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Sustainability and financial innovation: The emerging role of Fintech for Good (F4G)

Alessandro Lentini and Daniela Elena Munteanu*

Abstract

Technological innovation in support of sustainable financial development (Fintech for Good, F4G) pursues specific environmental and social goals, and promotes financial inclusion, in line with the Sustainable Development Goals outlined by the United Nations. This paper proposes an operational definition of F4G, outlining its fundamental characteristics and fields of application. Subsequently, the paper makes the case for introducing a regulatory framework to mitigate the risks of false claims regarding the adoption of environmentally sustainable measures (greenwashing) and to ensure that F4G initiatives are consistent with measurable and verifiable sustainability objectives. To this end, the paper emphasizes the importance of promoting public-private collaboration and strengthening financial education programmes.

JEL Classification: O33, Q01, G23.

Keywords: fintech, sustainability, green finance, ESG, technology, innovation.

Sintesi

L'innovazione tecnologica a supporto di uno sviluppo finanziario sostenibile (*Fintech for Good*, F4G) persegue, anche attraverso la promozione dell'inclusione finanziaria, specifiche finalità ambientali e sociali, in linea con gli Obiettivi di Sviluppo Sostenibile delineati dalle Nazioni Unite. Il lavoro propone una definizione operativa del F4G, delineando le caratteristiche fondamentali che lo contraddistinguono e i suoi campi di applicazione. Viene poi sottolineata l'opportunità di introdurre un quadro normativo che mitighi i rischi di affermazioni false riguardo all'adozione di misure a favore della sostenibilità ambientale (*greenwashing*) e garantisca che le iniziative F4G siano coerenti con obiettivi di sostenibilità misurabili e verificabili. A tal fine, si sottolinea l'importanza di promuovere la collaborazione tra settore pubblico e privato e di rafforzare i programmi di educazione finanziaria.

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1. Introduction[1]

In recent years, Fintech for Good (F4G) has emerged as a new paradigm that combines finance, technology, financial inclusion, and social and environmental sustainability through the adoption of innovative solutions. In this perspective, Banca d'Italia has recently updated its classification of Fintech, recognising F4G as an economic and technical phenomenon geared towards innovating financial services in order to achieve social and environmental objectives[2]. In this work, Fintech for Good is defined as:

"The application of [digital] technology to financial services aiming at generating a positive and measurable social and economic impact, complementary to financial returns. This encompasses initiatives for financial inclusion, environmental sustainability, reducing inequalities, and promoting ethical and responsible innovation models".

So far, the use of technology has enabled segments of the population to access financial services and products thanks to the ubiquity of the tools used and their low costs. In particular, the shift of financial services to mobile devices (such as smartphones and tablets), web platforms and the increasing availability of internet access has enabled millions of users, especially in developing countries, to open current accounts, make payments and access credit, even in the absence of physical access points. Moreover, these financial services are offered at lower fees than those of traditional intermediaries, thanks to the leaner operational structure of companies and the intensive use of enabling technologies such as process automation, cloud computing and big data analytics. Finally, the development of synergies among companies based on third-party access to bank payment data has driven the personalised offer of financial services, the so-called open banking.

At the same time, the growing awareness of both world governments and the population regarding environmental and social issues [30] [35] has further driven the demand for innovative financial solutions. This trend pushed the global market value of sustainable finance at a rate of 22% (forecast between 2024 and 2032), and reached the equivalent of USD 5.4 trillion by 2023[49]. This growth could continue to be marked by the entry of new generations of investors, such as Millennials (those born between 1980 and 1995) and Gen-Z (those born between 1996 and 2012, also referred to as "digital natives") characterised by greater sensitivity to the social and environmental impact of their allocation choices.

According to data from research conducted by Patil and Gokhale (2023), today more than half of the younger generations actively manage their financial investments [73]. On the one hand, Millennials integrate ESG considerations into their portfolio choices; on the other hand, Gen-Z appears to be a socially responsible investor [66] – 86% are aware of the impact of their investments on the climate

[1] The views expressed in this document are those of the authors and do not necessarily represent those of the Bank of Italy. The authors would like to thank Costanza Iacomini, the SSD Service Management and the anonymous reviewer for helpful suggestions.

[2] The classification referred to, and which includes F4G among "Financial related activities", is the one developed internally by the Institute and described in the work *Fintech Classification Methodology* by Lentini, Munteanu and Zennaro [59]. This taxonomy provides an analytical framework to map the evolution of the sector.

– but oriented towards a return balanced with social impact; only 35% favour exclusively financial return (Nilsson [67]). However, several studies ([73][66][74]) point to similarities between the two generations, in terms of technological exposure and sensitivity to sustainability, which lead to similar investment choices.

