Innovative Sustainable Finance Schemes: The Role of Public-Private Partnerships[*]

New public-private partnership schemes (also involving philanthropic foundations and other third-sector entities) may help to overcome the financing barriers faced by many types of projects focused on achieving social and environmental net positive impacts. This article explores the role that policy makers can play, through specific policies, to foster innovative collaboration and governance schemes across agents that help to reduce the green financing gap. A mixed non-systematic literature review and case study analysis (focusing on the experience in novel sustainable finance schemes in the region of Greater Manchester) are used to extract lessons and draw policy implications. An active role can be played by governments and public institutions to facilitate the financing of hard-to-fund innovative sustainability projects and activities via creating adequate conditions in the green financing market that induce innovative ways of public-private collaboration, such as the new 3P and 4P schemes.

Los nuevos esquemas de asociación público-privada (que también involucran a fundaciones filantrópicas y otras entidades del tercer sector) pueden ayudar a superar las barreras de financiamiento que enfrentan muchos tipos de proyectos centrados en lograr impactos sociales y ambientales netos positivos. Este artículo explora el papel que pueden desempeñar los formuladores de políticas, a través de políticas específicas, para fomentar esquemas innovadores de colaboración y gobernanza con otros agentes que ayuden a reducir la brecha de financiamiento verde. Se utiliza una revisión mixta no sistemática de la literatura y un análisis de estudios de casos (centrándose en la experiencia de nuevos esquemas de finanzas sostenibles en la región del Gran Manchester) para extraer lecciones y adoptar implicaciones políticas. Los gobiernos y las instituciones públicas pueden desempeñar un papel activo para facilitar la financiación de proyectos y actividades de sostenibilidad innovadores difíciles de financiar mediante la creación de condiciones adecuadas en el mercado de financiación verde que induzca formas innovadoras de colaboración público-privada, como los esquemas 3P y 4P.

Elkartze publiko-pribatuaren eskema berriek (fundazio filantropikoak eta hirugarren sektoreko beste erakunde batzuk ere inplikatzen dituzte) lagundu dezakete gizarte- eta ingurumen-inpaktu garbi positiboak lortzera bideratutako proiektu mota askok dituzten finantzaketa-oztopoak gainditzen. Artikulu honek politika-egileek politika espezifikoen bidez beste eragile batzuekin lankidetzan eta gobernantzan aritzeko eskema berritzaileak sustatzeko izan dezaketen zeregina aztertzen du, finantziazio berdearen arrakala murrizten laguntzeko. Literaturaren berrikuspen misto ez-sistematiko bat eta kasuen azterketen analisi bat erabiltzen dira (Manchester Handia eskualdean finantza iraunkorren eskema berrien esperientzian zentratuz) ikasgaiak ateratzeko eta inplikazio politikoak hartzeko. Gobernuek eta erakunde publikoek zeregin aktiboa izan dezakete finantzatzen zailak diren iraunkortasun-proiektu eta -jardueren finantzaketa errazteko, finantzaketa berdearen merkatuan baldintza egokiak sortuz, lankidetza publiko-pribatuko modu berritzaileak eragiteko, hala nola 3P eta 4P eskemak.

* This article is, partly, an adaptation and extension of Fernández Gómez (2024).

Jorge Fernández Gómez
Orkestra-Basque Institute of Competitiveness
and Deusto Business School

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1. INTRODUCTION

Guaranteeing an adequate availability and continuity of flows of financing capital to sustainability projects and activities is, arguably, the greatest challenge facing the global sustainability transition in the short-to-medium term.

Although investments in the so-called energy transition (the transformation of the energy system into a zero-emissions, environmentally sustainable value chain) have increased significantly in most countries in recent years, we are still far from the volumes of capital required to decarbonize the global economy (IEA, 2024).

Additionally, massive amounts of investment will be required to adapt societies and economies to the inevitable effects of climate change and try to mitigate and manage other environmental issues related to the health of ecosystems and a reasonable use of resources throughout the economy that respects the so-called planetary boundaries (Rockström *et al.*, 2009; Steffen *et al.*, 2015; Richardson *et al.*, 2023).

In all, it is estimated that up to 6%-8% of global GDP should be devoted annually over the next three decades to the sustainability transition (i.e., mitigation and adaptation projects and activities) to cover all the necessary investments in (energy and other) infrastructure, services and research, development and innovation (R&D&I) activities (UN Environmental Programme, 2022, 2023a).

Unfortunately, there is a so-called «green financing gap» between the expected investment requirements and the actual capital outlays, so that, at present, energy and financial markets are unable[1] to materialize the high levels of investments in the development and adoption of low-carbon assets and new technologies and business models that are required to meet energy and climate policy objectives (Polzin & Sanders, 2019; Sachs *et al.*, 2019; Hafner *et al.*, 2020; Fernández Gómez & Larrea Basterra, 2021).

A broad range of factors, including regulatory, market, technological and knowledge-related gaps, create serious barriers to investment in sustainability projects and activities –see the discussion in Fernández Gómez & Larrea Basterra (2021, 2022). Access to finance is seen by many businesses as a significant barrier to the commercialization of clean and sustainable technologies (European Investment Bank & European Patent Office, 2024).

While the research effort of the scholars has mainly focused on the analysis of the effectiveness of different green financing tools and instruments (e.g., green bonds, seed capital, structured loans or yieldcos, to name a few –see the discussion in Fernández Gómez and Larrea Basterra (2021)–), the types of funding –see the discussion in Fernández Gómez (2024)– or the roles of different (generally institutional) players (i.e., commercial banks, public financing and investment institutions and other investment companies) (Jones, 2012, 2015) or standard public-private collaboration schemes (e.g., in the form of public-private partnerships, PPP, involving large companies and public institutions), less attention has been paid to how new forms of collaboration and innovative governance schemes may facilitate an active participation in the financing of projects by new types of investors (i.e., smaller companies, citizens and other smaller private investors, foundations and other third-sector institutions and even municipalities) that help to unlock and channel private new streams of public and private capital to projects and activities with a positive net social and environmental impact.

