of industry-led initiatives, complemented by clear government policies and targeted incentives, to establish the enabling conditions for scaling AD technologies and applications.

Policymakers play a critical role in fostering a transparent regulatory environment and providing the necessary support, while agribusinesses must explore transformative solutions that align with these frameworks. Importantly, AD must be positioned within the interconnected transitions of climate, energy and circularity, with biodiversity and social dimensions underpinning its success ([Jonker and Faber, 2021](#)). Such an integrated perspective ensures that AD is not seen solely as a bioenergy solution but as a cornerstone of a broader sustainability strategy. By addressing structural barriers and fostering collaboration across stakeholders, Ireland has the opportunity to lead in agricultural sustainability, balancing its Agri-centric economy with its environmental responsibilities.

The findings presented here form the foundation for a broader analysis of market development strategies and policy recommendations, which will be explored further in the full publication. By leveraging AD and adopting circular business models, Ireland's dairy sector can achieve transformative change, advancing environmental, economic, and societal goals while setting a benchmark for sustainable agricultural practices.

6. Private Financing Solutions in Public Authorities and Public Enterprises

6.1 Public Enterprises

Public enterprises play a significant role in land-use management including the management of forestry, rivers and seascapes, agriculture, bioenergy, water services, and waste management, to name but a few ([Palcic & Reeves, 2022](#)). While public corporations are motivated to make a profit, they are often incentivised or required by the state to balance this motive with goals related to sustainability and the climate crisis. (Systematic Review) Nature based solutions (NbS) can help these corporate entities to manage these competing interests, and thus, it is crucial to identify and explore the various factors that help or hinder investment into NbS. Barriers to investment can be internal and external, with research on internal barriers focused on shareholder prerogative tools that are used to direct public corporations towards NbS. ([Benoit et al, 2023](#)) These can include mandates and public missions (formal objectives) and the setting of clear NbS investment targets. Bottlenecks can occur where there is a lack of clarity related to these tools. There can also be friction related to the level of autonomy that public enterprises have and whether a ‘whole-of-government’ approach, is followed, where there is an incorporation of climate and NbS related mandates and targets within state ownership policies for their public corporations, or if investment is hindered by less climate-friendly executives, and directors who may focus more heavily on the profit motive. ([Schwarz et al, 2023](#)). External (non-government) institutions and market forces can also incentivise, or hinder investment into NbS, by for example, granting access to funding through the EU Green Deal and to the EU’s taxonomy for sustainable activities, and through access to funding from financial markets. The motivation is to find out how public enterprises finance and govern NbS, and what incentivises and hinders their deployment will help establish the effectiveness of NbS used by these corporations and the policy tools that might be developed to address any obstacles to their successful deployment.

6.2 Public Authorities: Financing Community Led Nature-based Solutions

There are several funding mechanisms available to support community actions in relation to climate, water, and biodiversity. Flexible and innovative approaches to funding are an important staging post to increasing awareness of the set of possible Nature-based Solutions that can be implemented and provide a meaningful way for local communities to reveal their preferences and build their capabilities in this regard. An example of this is the [Community Climate Action Programme \(CCAP\)](#). Funds under the CCAP are allocated by local authorities in a competitive process and while many of the invested projects are focused on decarbonisation (e.g. financing solar PV installation), there are also examples of local communities using funds to invest in Nature-based Solutions.

To date, these are publicly financed initiatives that share some characteristics with private financing mechanisms that are deployed for early-stage commercial ventures (e.g. angel investors or seed investment funds) where the outcome is not well-specified and the decision to invest is guided by a combination of quantitative and qualitative data. In the private finance domain, forward looking metrics that describe the expected impact (in revenue or market) are typically used to guide the investment decision (for example, *Total Available Market* and the *Total Addressable Market*) and these figures are complemented by variables such as the experience and skills of the founding team. In the context of undertaking investment in small scale Nature-based Solutions, establishing a

systematic approach to accounting for actions and expected impacts and sharing information on NbS implementation is likely to contribute to improved capital allocation across funding rounds.

The range of financial instruments that can be deployed by local governments to support the energy transition are summarised in Figure 6.1. Local government have provided a template for identifying how financial flows can be redirected towards NbS in the public realm. The main focus thus far has been on decarbonisation projects such as retrofitting; however, these efforts have created innovative financing solutions. In the context of renewable energy, blended solutions have been successful. In this context, local authorities coordinate with private power companies to create a package where the first block of finance is delivered through (i) grants + tax breaks (public) with the balance supported through (ii) power purchasing agreement (private).