Responsible investors' allocation choices are significantly influenced by their individual preferences, which increasingly include non-financial considerations, such as those related to sustainability [30][48][49]. A potential obstacle to the spread of sustainable investments may lie in the mistrust of economic agents, as these criteria are only partially understood [30]. Therefore, companies pursuing sustainability criteria and managers of sustainable financial assets (i.e. ESG funds) might want to improve their communication efforts about their objectives and the impact generated by their investments. In so doing, they could raise awareness among Millennials and Gen-Z about the contribution of sustainable investments in addressing global environmental and social challenges. Similarly, it becomes crucial for F4G operators to effectively communicate their added value in terms of impact, potentially exploiting digital technologies to increase transparency and foster financial education on these issues, a particularly relevant aspect in the Italian context where the penetration of such solutions is still developing [12].

Overall, Fintech appears to have considerable potential to foster sustainable and inclusive development, in line with the United Nations 2030 Agenda for Sustainable Development and the *Sustainable Development Goals* (*SDGs*)[3]. In this context, the F4G phenomenon lies at the intersection of financial innovation and the pursuit of sustainable investments and proposes a synergy between institutions and operators to increase the innovative and inclusive role of finance. Thus, F4G not only meets the financial needs of segments of the population hitherto excluded from traditional financial services but also acts as a catalyst for the field of Green Finance, i.e. the sector that uses digital technologies in the field of Climate Tech[4] (see Appendix 1).

The relationships between the definitions proposed in this paper are depicted in Figure 1, which shows that:

- Fintech for Good (F4G) is the broadest category that includes all Fintech solutions for promoting environmental (E) and social (S) pillars of ESG criteria.
- Green Fintech is a subset of F4G that focuses on the application of financial technologies to address environmental challenges, such as the conservation of natural resources, promotion of renewable energy and sustainable agriculture; it represents the environmental (E) dimension of the ESG criteria[5]; there are specific classification attempts for this specific segment, such as the one proposed by the Green Digital Finance Alliance (2022)[51];

[3] The Agenda includes 17 global goals that aim to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030 [64].

4 *Climate Tech* refers to a wide range of innovative technologies and solutions that aim to reduce greenhouse gas emissions, promote the transition to a low-carbon economy, contribute to achieving the goals of the Paris Agreement and mitigate the impacts of climate change.

[5] The distinction between F4G and *Green Fintech* is not always clear-cut, as many projects can generate positive social and environmental impacts. For example, a microcredit platform that provides loans to small farms in rural areas not only

- Climate Fintech is in turn a subset of Green Fintech dedicated to innovative digital applications in finance aimed at supporting the process of decarbonisation and sustainable transition, such as the financing of climate-related projects, the assessment of climate risks and the promotion of sustainable investments; it has recently been the subject of an in-depth study by Banca d'Italia [12] which offers a detailed analysis of Climate Fintech in Italy in the international context;
- Climate Tech is a category that includes not only Green Fintech and Climate Fintech, but also non-financial technologies geared towards combating climate change; it overlaps with F4G when the latter uses technological solutions applied to the financial world to promote environmental sustainability.

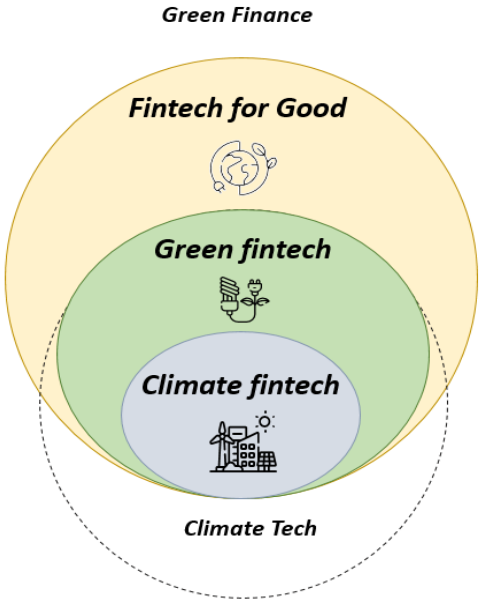

Figure 1. Relationship between F4G, Green Fintech and Climate Fintech

In summary, F4G refers to a broad set of companies operating in the financial sector that includes Fintech solutions whose goal is to generate a positive impact on society and the environment. Within the F4G, Green Fintech focuses on the general environmental dimension, while Climate Fintech specialises in climate change.

The F4G can therefore play a significant role in achieving sustainable development goals by building a bridge between financial inclusion and social and environmental sustainability. In order to achieve the full realisation of this potential, it is of paramount importance that its implementation takes place in a responsible and inclusive manner, involving both public institutions and private actors. In this context, public institutions could:

promotes financial inclusion and job creation (social impact) but also encourages the adoption of sustainable agricultural practices and the conservation of natural resources (environmental impact).