The issue of public-private collaboration has been studied in depth in the academic literature. A number of studies have analyzed the differences between traditional PPP schemes (usually targeting the deployment and financing of large infrastructure projects and the provision of related services by large companies or utilities) and the so-called green, sustainable or social PPP schemes (Koppenjan, 2015; Marx, 2019; Vassileva, 2022). The latter incorporate sustainability goals (along the environmental, social and economic dimensions) and focus on many types of sustainable projects or activities (i.e., related to clean energy, circular economy, responsible production and consumption, energy efficiency, reduction of greenhouse

[1] The World Economic Forum estimates suggest that up to $3.5 trillion per year of additional investments are required to reach a net-zero scenario and restore nature. In December 2023, only 6% of the 2025 investment needs had been met (World Economic Forum, 2023).

gas (GHG) emissions and pollution, waste management, regeneration of ecosystems and natural resources, etc.).

Fernández Gómez (2024) argues that these new public-private partnership schemes (also including so-called 4P schemes, which involve philanthropic foundations and other third-sector entities), much better adapted to face sustainability challenges and to meet the requirements and preferences of the participating agents, offer a promising and novel avenue for generating the private capital flows needed to finance projects strongly focused on achieving social and environmental net positive impacts.

Continuing this discussion and with the aim to contribute to the study of new forms of public-private collaboration and governance structures in the area of sustainability, the research question we attempt to answer in this article is: what role can policy makers play, through specific policies, to foster innovative collaboration schemes across agents that facilitate the financing of sustainable projects and activities?

In order to answer this question, we conduct a mixed non-systematic literature review[2], focusing mainly on academic references, but also on relevant references from the grey literature. We also use case study analysis, based on the review of primary (i.e., entities directly involved in the case study) and secondary sources, to extract lessons and conclusions from the experience in novel sustainable finance schemes in the region of Greater Manchester, in the United Kingdom. This case, initially reviewed in Fernández Gómez (2024) offers valuable insights about how pioneer, innovative governance structures help to raise and direct public and private capital (from a large variety of agents and institutions) to sustainability projects and activities that in the past have not been able to attract private investors for a variety of regulatory, market and technological reasons.

The analysis in this paper strongly suggests that there is an active role for governments and public institutions to facilitate the financing of hard-to-fund sustainability projects and activities via fostering innovative ways of public-private collaboration, including sustainable or green public-private partnerships and public-private-philanthropic partnerships.

These new types of partnerships may help to overcome certain market barriers and generate new flows of private capital in a context of great uncertainty about cli-

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[2] The term non-systematic literature review (non-SLR) refers to any literature review that cannot be considered "systematic" in the sense described in Shamseer *et al.* (2015), for instance. Systematic literature reviews are scientific reviews based on statistical and meta-analysis protocols and generally aim to provide a thorough scan of all academic (and/or non-academic) publications in relation to a given, specific topic or issue (Huelin *et al.*, 2015). Non-SLRs, generally based on critical evaluations and subjective choices by the author(s) through a process of discovery and critique on the basis of expertise and expericence, are, essentially, critical reviews of the literature (Kraus *et al.*, 2022).

mate change, technology, regulations, geopolitical and macroeconomic conditions, etc. Also, the participation of new types of agents in the green financing ecosystem will likely increase social acceptance and social involvement in the sustainability transition.

In order to maximize the potential positive impact of these new collaborative approaches, integral strategies must be defined to strengthen the green financing ecosystem.

The article is structured as follows. In the next section, key issues related to how sustainable projects and activities are financed and to the "green financing gap" are discussed. The following section discusses new trends in green financing and how sustainable financing may be strengthened by fostering the development of new financing ecosystems characterized by the irruption of new agents, the design, development and adoption of new instruments and financing solutions, new regulatory frameworks, new, specific knowledge and skills and the implementation of innovative public-private collaboration schemes.

The fourth section focuses on the case of Greater Manchester and its strategy to promote the financing of sustainable projects and activities in the region via innovative public-private governance arrangements. While this case was reviewed in depth in Fernández Gómez (2024), the analysis here focuses on the key factors that may be fuelling the relative success of the novel public-private collaboration approaches in the region.

The fifth section presents a number of policy implications that can be directly derived from the analysis and the related literature. Finally, the last section presents the key conclusions of the analysis and identifies avenues for further research.

2. THE GREEN FINANCING GAP: KEY ISSUES

Confronting climate change and minimizing its risks and implications for future generations have become one of the main social and political goals in most societies around the world.

What must be done as a response is well known and understood. The 2015 Paris Agreement was the first planet-wide agreement where mandatory GHG emissions reductions are accepted by all countries in the quest to maintain the global average temperature increase to 1.5 ºC.

Global net-zero scenarios in 2050, such as the ones developed by the International Energy Agency (IEA, 2021) clearly illustrate the magnitude and scope of the transformation, reaching all sectors and segments of the economic value chain.

Despite goals being set and transition paths being delineated in most countries, global GHG emissions keep growing (UN Environment Programme, 2023b) and

the deceleration following the coronavirus pandemic in 2020 and 2021 has been left behind as an anomaly.

Thus, although change is slowly taking place, there is not sufficient green financing or investment capital flowing to projects and activities that are required to transform de global economy and reach environmentally sustainable outcomes in the medium and long run. The inability of current financial markets to guarantee such green investment levels leads to the so-called "green financing gap".

Estimates of this green financing shortage have increased in recent years. While the global green financing gap was estimated to be in the range $2.5 trillion-$4.8 trillion (per year) in 2017 (Yeo, 2018), more recent estimates may imply a gap in the range $5.2 trillion-$7.3 trillion (per year) (Allen & Overy, 2023).

Green financing refers explicitly to the financing of investments in sustainable activities and projects (Lindenberg, 2014). In turn, sustainable activities and projects can generally be defined as those that contribute to increased economic, social and environmental[3] sustainability in the sense originally brought about by Bruntland (1997), although the concept of sustainability may be difficult to pin down (Owens, 2003).

This focus on environmental (but also social and economic) sustainability implies some substantive differences with standard investment financing. First, the sustainability transition is a regulation-led process whose origin was the belief, based on scientific evidence, that the current economy-wide value chain and its dependence on fossil fuels, leads to climate change with adverse effects for humankind and other environmental problems. This is in stark contrast with technology- or market-let transitions in the past (i.e., such as the transition from coal to oil and then natural gas in the energy sector).