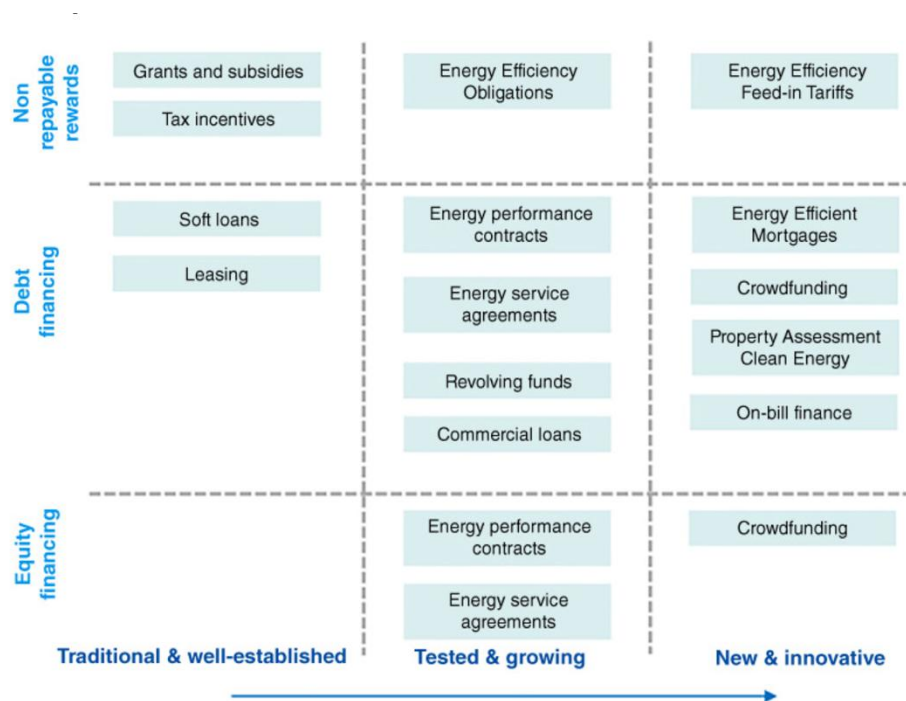


Figure 10: Financial instruments deployed by local government to support the energy transition (Bertoldi et al, 2020) <https://doi.org/10.1002/wene.384>

In Year 2 of the BIOFIN-EU project, research will include the governance and data systems needed to activate financial flows towards Nature-based Solutions. Existing governance rules in some cases prevent such investment. For example, local authorities cannot directly incentivise farmers living upstream to slow river systems which may mitigate flood risk to urban areas. Payments to farmers must be made by the Department of Agriculture.

7. Concluding Remarks

The current report identifies data bottlenecks and data systems at the product-, organisation and system-level of the financial system. Our aim is to provide new information to inform ongoing and future discussions on how to redirect financial flows towards the protection and restoration of biodiversity.

Green Bonds for Biodiversity A product-level analysis undertaken by Garvey et al. (2025) shows that instruments that direct funds towards ecological restoration have idiosyncratic features that prevent them from being integrated into the global financial system. These instruments incur significant costs in their design phase and being brought to market and these costs are not described in existing research. For this reason, green bonds issued by sovereigns provide the greatest promise for raising capital for the purposes of ecological restoration and doing it efficiently and at sufficient volume. However, protection and restoration projects are typically locally led, and appropriate for local ecosystems yet conventional financial instruments are typically designed to move capital at scale - for example, payments to workers during Covid-19 lockdown or investment in infrastructure projects. The development of national accounts on the extent and condition of ecosystems offers the promise of high-quality, science-based data that can be used to efficiently allocate public funds. However, the issuance of green bonds for ecological restoration will require new governance procedures and a financial architecture that can address the mismatch between available funds and qualifying activities.

Greener Lending The report identifies new approaches designed to streamline 'greener' lending that can redirect financial flows towards qualifying activities aimed at the protection and restoration of biodiversity. Providing simple technologies that can allow loan counterparties to more easily identify where and how loan proceeds are being deployed is a first step. In the context of retail lending, there is an opportunity to match prospective borrowers more easily with operators who can assess and identify the set of qualifying activities that should be undertaken to protect local ecosystems. Streamlining this matching procedure will provide adoption pathways to integrate qualifying activities into a green loan product. Further testing of lending procedures and development of the supporting technology is underway.

The report provides a preliminary view on active research that aims to identify the enabling conditions necessary to redirect financial flows in other contexts including institutional investment protocols, individual investment and savings decisions, the governance and investment priorities for public enterprises and local authorities. The impacts and dependencies of financial decisions on biodiversity is a nascent area of analysis in all these settings. The active research outlined in this report attends to operational challenges relating to technology, data sharing and governance.

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