(i) facilitate collaboration between different actors, through the promotion of initiatives such as hackathons[6], acceleration programmes and pilot projects; an example of this is the '*Fintech for Sustainability*' programme set up by the Singaporean government;
(ii) invest in digital infrastructures in order to ensure that digital financial services are accessible to the whole community, as in the case of the Italian government's '*Italia digitale 2026*' plan, which includes the construction of a nationwide broadband network;
(iii) promote financial education, in co-operation with institutions and civil society organisations to increase citizens' awareness and ability to make informed financial decisions; examples include the '*Financial Education Month*' promoted by Banca d'Italia and its financial education portal '*Economy for All*', which offers insights on sustainable finance, Fintech and crypto-assets, among others.

These initiatives help to support the creation of a favourable environment for the development of F4G solutions. Other relevant examples are: the adoption within the European Union (EU) of the Taxonomy Regulation [42]; the introduction of guidelines on climate disclosure by the Monetary Authority of Singapore (MAS); and the update issued by the British Financial Conduct Authority (FCA) of its rules on sustainable finance in an effort to prevent greenwashing and to protect consumers[7].

In this context, Fintech companies can adopt two strategies that reflect different modes of intervention and strategic priorities. On the one hand, the institutional approach focuses on working with traditional financial institutions to redirect existing financial resources towards a more sustainable allocation; for instance, financial intermediaries can invest in environmentally friendly projects or microfinance initiatives. On the other hand, the social approach addresses the needs of the population with no or limited access to traditional banking services, promoting mobile banking, digital payments, microcredit and crowdfunding.

However, the full realisation of the F4G's potential is subject to some significant challenges that will be explored in more detail later in this paper (see Section 4). Among these, firstly, is the potential trade-off between the use of energy-intensive digital technologies, such as Artificial Intelligence (AI) or some DLT applications, and the pursuit of sustainable finance objectives, primarily the environmental ones. Secondly, although a specific and shared taxonomy of F4G would facilitate the understanding and evaluation of the sector, the introduction of an associated regulatory framework, in addition to its benefits, might also produce undesirable effects. For instance, it might not reflect the speed of technological change, expanding the opportunities for regulatory arbitrage, or stifling innovation in a rising sector, while also requiring prior knowledge of the phenomenon. To this end, monitoring the trend can be supported by cognitive tools such as the recent "*Survey on unsupervised fintech operators*" [3], which complements the periodic "*Survey on fintech in the financial system*" [7], both conducted by Banca d'Italia. The monitoring activity supported by these tools could provide

[6] Hackathons are short intensive events where teams of developers, designers and other experts collaborate to create innovative technological solutions to specific challenges. In F4G, hackathons can also stimulate the creation of new applications and services.
[7] Given the vastness and complexity of the framework, this analysis does not include an exhaustive review. Please refer to Appendix 3 for the main references and to specialist publications for more in-depth studies on the subject.

useful elements to identify the emergence of new financial risks and inform possible regulatory interventions, while respecting the principle of proportionality and the objective of not hindering good innovation.

2. Characteristics and fields of application

In the face of global sustainability challenges, F4G emerges as an innovative solution in the financial landscape, offering an ethically sound path, partly set as an alternative to traditional finance. F4G companies differ from traditional Fintech companies according to three key characteristics, defined by the literature on social entrepreneurship ([13][48][61][79]):

a) **intentionality**: the company explicitly pursues the generation of a positive social impact through an *ex-ante* declaration of its social and environmental objectives and by engaging in activities aimed at creating social and environmental value;
b) **additionality**: the company operates in sectors and geographical areas characterised by market failures, i.e. in which other players are absent, uninterested or unable to intervene due to the risks characterising these sectors or areas; additionality is achieved, for example, by gearing Fintech services towards beneficiaries excluded from access to the traditional financial system, due to factors such as low income, low financial literacy or residence in remote areas;
c) **measurability**: the company defines specific, measurable, attainable and temporally defined impact objectives and assesses their achievement in quantitative and qualitative terms; this can be done, for instance, through explicit reference to the alignment of activities with the SDGs or specific product achievements that can be measured through social and environmental performance indicators.

Analyses of F4G and the relationship between Fintech and sustainability are still at an early stage[8], (see [55][73][18][19]). The main contributions are provided by the consulting firms Deloitte ("Fintech for All, Fintech for Good") [29] and EY ("Fintech Waves") [34].