The urgency to make radical transformations in all sectors of the economy and all segments of the value chains (from exploration, mining to consumption of all materials) implies the need to innovate and foster changes in economic processes that are characterized by (1) the lack of mature technologies; (2) underdeveloped markets for "green" products and solutions; (3) unreliable and non-credible economic signals about the value of new technologies and solutions; (4) no established and tested business models based on these new technologies and solutions; (5) growing, but still insufficient, knowledge and skills about sustainability in general;

[3] On a more practical plane, the EU Taxonomy for Sustainable Activities, for instance, includes a definition of economic activities that can be considered environmentally sustainable (European Commission, n.d.). This classification helps agents (in both the financial and non-financial sectors) make financing and operating decisions about specific projects and facilitates channelling public and private funds towards sustainability-enhancing activities.

and (6) consumers' culture and preferences not yet adapted to the risks and challenges facing all societies and economies.

All these factors have a (negative) influence on the financial viability of many projects and activities that focus on sustainability. The determinants of the green financing gap are therefore varied and related in a complex manner and include, among others, the state of regulation in general, the state of technology, the degree of development of markets for sustainable products and services, the complexity of the financial markets, the stock of technical skills and technical knowledge (about new technologies, advanced finance…) or the political push and social support for the sustainable transition.

Hafner *et al.* (2019) identify, via a scoping review of academic literature, the key barriers to investment in sustainable activities and projects. Among these can be cited unstable (energy and climate) policy frameworks, policies favouring "brown" energy infrastructure (e.g. fossil fuel subsidies; limited pricing of CO^2 emissions), constraints on decision making by private investors, unfavourable views about the return on invested capital in sustainability projects, hard requirements on credit ratings, technology risk, climate risks and lack of integration into financial decision making, non-standardized data, insufficient liquidity, limited suitable financial vehicles and instruments and lack of technical knowledge.

Hafner *et al.* (2020), in turn, adopt a systems perspective to analyze the barriers to green investments and argue that a diverse set of policy solutions or system's changes will be required to scale-up green investments at the required scale and pace due to the complexity involved, in line with similar arguments about the need to foster new approaches to innovation (which also imply innovation in financing) (Mazzucato, 2016), shape new roles for public agents such as public investment banks (Mazzucato & Penna, 2016) and drive a change and evolution in the entire financial system in order to respond to the current challenges (Hall *et al.*, 2017).

Their analysis concludes that the green investment barriers are interrelated in a complex way and characterized by path-dependency, lock-in effects, delays and non-linearity. This makes closing the green finance gap a demanding task and suggests the need to design policy responses based on policy instruments beyond price incentives, such as bold, innovative changes in regulations and market-shaping policy approaches in general. Reducing policy uncertainty, fostering "long-termism" in the financial system, aligning policy objectives and stakeholders' interests and developing tools and institutional settings that support systematic planning and multi-stakeholder engagement are other ingredients of a successful recipe for reducing the green financing gap.

The demanding green financing requirements will require profound changes and an adaptation of the financing ecosystems, affecting all segments and dimen-

sions of the financial markets. The traditional players in the clean energy, sustainable investment supply chain (capital providers, such as institutional investors including pension funds, mutual funds, sovereign wealth funds, insurance funds and hedge funds; capital facilitators, such as banks, asset managers, brokers and advisors; and project developers, mainly private companies) (Jones, 2012) are at present unable to raise sufficient volumes of investment capital and respond to growing financing requirements in sustainability projects and activities throughout all sectors and areas of the economy.

The financing ecosystems and markets will have to respond, in this context, by adapting rules and procedures and generating new knowledge and skills that attract new potential investors, foster the development of new financial products and services and facilitate new forms of collaboration and partnerships that help to materialize the required investments.

These changes can be catalyzed in various ways and through a variety of channels (Fernández Gómez & Larrea Basterra, 2022), including (1) facilitating new avenues and solutions for both public (e.g., public investment banks and institutional financing, sustainable bonds, etc.) and private financing (both bank and non-bank, including new forms of venture capital, and other novel channels such as crowdfunding, business angels, foundations and other third-sector entities, etc.); (2) generating capacities on the supply side (financial services) and on the demand side (better intelligence and knowledge about specific aspect of sustainability projects and activities in all sectors); (3) fostering innovation in all sustainability areas, by designing and articulating new financing mechanisms and instruments adapted to each sector and new instruments adapted to each segment in the R&D&I value chain, from the lowest levels of technological maturity up to stages close to large-scale commercialization of new solutions, with special attention to the financing of start-ups in the early stages of projects and in the so-called "valley of death"; and (4) creating an appropriate breeding ground for the development of innovative public-private collaboration schemes around new financing mechanisms, products and services adapted to the risk profiles of a variety of agents and the technological uncertainty of investment projects in different sectors.

In the next section, we analyze how innovation in various dimensions of green financing may facilitate closing the green financing gap by dealing with some of the problems and barriers mentioned above.

3. BRIDGING THE GREEN FINANCING GAP THROUGH THE DEVELOPMENT OF INNOVATIVE FINANCING ECOSYSTEMS

An issue of utmost relevance for policy makers is then finding ways to close the green financing gap and channel larger volumes of public and private capital funds to sustainability-enhancing projects and activities.

As suggested by the discussions in Fernández Gómez & Larrea Basterra (2021, 2022) and Fernández Gómez (2024), strengthening the main pillars of the financial ecosystems and fostering innovative financing schemes based on new financial tools and solutions, novel governance structures and multi-agent collaboration may facilitate the unlocking of new private capital flows towards social and environmental value adding projects and activities. These key elements of the new green financing ecosystems are briefly discussed in the following subsections.

Directing capital flows, in particular, new private capital flows to green projects, activities and infrastructure that do not crowd out financing that would in any case take place under normal market conditions requires somewhat of a departure from conventional financing schemes based on public or grant funding, traditional financing tools (e.g., debt-based, equity-based, combinations of these or project finance), fee- or toll-based revenue models and standard service delivery models (e.g., based on public-private joint ventures, long-term leases, licensing, conventional procurement or direct delivery by public entities).

In contrast to (and, often times, complementing) these conventional schemes, innovative ways of promoting and financing projects and activities that represent added value from the point of view of sustainability in its three dimensions (economic, social and environmental) are emerging. These new approaches are characterized by (1) the participation of new agents in the (green) financing ecosystem; (2) the use of innovative financing tools and financing schemes (which may be used in combination with existing instruments); (3) the development of new regulatory frameworks; (4) new knowledge and skills; and (5) the irruption of novel forms of collaboration between different agents and between public and private institutions (Figure 1).

3.1. New agents

Attracting new agents to the green financing ecosystems appears to be critical for generating new flows of capital towards sustainability projects.