Deloitte analysed 485 companies[9] operating in the Fintech sector, classifying their business models, identifying their target markets and assessing their impact in terms of financial inclusion, environmental sustainability and social progress. Similarly, EY identified six main business models that characterise the operations of Fintech companies and whose impact was assessed according to their contribution to society and the environment in terms of: 1) financial inclusion, through the provision of banking and financial services to people with no or limited access to traditional banking services, such as free current accounts, microcredit and digital payment instruments; 2) access to finance, such as crowdfunding and online donation systems to raise funds for social and

[8] Most existing studies focus on analysing the benefits of adopting Fintech solutions in the banking sector, e.g. in terms of improving operational efficiency and reducing risk.
[9] For the identification of the analysis sample, three main sources were considered: the Fintastico database, the Crunchbase database and the Dealroom database. To an initial set of 1193 Fintechs, potentially labelled as F4Gs, the principles of intentionality, additivity and measurability were applied, identifying a final sample of 485 Fintechs that meet the F4G criteria.

environmental projects; 3) efficiency of financial transactions, which reduce management costs and increase transparency through the use of blockchain and smart contracts technologies; 4) impact finance, which directs investments towards activities with a social and environmental impact, such as renewable energy, energy efficiency and sustainable agriculture; 5) reporting and management of the social and environmental impact of financial activities, through the development of *ad hoc* tools to enable companies to report on their contribution to sustainability; 6) and access to private welfare services in InsurTech, through the provision of innovative insurance solutions for social and environmental protection, such as micro-insurance and climate risk insurance.

Deloitte's analysis shows that Fintech companies operating in the areas of digital banking, payments and investments account for about one-third of the F4G sector's turnover, with percentages of 24%, 20% and 19%, respectively. This is followed by the TechFin segment[10] with a significant share of 11%. The geographical distribution of F4G companies is homogeneous across advanced and emerging economies, underlining the global nature of the phenomenon. In terms of business models, F4G is mainly active in the B2C market (42%), followed by B2B (36%) and B2B2C (22%).

With reference to the motivations that drive F4G companies towards a socially responsible business approach, 27% of Fintech & Insurtech start-ups declare themselves attentive to at least one of the SDGs. The most relevant topics are social issues, in particular reducing inequality (10%) and supporting economic growth (9%), and environmental issues, such as combating climate change (4%). Geographically, these issues are considered particularly relevant in Africa, where 54% of start-ups say they pay attention to them, followed by Asia (40%), Europe (26%) and North America (22%)[71]. The geographic distribution highlights some specificities: for instance, reducing inequalities is a priority theme for start-ups paying attention to sustainability in Africa, while the fight against climate change receives particular attention in Europe.

Although these initial studies provide some dimensional indications, hitherto there is a lack of exhaustive data for an accurate quantification of the F4G phenomenon, particularly in the Italian context. The fact-finding Survey on unsupervised Fintech operators, recently launched by Banca d'Italia [3], could help fill this information gap, providing an initial quantitative survey of the sector.

Within the F4G phenomenon, this study proposes a preliminary attempt to categorise operators by distinguishing between two main types of F4G companies. On the one hand, 'F4G by design' are defined as companies established with the statutory objective of promoting social and environmental sustainability through financial innovation. These are generally innovative start-ups that place F4G at the heart of their company name and develop products and services specifically designed to generate a positive impact. On the other hand, 'F4G by product' are defined as companies in the traditional financial sector that have progressively integrated products and services with sustainability purposes into their offering, developing F4G products and services in response to demand from customers sensitive to these issues, such as Millennials and Gen-Z. This conceptual distinction is echoed in similar classifications that have emerged within the Italian Fintech ecosystem [82], where a distinction is made between F4G initiatives whose primary purpose is to generate a positive impact

[10] TechFins focus on providing services to other financial and non-financial actors through advanced technological applications.

(defined as 'Core business F4G') and those that develop specific products or services linked to ESG principles (defined as 'Product F4G').

This note does not consider the role of corporate governance, despite Accenture [1] pointing out that medium and large-sized companies, with a complex organisational structure and significant market share, show an increasing attention to sustainability (see [29],[76]) both environmental and of governance[11]. In particular, Accenture points out that these companies invest in advanced technologies (so-called green computing) as part of a more sustainable and socially responsible production model, in which the creation of economic value is integrated with environmental protection and social welfare. This approach translates into a growing interest in digital technologies, such as AI, which can support companies in achieving their sustainability goals. Appendix 2 delves into the role of these enabling technologies, with a focus on the impact of AI and the evolution of Green Data Centres.

The F4G phenomenon in Italy is monitored by Banca d'Italia through its Innovation Facilitators[12] and highlights the awareness of start-ups, investors and financial institutions of the potential of innovative solutions. With reference to the Italian market, the role of F4G is sizable in the payments and credit sectors and is not limited to the environment but also extends to the social dimension. For instance, in the retail payments sector, F4G initiatives range from interventions on the physical product to purely digital innovations. An example of the former type, although more related to product sustainability than to financial innovation per se, is the production of payment cards from recycled materials. On the other hand, *apps* that calculate the carbon footprint of purchases or platforms to offset emissions [81], as well as technologies developed to enable access to financial services for traditionally excluded segments of the population, fall fully within the realm of innovative F4G solutions. However, such initiatives, while representing a step in the direction of sustainability, need to be carefully analysed to assess their actual impact. It is important to distinguish between those that generate a concrete and measurable social and environmental benefit and those that, by emphasising aspects of communication and marketing without adequate factual validation (a phenomenon known as "greenwashing"), risk misleading stakeholders (consumers, investors) about the real sustainability characteristics of the offer.

2.1. *Social objectives*

Although the pursuit of profit is a common goal of business initiatives, this does not preclude them from generating a positive social impact. The distinction between profit-oriented and social impact-oriented initiatives is not always clear-cut, and many "hybrid" business models try to combine profit generation with the creation of social value. In the context of F4G, this translates into a variety of approaches that aim to achieve social and environmental objectives while maintaining the economic sustainability of initiatives. To fully understand the nature of each initiative and assess its actual social impact, it is crucial to carefully analyse several factors, including ownership structure, business model, profit allocation and transparency in communication.

[11] In this context, governance is understood as the set of principles, rules and processes that guide a company in managing its activities and pursuing its objectives in respect of its stakeholders.
[12] These include Fintech Channel, Milano Hub and Regulatory Sandbox.

The F4G aims to redefine the role of finance in society, balancing corporate economic sustainability objectives with social ones, taking into account the profitability of investments. In particular, the EY analysis [34] shows a connection between F4G and social objectives, such as access to credit for small and medium-sized enterprises, open banking for greater inclusion and InsurTech for the protection of the vulnerable, and environmental objectives, including the promotion of green investments and the reduction of the carbon footprint through impact finance.

In particular, recent analyses illustrate how Fintechs are pursuing social objectives in several areas.

In digital banking, the main objective is to foster financial inclusion by offering banking services and financial management tools to those who are otherwise excluded. The use of digital channels and new technologies makes it possible to reach segments of the population in remote or economically disadvantaged areas, while financial education, which is increasingly widespread, helps to improve users' financial awareness and skills.

With regard to loans, F4G companies strive to provide access to credit also to those who do not have a bank account through alternative methods of assessing creditworthiness and reducing loan costs. In particular, microcredit proves to be a key tool for empowering individuals and small businesses that would otherwise find it difficult to obtain financing. In the F4G context, microcredit takes on an even broader significance, going beyond the mere provision of loans. Companies operating in this field often complement microcredit with financial education services, business development assistance and support in adopting sustainable practices. In this way, microcredit not only promotes financial inclusion, but also fosters the economic and social development of disadvantaged communities.

Investments can promote social impact generating not only financial returns but also benefits for society and for the environment. Some companies specialise in investment and credit solutions for the purchase of social housing, helping to reduce housing inequality.

F4G manifests itself in crowdfunding activities, offering non-profit organisations and social enterprises the opportunity to raise funds from a wide range of supporters. The use of digital platforms increases transparency and accountability in the funding process, fostering trust and mutual commitment.

Finally, InsurTech and RegTech contribute to social sustainability by making insurance services more accessible and affordable, also through the provision of micro-insurance and digital identity management services, which are crucial for social inclusion.

In the payments sector, F4G companies focus on offering financial services to a wider audience, overcoming barriers to accessing traditional financial services. This focus translates into offering services to individuals and households with no or limited access to traditional financial services, leveraging solutions and technologies (such as mobile payments, digital wallets and blockchain) in order to reduce transaction costs and barriers to entry. In so doing, these companies are able to reach communities located in geographically isolated or hard-to-reach areas, where traditional financial infrastructure is limited or absent.

F4G companies operating in the payments sector create significant social value mainly in emerging countries, where innovations foster economic growth and social inclusion. In fact, the development of services and products in geographic areas underserved by digital payments makes it possible to extend the offering to previously excluded users, reducing the costs of remittance services and enabling larger sums to be sent with rapid processes, regardless of geographic location.