The conventional classification of agents participating in financial markets –see U4SSC (2021), for instance– includes public investors (mainly governments, public banks and multilateral institutions), private investors (mainly institutional investors such as commercial banks, investment companies, hedge funds and the like) and third-sector entities (such as certain NGOs).

New trends shaping the development of efficient, dynamic green financing ecosystems are driven by increased participation of other types of agents in each of these categories. In the public sphere, for instance, municipalities and other local (or regional) public entities (such as local or regional public investment or credit entities) are becoming more and more relevant in the financing of local projects with a positive social and environmental impact.

Figure 1. **ELEMENTS OF THE NEW GREEN FINANCING ECOSYSTEM**

Source: own elaboration.

In the private sector, smaller non-institutional investors (including, for instance, family offices, business angels, trust funds, standard foundations and other small investors in general) are participating more actively in crowdfunding or crowdlending mechanisms.

Finally, in the so-called third sector, a number of philanthropic foundations and societies (e.g., linked to financial institutions or large fortunes) with stated social or environmental sustainability goals are becoming protagonists in the financing of projects (for instance, focusing on nature-based solutions, habitat banking and other innovative environmental tools and approaches) that could not attract capital in conventional markets.

In addition, a number of players that are not necessarily investors, such as entrepreneurs and/or project developers (for instance, private companies in different sectors, such as construction, environmental services, energy companies, etc.), providers of relevant services (i.e., related to ICT, engineering, construction), manufacturers and suppliers of equipment, components, etc., and other providers of legal, financial, consulting

and analysis services are playing key roles in the new financing schemes and governance arrangements that characterized the new green financing ecosystems.

These new types of players in the financial markets are, often times, better suited to participate in the financing of sustainability-enhancing projects, thanks to their preferences, a stronger focus on creating positive net social and environmental impact, greater tolerance for technological risk, long-term vision and "patience" as financiers and better knowledge about the local reality.

3.2. New instruments and financing solutions

A second pillar of the new, dynamic green financing ecosystems is the design, implementation and adoption of innovative instruments and financing solutions. These new tools have been developing for years and, in many cases, can be considered relatively mature by now (Wang & Zhia, 2016; Polzin, 2017; Polzin & Sanders, 2019). Table 1 presents examples of various types of green finance instruments and arrangements.

Table 1. **GREEN FINANCE INSTRUMENTS AND ARRANGEMENTS**

TYPE OF INSTRUMENT	EXAMPLES
EQUITY FINANCING	• Seed capital • Venture/risk capital • Growth capital • Investment funds (mutual funds, hedge funds, private equity funds, pension or insurance funds) • Crowdfunding
DEBT FINANCING	• Bank loans (green or sustainability-linked, green promissory notes, etc.) • Structured loans and new services (e.g., leases, invoice factoring, supply-chain finance, off-balance sheet financing, working capital schemes…) • Loans from governments and multilateral institutions (concessional and non-concessional, credit lines, subordinated debt, debt-for-climate swaps and other innovative instruments…) • Green bonds • Crowdlending
GRANTS	• Conventional grants • Convertible (into debt or equity) grants

.../...

TYPE OF INSTRUMENT	EXAMPLES
OTHER FINANCIAL INSTRUMENTS AND ARRANGEMENTS	• Advanced project finance and other sophisticated structured finance solutions (incorporating multiple financing instruments, mezzanine capital, etc.) • Yieldcos • Long-term contracts (e.g., power purchase agreements) • On-bill financing, green mortgages, municipal and private PACE (property assessed clean energy financing) and other asset-based solutions (habitat banking, nature-based, etc.) • Services and performance contracts (e.g., energy services agreements, etc.) • Policy instruments (subsidies, tax incentives, feed-in tariffs, quota-based schemes…) • Risk-sharing or risk-reducing schemes (guarantees, insurance…) • Smart financing structures (i.e., with conditionality or performance-based clauses) • Debt securitization products • Blended finance co-financing • Project facilitation initiatives (e.g., connecting developers and financing providers) • Endowment funds • Targeted innnovation funds[4] • Vendor finance, use-based financing, "as a service" schemes…

Source: adapted from Fernández Gómez & Larrea Basterra (2021) and Fernández Gómez (2024). See also Mell (2016), Deloitte (2019), U4SSC (2021) or European Commission (2023).

The development of new financing solutions and arrangements (some of which are mentioned in the above table) that combine different instruments and revenue and financing formulae is key to channeling capital to sustainability projects and activities involving new technologies, business models, assets (i.e., natural resources) and social and environmental objectives.

The range of new solutions is broad and new instruments, solutions and arrangements help to facilitate access to capital to certain agents and entities (e.g., SMEs or other smaller private entities), improve the assessment and allocation of project and activity risks between public and private entities, optimize the know-how of the different actors

[4] An example of a fund with a strong focus on innovation and sustainability is the Innovation Fund of the Bizkaia provincial government, which aims to foster R&D activities by SMEs under a public-private collaboration approach (Bizkaia Foru Aldundia, n.d.).

involved in sustainable projects and activities and design, develop new projects that are better aligned with better reflect the preferences and needs of society and promote R&D&I activities at lower or experimental technology readiness levels (TRL) (Fernández Gómez, 2024).

The EU's Recovery and Resilience Facility (RRF), a performance-based financing mechanism and the key pillar of the NextGenerationEU plan to boost the European economy following the Covid-19 crisis, has a strong focus on innovative sustainability projects and is expected to channel more than €650 billion of public funds raised through bonds and other mechanisms to private or public-private projects via grants and loans (European Commission, n.d.,a).

3.3. New regulatory frameworks

The effectiveness of the green financing ecosystems will also be determined by how they adapt and incorporate the key elements of the regulatory framework. In the European Union, for instance, a new approach to sustainable finance is being developed, defining new rules and standards that must be understood and appropriately adopted by all players in the green financing value chain.

This new sustainable finance framework rests on six major elements (including directives, regulations, standards and platforms) (European Commission, n.d.,b): (1) rules for the systematic disclosure by corporations of sustainability-related (non-financial) information; (2) EU labels for benchmarks (climate, ESG) and benchmarks' ESG disclosures; (3) rules for the disclosure of sustainability-related information in the financial services sector; (4) the EU's taxonomy of sustainable activities (a set of common definitions and classification of activities); (5) standards for European Green Bonds (facilitating their issuance at the European level); and (6) the International Platform for Sustainable Finance (a forum for regulatory dialogue on green financing issues aiming at the creation and dissemination of new knowledge, best practices and common standards and ideas across countries and agents in the economy).