Below are some purely illustrative and not exhaustive examples of F4G companies specialising in the payments sector that stand out for their focus on financial inclusion and social sustainability. The selection is based on the notoriety of the cases and the availability of public information gathered through a literature review and online searches using specific keywords, with the aim of representing different types of F4G services and business models:

- **PayPal**: a global payment platform that facilitates online transactions and in-store payments; through its "PayPal Giving Fund" programme it allows users to make donations to non-profit organisations, either directly or by allocating a percentage of their online purchases;
- **Satispay**: a mobile payment app that allows digital payments to be made using a mobile phone, even without a credit card or bank account; it also provides small businesses with low-cost digital payment acceptance tools and integrates functionality to make donations to non-profit organisations;
- **M-Pesa**: a global payment platform via mobile phone (mobile banking) that was successful in Kenya and, within a decade, developed in Tanzania, Afghanistan and India; M-Pesa has contributed significantly to the economic development of local communities[13];
- **Flutterwave**: an affordable pan-African payment platform that also offers remittances and Fintech-as-a-Service tools, contributing to the financial inclusion and economic development of local communities[14];
- **Scalapay:** an Italian company that offers Buy Now, Pay Later (BNPL) solutions, allowing consumers to defer payment for online purchases without interest, enabling a wider audience to make purchases, even in the absence of immediate availability[15]; Scalapay prevents over-indebtedness through affordability checks, promoting responsible credit management;
- **Paycode**: a company that uses biometrics to provide financial services, including payments, to people who do not have access to traditional identity documents; Paycode's technology enables secure and inclusive payments in remote areas and marginalised communities.

[13] M-Pesa has engaged in a collaboration with software developers to create "mini apps", which would allow companies to create their own platforms within M-Pesa's SuperApps*:* https://www.vodafone.com/news/empowering-people/mpesa-marks-15-years.

[14] Flutterwave, boasting a presence in over 30 African countries with a market valuation of over USD 3bn in 2022, has raised significant funding from international investors, including Visa and MasterCard, processing over USD 20bn in transactions since its launch.

[15] The BNPL model plays an ambivalent role in the context of digital payments. While on the one hand it is a strategic tool for businesses, allowing them to increase sales and improve cash flow thanks to the payment deferral offered to customers, on the other hand BNPL can foster financial inclusion, allowing consumers, especially those with limited spending capacity, to access goods and services through instalment payments without immediate financial costs. However, easy access to credit may entail the risk of over-indebtedness, underlining the importance of a balanced regulatory framework to protect both businesses and consumers (see [11]).

- **Beam**: a payment platform that integrates a micro-donation functionality, enabling small automatic donations to charities for every purchase made.

These companies demonstrate a real commitment to extending financial services to previously excluded segments of the population, such as rural communities, women and youth. In addition to offering financial services, they potentially contribute to supporting education, health and poverty alleviation.

Mobile banking represents a solution for fostering financial inclusion and economic development due to its widespread use and the low cost of the financial services offered. However, it requires a careful assessment of the opportunities and challenges to ensure its success, as some notable initiatives demonstrate, such as the United Nations' MM4P (Money Mobile 4 poor people) programme [83]. Designed to promote financial inclusion in developing countries, the programme relies on collaboration between governments, financial institutions and mobile operators to create a favourable ecosystem for the adoption of financial services on mobile devices. The initiative provides technical and financial support for the development of infrastructure, the creation of financial products adapted to local needs and for user training. Implemented between 2011 and 2017, the MM4P programme has achieved significant results in several countries, helping to increase access to financial services for millions of people and fostering economic development in rural and remote areas.

Other large private players in the digital payments sector are investing in the development of mobile banking. MasterCard has started pilot projects in several countries, including Vietnam, to offer access to financial services via mobile phones to people with no or limited access to traditional financial services. In India, several collaborative initiatives between banks, governments and companies have been launched. One example is the collaboration between the Indian government and Samsung, which led to the launch of a money transfer project based on mobile technology. However, this project has encountered difficulties in actual implementation due to the complexity of integration with existing financial infrastructures, the lack of adequate digital literacy among the population, and resistance to change on the part of some actors in the financial sector.

To date, the integration of crypto-assets and blockchain in mobile banking represents a significant evolution in the financial sector, with potential implications for financial inclusion and economic development. As illustrated by [63], companies such as BitPesa and Coins.ph show how these technologies can be used to foster an evolution of "inclusive" mobile banking. BitPesa, which operates in cross-border payments and remittances in Africa, allows users to send and receive money in different African currencies, converting them into Bitcoin for faster and cheaper transactions. In the Philippines, Coins.ph enables the large migrant population to make remittances from abroad, offering a mobile wallet for cryptocurrency transactions, bill payments and phone top-ups.

In conclusion, mobile banking, complemented by crypto-assets and blockchain, can contribute to financial inclusion by offering services accessible even to populations excluded from traditional financial systems. Despite the challenges, efforts to promote digital literacy and shape solutions in line with local needs represent a major step towards more inclusive and accessible participation in the financial system.

2.2. *Environmental goals*

The energy transition is profoundly altering the structure of global economies, leading to a decline of fossil fuel-related sectors in favour of renewable energy-related ones. This shift not only opens up new opportunities for countries rich in renewable resources, such as solar, wind or hydropower, or with a strong capacity for technological innovation and development[16], but also presents significant challenges for those economies heavily dependent on fossil fuel exports[17].

In this context, financial institutions[18] are starting to finance mitigation and adaptation projects, developing platforms dedicated to renewable energy, energy efficiency and sustainable infrastructure. Innovative financial instruments, such as green bonds, are gaining popularity as a vehicle to specifically finance climate change initiatives.

Fintech companies, in particular Green Fintechs, play a crucial role in this area by driving the development of digital solutions dedicated to sustainability. For example, some digital platforms make it possible to raise funds for initiatives with a positive environmental impact (Impact Investing). These ensure a high degree of traceability of both the financial flows and the environmental impact of projects, allowing constant monitoring of the effectiveness of investments. Furthermore, Green Fintech companies, by exploiting technologies such as blockchain for the issuance of tokenised green bonds, increase transparency and accessibility for investors. Initiatives such as *Project Genesis* (see BOX 1) further advance the development of these instruments.
In addition, Green Fintech companies leverage AI and the analysis of large databases (Big Data) to assess and manage climate change risks through climate scenario analysis and climate-related financial accounting.

Another area where Green Fintech companies are making progress is in the promotion of circular economy models, facilitating the recycling of products and the financing of initiatives towards a more sustainable economy. Innovative solutions consist of peer-to-peer lending platforms for financing circular economy projects, blockchain-based traceability systems to guarantee the sustainable origin of products, and applications for efficient resource management and waste reduction.

Besides the action of Green Fintech companies, international financial institutions also play a crucial role in fostering sustainable finance. The Bank for International Settlements (BIS) plays a relevant role by addressing the challenges of climate change and sustainability in the financial sector[19].

[16] Although China has not completed its energy transition and continues to rely on coal, it has invested heavily in solar energy, becoming a world leader in solar panel production. This has offered a competitive advantage to the country in the renewable energy sector.
[17] Countries such as Australia and South Africa, which have historically based their economies on coal exports, may face economic and social difficulties due to reduced demand for this commodity.
[18] Cassa Depositi e Prestiti in Italy supports the energy transition through the Green Transition Fund, dedicated to innovative start-ups in the sector, and the Italian Climate Fund, which finances climate change mitigation and adaptation projects.
[19] Recent research [19] analysed the effects of extreme weather events, such as storms, droughts and fires, on macroeconomic recovery models. The study showed that such events not only cause extensive damage to property and infrastructure, but also increase production costs and inflation volatility, with negative impacts on economic growth. The

Through its Innovation Hub (BIS-IH), it works together with central banks and financial institutions to develop innovative solutions using AI and data analytics (see BOX 1). This cooperation underlines the necessity for various actors within the financial system to address the complexities of the energy transition and promote sustainable economic initiatives.

Finally, in the field of "**green payments**", innovation in payment systems results in solutions that incentivise sustainable consumption behaviours. For example, cashback payment cards for green purchases illustrate how payment methods can be exploited to promote environmental sustainability by rewarding consumers who make responsible choices.

Below are some illustrative examples of Green Fintech companies[20]. The selection was made by researching public online sources, checking for relevance to the F4G concept with environmental focus discussed here:

- **Stripe**: a sustainability-focused payment platform that allows companies to contribute to carbon removal projects via Stripe Climate (see BOX 2).
- **Ecolytiq**: a payment platform with carbon footprint tracking functionality, helping consumers to make more sustainable choices (see BOX 2).
- **Clim8 Invest**: an investment platform allowing users to invest in companies fighting climate change.
- **PayGreen**: a French payment platform that allows companies to offset the carbon emissions of their transactions.
- **Helios**: an Italian Fintech that offers a payment card that plants trees for every transaction made.

analysis also points out that these physical risks, linked to ongoing climate change, are likely to increase in the future, requiring early action for risk mitigation and adaptation to climate change.

[20] The list may not necessarily be exhaustive (see below). An attempt has been made to include relatively well-known cases that would exemplify different types of Green Fintech services (a category that includes, but is not limited to, Climate Fintech covered in [12]), different business models and geographical areas of operation.