These new regulatory (and other) tools are increasing the transparency of the market, facilitating the exchange and comparability of relevant, critical information about sustainability projects and activities, reducing the risk of greenwashing and fostering the channeling of funds from public and private entities towards sustainability-enhancing projects by setting understandable, clear technical and benchmarks and guidelines for institutional investors, project developers, financing entities and potential smaller private investors and entities in the third sector (Platform on Sustainable Finance, 2024).

3.4. New knowledge and skills

Generating new knowledge and skills across the board will be a critical ingredient of a successful recipe for creating dynamic, efficient green financing ecosystems.

The required green skills and capacities in financial markets are quite varied and imply developing new views and understanding about how projects and activities contribute to higher sustainability along the different dimensions (social, environmental, economic) and what are the risks and opportunities, from a financial perspective and for all the actors involved (public entities, private financial companies, smaller investors, project developers, third-sector entities…), of the projects at their different stages.

Of special relevance is understanding how R&D&I activities in relation to relevant low-carbon technologies may best be funded at the various TRLs and keeping in mind the specific difficulties faced by private companies and start-ups in the early stages (basic R&D, applied R&D), in the demonstration and pre-commercialization phase and, finally, in the commercialization and industrialization (market diffusion of innovation) phase (Polzin & Sanders, 2019).

In recent times, more attention is being paid by the industry to the need to securing adequate financing to so-called "first of a kind" (FOAK) projects, given that many climate and sustainability-enhancing technologies in many sectors are emerging and still in relatively low-maturity phases. There are many specific financing issues around FOAK investments that need to be addressed, including the lack of "off takers", high technology and pricing risks, a scarcity of know-how and technical knowledge about these highly-innovative projects in the financing industry and the need to fund high-capex pilots with uncertain returns (Reinaud, 2024). Innovation in financing products, structures and arrangements[5] for these types of projects will require, in turn, new knowledge and skills.

There are, arguably, three areas where it is more urgent to develop adequate knowledge and skills in the market. First, new capacities are required for workers and companies (in the financial and non-financial sectors) to achieve a profound understanding about the concept of sustainability and how net positive social and environmental impacts may be created through the use of new digital and low-carbon technologies in different economic sectors and by changing processes throughout the entire value chain of the economy. This should be coupled by a thorough grasp of the regulatory framework (i.e., EU's taxonomy, accounting and disclosure rules, etc.).

It is also relevant to develop new knowledge and skills about how to apply standard and non-standard financing instruments and schemes (such as the ones listed on Table 1) in different types of projects and sectors and with a large variety of low-carbon technologies.

Thirdly, advanced skills in relation to data management, data analytics and the use of advanced digital and analysis tools (such as AI applications and techniques)

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[5] New approaches include off-balance-sheet financing, innovative structured or blended financing schemes, catalytic (or anchor) capital, semi-concessions, tailor-made government programs or innovative equity-debt funds (Kann, 2023; European Commission, 2016).

are now needed by all agents in the value chain of the green financing ecosystems to make efficient investment, project-development and financing decisions.

The urgency to create these new sources of knowledge and skills is giving rise to increasingly sophisticated green fintech industries in countries where green finance is at a more mature stage, such as the United Kingdom (CGFI, 2024). New products and services combining specific knowledge about green financing, digital tools and climate, environmental and sustainability are being deployed, facilitating decision making by all types of companies and inducing more sustainable outcomes (Chueca Vergara & Ferruz Agudo, 2021; Macchiavello & Siri, 2022; Li *et al.*, 2024). These new products and services include highly specialized tools for reporting, estimating the carbon and environmental footprint, carbon offsetting and trading, (climate and nature) risk management, ESG and sustainability data management, developing green ratings and insurance products, estimate and assess social and environmental impacts or carry out natural capital accounting, to name a few.

3.5. New collaboration schemes

A strategic pillar for the development of new, sophisticated green financing ecosystems will be their capacity to facilitate new public-private partnerships (PPP) between agents with different preferences, profiles and economic roles that generate new financing opportunities for project developers and investors.

Fernández Gómez (2024) reviews both conventional PPPs and new, innovative approaches to these types of partnerships, including green or sustainable PPP (green 3P) and 4P (public-private-philanthropic partnerships).

Traditional 3P arrangements usually focus on the financing of public infrastructures and the provision of the associated services (Local Government Association, 2022). These arrangements are quite flexible and help to tackle a large variety of financing challenges. They can take various forms. Public-private corporate joint ventures, for instance, create special purpose vehicles that can be financed via project finance schemes and can carry out investment, management and operation and maintenance activities under a variety of formats (i.e., build-operate-transfer, build-own-operate, build-own-operate-transfer, lease-develop-operate and additional variations). Contractual arrangements (involving association, collaboration and concessions) between public and private entities offer more flexibility and may be able to generate more certainty for public investors. Other investment and financing solutions (i.e., leasing or lease-leaseback agreements) facilitate investments in large public strategic infrastructure that will eventually be owned by a public entity and are increasingly attractive for private investors due to the public guarantees, their application to high-capex, 30-40 year investments and strong ESG credentials. Finally, long-term cooperative agreements allow public entities to access private financial, technical, training and operational resources in multiple areas related to en-

vironmental sustainability and in the context of strategic projects (e.g., regeneration of urban areas) involving major transformations.

In recent years, newer types of PPPs are being developed that allow for sustainable projects and activities to raise funds that would, otherwise, flow elsewhere (Vassileva, 2022). The so-called green or sustainable PPPs can play a relevant role in green financing by facilitating innovative public-private partnerships and arrangements that are expressly tailored to solve financing challenges faced by sustainability-enhancing projects. Green 3P arrangements explicitly incorporate sustainability (environmental, social, economic or all three) among their main goals and may be implemented in areas such as clean energy and clean technologies, circular economy, material and energy efficiency, responsible production and consumption, reduction of GHG emissions or pollution, waste management, sustainable exploitation and regeneration of ecosystems and natural resources, protection and restoration of biodiversity, etc.

In addition to the ample spectrum of projects and activities where they can be effectively deployed, green 3P arrangements are characterized by involving a quite varied typology of agents, including different public, private and third-sector entities (NGOs, associations, foundations, etc.), which, in turn may play different roles (financiers, project developers, asset management or maintenance), and by advanced, innovative and flexible governance, collaboration, stakeholder relationship, coordination and leadership structures (Marx, 2019; Vassileva, 2022). In addition, they are strongly biased towards technological, social and financial innovation and experimentation and may adapt to changing regulatory frameworks and benefit from regulatory sandboxes. Hybrid financing solutions, mezzanine financing, and the use of "green bonds"[6], "green funds" or "green banks" are commonplace in green 3P schemes. It is also noteworthy that green 3Ps are a sign of changing views about public-private collaboration in the implementation of public policies and the provision of public services and, often times, are based on collaborative governance scenarios in which private agents are (at least partially) responsible for the provision of certain public services.

As argued in Fernández Gómez (2024), key success factors for 3P schemes are an active involvement of public entities, stable and transparent legal and regulatory frameworks that attract potential private investors, the existence of "de-risking" mechanisms (e.g., public guarantees, etc.), the promotion of new markets in sustainability-related areas, building specific capacities and skills and improving the tools for monitoring and assessment of impacts and effectively facilitating participation by civil society organizations and even private individuals (Gardiner *et al.*, 2015).

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[6] 6.5% of bonds issued by EU companies in 2023 were green bonds (Platform on Sustainable Finance, 2024).

A specific type of green or sustainable 3P schemes involves the participation of philanthropic entities, such as private foundations aiming to generate net positive environmental and social impact. Public-private-philanthropic partnerships, also known as 4P schemes (Samandari *et al.*, 2023), are starting to spread in many countries, especially in the global South, but also in Europe and other regions (GAEA & World Economic Forum, 2023; Postma, 2023). 4P schemes benefit from the participation of philanthropic funds and foundations because of their greater tolerance for technological risk (in comparison with that of other financial entities), a long-term systemic vision (i.e., greater "financial patience"), greater technical knowledge about sustainability issues and challenges and a focus on social issues (i.e., by taking into account the inclusion or fairness dimension or focusing on young people or disadvantaged subgroups of the population, for instance).

In short, innovative 4P schemes have a comparative advantage vis-à-vis green 3P schemes that facilitates innovation in financial and technological solutions, newer business models, etc., and appear to be especially effective in the promotion of next-generation technologies and "first-of-a-kind" pilots (e.g., as shown by Breakthrough Energy Catalyst), creation of new markets (Tropical Forest Alliance), inducing private investment decisions (Climate Finance Partnership) and fostering behavioral change (Food Action Alliance) –see Fernández Gómez (2024).

4. THE CASE OF GREATER MANCHESTER

4.1. The Greater Manchester approach to sustainable financing

Relevance of the case study

The case of the city-region Greater Manchester offers an example of successful implementation of a (still evolving) pioneer, innovative 4P collaboration scheme with a focus on green, sustainable financing.

The example of Greater Manchester has all the elements of a relevant case study, according to the academic literature on research methods based on the analysis of specific cases. For instance, there is an absence of a well-defined theoretical framework and its analysis can be seen as a first step within a new research line (Villarreal Larrinaga, 2017). Focusing on situations with transparently observable interest that cover a variety of items can lead to generalizations (Eisenhardt, 1989; Dyer & Wilkins, 1991). The object of analysis (the Greater Manchester Environmental Fund, GMEF) can also be considered to have enough importance and significance within a larger context (such as green financing) because of its novelty (Villarreal Larrinaga, 2017).

Key elements of the 4P approach in Greater Manchester

The 4P approach to sustainable finance by Greater Manchester has been discussed in recent works by the author of this article (also with other colleagues). Fernández Gómez & Larrea Basterra (2022), for instance, introduced the discussion of the Greater Manchester Environment Fund in the context of newer approaches to green financing under mission-oriented innovation policies aiming to fulfill the goal of reaching zero net emissions in the region by 2038, set in 2019 –see Bellinson *et al.* (2021).

The Greater Manchester Environment Fund, managed by the Greater Manchester Combined Authority (GMCA) (an entity with certain fiscal powers and public service obligations in the region), aggregates resources from the public sector, foundations, philanthropic organizations, businesses and other stakeholders, including private individuals, to fund sustainability projects with net-positive social, financial and/or environmental impact. Especially relevant is the use of innovative financing solutions involving multiple financial tools, such as targeted public procurement, urban wealth funds, seed capital, incentive schemes (e.g., innovation prizes), value- and profit-sharing mechanisms, project-linked subsidies, alignments of project goals with companies' or other institutions' interests (e.g., philanthropic entities, cooperatives, other small private investors), identification of new assets/goods (i.e., energy efficiency projects, public green spaces, compensation credits, etc.), and municipal bonds and other innovative financing structures (crowdfunding, crowdlending, etc.).

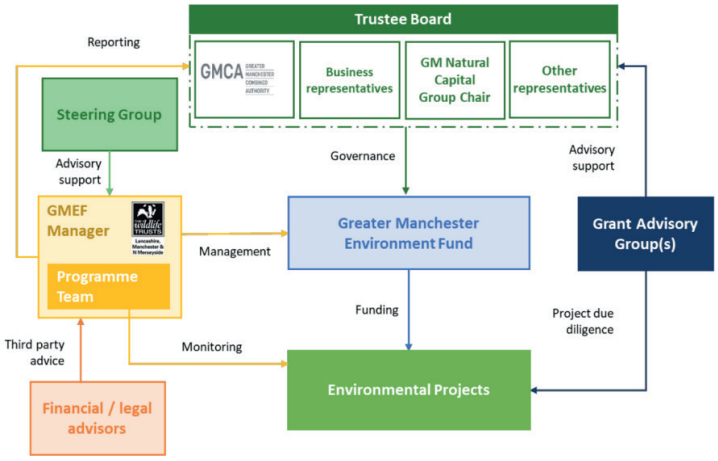
The GMEF allows for a more efficient use of public resources, as its decision-making process better facilitates adopting an integral, holistic view (as opposed to silo or departmental approaches) focusing on projects that may yield benefits in multiple dimensions. Additionally, it is a great example of how innovation in financing solutions may support and foster technological, business model and social innovation.

The governance structure of the GMEF involves the participation of multiple types of agents (Figure 2), and its financing scheme (Figure 3) facilitates the engaging a variety of private investors who wish to devote their capital to specific types of projects, activities or sustainability goals.

Fernández Gómez (2024) discusses the creation, governance structure and business model of the GMEF. In short, the GMEF channels capital from a variety of sources, including private, public and third-sector investors and earmarked public funding (restricted funds, in Figure 2) towards investment projects that may provide an economic return and other social and environmental projects. The GMEF includes, in turn, several sub-funds for different types of projects, allowing for better, tailored financial structuring and more efficiently taking into account investor preferences and the realities of the agents involved (project developers, commercial

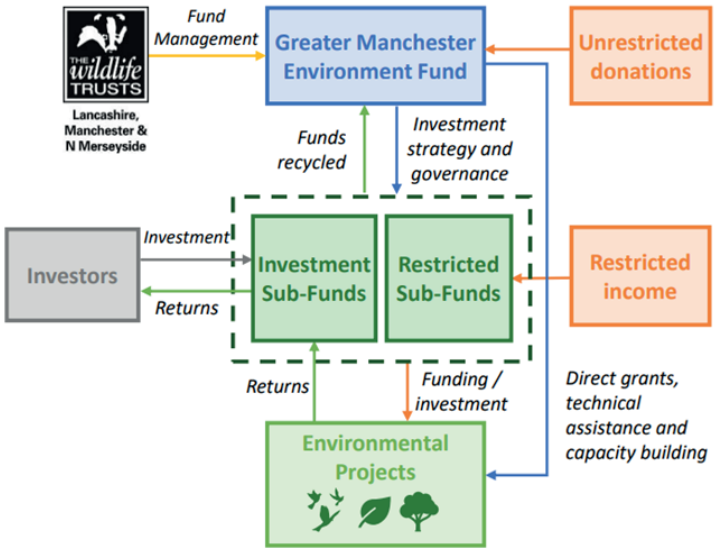
and industrial companies, public entities, different types of investors, financial operators and service providers, universities and R&D&I entities, associations, foundations and other third-sector entities, etc.)

Figure 2. **(SIMPLIFIED) GOVERNANCE STRUCTURE OF THE GMEF**



Source: Bellinson *et al.* (2021, p. 17).

Figure 3. **GENERAL FINANCING SCHEME OF THE GMEF**



Source: Greater Manchester Environment Fund (2021, p. 10).

This is especially relevant in projects involving FOAK technologies, nature-based solutions or ecosystem restoration and protection of biodiversity. Currently, the GMEF manages four sub-funds, including the Greater Manchester Green Spaces Fund (focusing on the development and improvement of green spaces), Recycle for Greater Manchester Community Fund (focusing on the management, recycling and reuse of household waste), Green Recovery Challenge Fund (supporting projects related to ecosystems, sustainability awareness, green spaces, etc.) and Natural Environment Investment Readiness Fund (focusing on the restoration of natural spaces).

Newer funds are under discussion, such as the Biodiversity Net Gain Investment Facility, the Habitat Bank Facility and the Carbon Mitigation Facility, and may increase the portfolio of funds within the GMEF. Other financing vehicles are also being considered involving green infrastructure (e.g., sustainable sewage systems), green bonds, the low-carbon built environment or the circular economy (Greater Manchester Environment Fund, 2023).

Innovation is also taking place in areas related to the management of the GMEF, such as project application and selection processes, data management, monitoring, assessment and impact analysis, etc.

By the end of 2023, the GMEF had attracted up to £20 million in financing capital into its four sub-funds (Evans *et al.*, 2023), from philanthropic entities, private donors and public funds. Private funds accounted for almost 20% of the resources raised by the GMEF in the first half of 2023.

4.2. Lessons from the Greater Manchester Environment Fund

The Greater Manchester experience with the GMEF provides a great example of large-scale, ample-scope 4P collaboration involving multiple agents and multiple local authorities.

There are several critical lessons to be extracted from the Greater Manchester approach to green financing that are worth highlighting.

First of all, the overall scheme is based on a public-private partnership under the leadership of a public local government entity (the Greater Manchester Combined Authority) with capacity to raise capital and define, apply and manage different economic and fiscal tools. It is noteworthy that the GMCA is a partnership of several municipalities that, in practice, form a "city-region". This provides the needed scale, critical mass and political support to foster certain public service, infrastructure and natural capital projects. Of course, an efficient functioning of the GMCA requires an appropriate legal cover and a clear definition of the powers granted to this supramunicipal entity and the responsibilities (financial and otherwise) of all the participating municipalities.

A complex governance structure has emerged since the GMEF was launched back in 2019. This is due to the need to tackle a number of operating challenges, including defining appropriate fund management, capital raising, monitoring, investor participation, strategic and steering, financial and legal support and advisory functions.

The growth of the GMEF has also been spurred by a targeted green strategy in the Greater Manchester region, which allows for a better identification and exploitation of synergies between political agendas and goals, citizens' preferences and private sector objectives. An example of this are the assessment criteria used to fund projects within the Green Spaces Fund, which include the goals of (1) benefitting local communities with a scarcity of public, green spaces, (2) dealing with the climate and biodiversity crises, (3) fostering connections of citizens with the surrounding natural resources and (4) supporting sustainable, viable and realistic proposals (i.e., with an attractive social value to cost ratio) (Greater Manchester Environment Fund, 2022).

Another relevant characteristic of the GMEF approach is its reliance on market-oriented mechanisms to generate the right incentives for the different types of agents (investors, financiers, public institutions, project developers, managers and operators, etc.). Steering project goals towards the simultaneous creation of environmental and social value, on one hand, and economic value, on the other hand, will be best carried out through incentive schemes that involve, to some degree, economic and market signals.

Finally, the success of the GMEF rests on its ability to lever and capitalize on the skills, capacities and knowledge of a rich, varied and dynamic green financing ecosystem encompassing private companies, public institutions, private and public foundations and a large array of other agents, such as universities and other learning and training institutions, business and citizen associations, NGOs, technical services providers and philanthropic entities. The profiles of all these agents complement each other in terms of financial resources, risk tolerance, sensitivity towards environmental and social issues or technical knowledge in ways that augment the probability of developing efficient partnerships and finding adequate funding structures for a myriad of projects and activities spanning the entire economy.

5. POLICY IMPLICATIONS

Arguably the main learning derived from the analysis of the green financing approach in Greater Manchester (in line with other developments of 3P and 4P green schemes reviewed in the academic literature) is that collaboration across a variety of public and private agents and stakeholders with different preferences, goals and risk profiles will increase the probability that capital flows reach projects and activities that would not have, otherwise, been able to attract the required financing resources.

Sophisticated governance arrangements involving public and private entities are, therefore, a lever for attracting new flows of private capital to sustainability projects and activities. Public entities play a critical role in the new green financing ecosystem, as they not only are responsible for channelling public capital towards sustainability-enhancing activities and projects, acting as patient financiers and helping to de-risk investments, but they also are in charge of developing appropriate policies to orient the private sector towards the desired societal objectives and induce changes with net positive impact in terms of sustainability and are well placed to generate spaces where all agents can interact and legal and business contexts that induce new types of collaboration across different types of entities.

In turn, private entities (both conventional financial institutions and the new agents in the green financing ecosystems identified in Section 3) must play the key role of relevant project and opportunity discovery as well as unlocking new sources of financing capital. Specifically, private philanthropic funds and entities can increase the probability of success of projects thanks to their focus on creating positive net social and environmental impact, greater tolerance for technological risk, long-term vision and better knowledge about local contexts.

The new green 3P and 4P governance and collaboration schemes are also complementary to Mazzucato's mission-oriented innovation approach to achieving grand societal goals (such as decarbonizing the economy), in that they provide innovative ways to involve public and private entities in hard-to-finance activities and projects, thus strengthening the role of public institutions as catalysts of change.

In order to maximize the potential of these new types of arrangements, policy makers must design policies with a view to strengthening the three key pillars of an efficient, dynamic green financing ecosystem, including measures to foster the growth of the demand and supply sides of the market and develop critical (financial) market infrastructure (i.e., development of platforms and diffusion of key green financial indices, adoption of reporting and compliance standards, implementation of an oversight function), etc. (Fernández Gómez & Larrea Basterra, 2021).

Additionally, policies must target other cross-sectional dimensions of the green financing ecosystem, such as the stock of knowledge, skills and capacities of both citizens and private and public organizations, which will lead to better assessments of the sustainability implications and risks stemming from the different projects and, therefore, to better investment and financing decisions, or the ability to innovate in (green) financial instruments and services. A sound, stable and transparent regulatory and legal framework will help to reduce costly information problems that reduce the probability that positive net impact projects receive the required funding.

All these policies, within a given territory, must be coherent with each other and with other key policies and strategies, such as industrial, economic development and

competitiveness, innovation and technology development, energy transition or climate mitigation and adaptation strategies.

A way to go about this is to define a well-founded green finance strategy that directs the available resources towards coordinated missions and projects that tackle grand societal goals while simultaneously generating economic value. The UK Green Finance Strategy (updated in 2023) is a good example of an attempt to structure in a sophisticated manner a strategy oriented to exploiting "the opportunities of [this] Green Industrial Revolution" (HM Government, 2023).

Critical elements of such a strategy include (1) developing an agreed vision by both the private and the public sector and citizens about the sustainability transition and key environmental, social and economic priorities given the strengths and comparative advantages of a territory; (2) rolling out detailed net-zero and sustainability investment roadmaps; (3) identifying key public institutions that may adopt a leading role in designing specific green financing schemes (i.e., such as the GMEF); (4) fostering the creation and development of spaces (fora, platforms, conferences, etc.) where different types of agents (and, in particular, potential small private investors and foundations and philanthropic entities) may exchange knowledge and information about project opportunities, new financing instruments and solutions, etc.; (5) putting in place institutions (e.g., specialized learning, training and research institutions), mechanisms, tools and to generate new knowledge and specific skills in the areas of sustainability (concepts, real-world examples, impact assessment, disclosure, due diligence, etc.), novel public-private partnership agreements, state-of-the-art green finance instruments in all segments and TRLs of the innovation value chain, and so on; (6) generating adequate boundary (macroeconomic, microeconomic and legal and regulatory) conditions throughout the economy and in the financial markets to attract foreign capital inflows into sustainability projects and activities and to support new financing vehicles (such as the various funds in place in Greater Manchester); (7) combining different types of tools (economic, fiscal, regulatory) to generate adequate incentives for all agents in the green finance value chain; (8) devoting resources to develop specific financing solutions and instruments tailored to each segment of the innovation value chain and, especially, for start-ups in key operating stages such as basic research, pilot deployment once a proof of concept has been validated (in particular, of FOAK technologies and solutions) and other critical phases in the life of a start-up, such as the "valley of death" and the stage of commercialization and innovation transfer to businesses; and (9) creating the right incentives for public institutions to act as patient investors and financiers in the sense implied by Mazzucato (2017), Mazzucato & Macfarlane (2017) or Mazzucato & Semieniuk (2017).

6. CONCLUSIONS AND FURTHER RESEARCH

This article has attempted to answer the question "what role can policy makers play, through specific policies, to foster innovative collaboration schemes across agents that facilitate the financing of sustainable projects and activities?".

It is argued that there is an active role for governments (at all administration levels) and public institutions to facilitate the financing of hard-to-fund sustainability projects and activities via creating adequate conditions in the green financing market that induce innovative ways of public-private collaboration, such as the new 3P and 4P schemes that have been described and discussed in this article.

Only through public-private partnerships will certain market barriers be overcome to generate new flows of private capital in a context of great uncertainty in terms of technology, regulations, complex geopolitical and macroeconomic conditions, growing concern about the impact of climate change or other profound global transformations in the making and related to the digital revolution, the demographic challenge or increasing economic and social tensions between the global North and the global South.

An additional benefit of fostering these new types of operating and financing agreements is that the participation of non-conventional agents in the green financing ecosystem will likely increase social acceptance and social involvement in the sustainability transition.

To maximize the potential positive impact of this collaborative approach, complex, far-reaching strategies must be defined and implemented and resources must be devoted to create the right institutions and generate new financial knowledge and skills and new ways to innovate in clean technology development, governance schemes and financial instruments and solutions.

Further avenues of research in the area of 4P collaboration oriented to financing net positive impact projects include deepening the analysis of the specific instruments and governance schemes deployed in Greater Manchester, comparing the Greater Manchester approach to green financing with that in other regions or countries, identifying a typology of potential PPP agreements (for instance, depending on their legal form, the types of agents, etc.), assessing the effectiveness of certain financing strategies (such as green funds, public and private green bonds, etc.) and understanding the relationship between the various types of PPP agreements and financing solutions and the different types of sustainability projects (for instance, FOAK decarbonisation solutions, innovative nature-based schemes, etc.). Additional areas for new research include exploring how other territories may adopt (and adapt) the solutions developed in Greater Manchester and how these innovative public-private collaboration schemes may need to be restructured in the context of less developed economies with less mature financial sectors.

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