BOX 1: BIS and central bank collaborative projects on climate change and sustainability in the financial sector

Project Gaia [16] is an initiative of the BIS-IH in collaboration with the Bank of Spain, Deutsche Bundesbank and the European Central Bank (ECB), which employed AI to facilitate a comprehensive analysis of climate-related risks within the financial system by developing a *Proof of Concept* (PoC) that was tested on financial climate risk analysis use cases. The PoC uses Large Language Models (LLMs) to automatically extract climate-related indicators from publicly available company reports. The climate data and information used to analyse climate risk also vary widely, making a consistent comparison difficult.

The recently concluded **Project Viridis** [18], a collaboration between the by BIS-IH in Singapore and the MAS built on the earlier work of the Ellipse Project, has defined a prototype platform for integrating two types of data: climate regulatory data, i.e. regulated and standardised information from official sources (such as governments, regulatory agencies or international organisations) and external sources of climate data, from unregulated sources (such as satellite data, climate models, scientific research or meteorological data). In the Viridis project, this integration is achieved through a prototype platform that enables regulators and financial institutions to better identify and assess climate risks, develop mitigation and adaptation strategies and make informed decisions to ensure long-term financial stability.

Also noteworthy is **Project Symbiosis** [17], initiated by the BIS-IH in Hong Kong, which aims to reduce information gaps related to climate and natural hazards. It employs targeted and simplified AI methodologies in supply chains and explores the use of advanced data analysis techniques to better understand emissions and the impact supply chains of key buyers and financial institutions have on nature. The objective is to identify opportunities where new financing can have a positive impact (defined as “financeable solutions”).

The efforts of Hong Kong’s BIS-IH and the Asian Monetary Authority to study and implement projects that employ innovative technologies to foster a more sustainable future through the transformation of finance date back to 2021 with **Projects Genesis 1.0** and **2.0** [14][15], which aim to make issuing and investing in green bonds more attractive to investors.

Alongside these projects, another example of how BIS is actively promoting innovation in the field of sustainable finance is the organisation of **TechSprint** [53]. Since 2020, three out of six initiatives implemented have had this thematic area as their main focus. In particular, the 2021 initiative, carried out in co-operation with Banca d’Italia, was dedicated to green and sustainable finance. In 2024, two initiatives were launched, both with a focus on sustainable finance: the first in collaboration with COP28 and the Central Bank of the United Arab Emirates; the second in collaboration with the Central Bank of Brazil, focuses specifically on the development of technological solutions for sustainable finance.

BOX 2: Use cases on Green Fintech companies

Stripe Climate [81]

This is an initiative launched by Stripe, a global financial technology firm, to help companies combat climate change. Through Stripe Climate, companies can contribute to carbon removal projects by allocating a percentage of their revenue to them.

How it works:

1. **Companies sign up for Stripe Climate**: companies that use Stripe to process payments can join the initiative.
2. They **set a percentage**: companies choose the percentage of their revenue to earmark to Stripe Climate.
3. **Stripe collects funds**: Stripe collects funds from participating companies and uses them to finance carbon removal projects.
4. **Stripe Climate selects projects**: Stripe Climate selects carbon removal projects based on their effectiveness, scalability and impact potential.
5. **Companies receive reports**: companies receive regular reports on the impact of their contributions, giving them a way to demonstrate their commitment to environmental sustainability, enhance their reputation, engage employees and evaluate the impact of their investments. These benefits can be leveraged for increased customer loyalty and attractiveness to investors, and for a competitive advantage in the market.

Objectives:

- **Accelerate the development and implementation of carbon removal technologies:** Stripe Climate aims to fund innovative projects that remove carbon dioxide from the atmosphere, such as direct air capture and carbon mineralisation.
- **Creating a market for carbon removal:** Stripe Climate aims to help create a stable and scalable market for carbon removal by stimulating the development of new technologies and solutions.
- **Involve companies in the fight against climate change:** Stripe Climate offers a simple and transparent way for companies to contribute to the reduction of carbon emissions and demonstrate their commitment to sustainability.

Ecolytiq [32]

Ecolytiq offers a climate engagement software platform designed to be integrated into banking and finance apps. The main objective of Ecolytiq is to increase consumers' awareness of the environmental impact of their purchases and encourage them to make more sustainable choices.

How it works:

1. **Integration:** the platform integrates easily with existing bank and corporate payment systems.
2. **Carbon footprint calculation**: Ecolytiq calculates the carbon footprint associated with each transaction made by customers, using scientific data and methodologies.
3. **Information and engagement:** the platform provides consumers with detailed information on the carbon footprint of their purchases, offering personalised suggestions to reduce their environmental impact.
4. **Offsetting emissions:** Ecolytiq offers consumers the opportunity to offset the carbon emissions generated by their purchases by supporting certified emission reduction projects.
5. **Loyalty programmes**: the platform enables the creation of sustainability-based loyalty programmes, rewarding customers for their green choices.

Objectives:

- **Differentiation**: enable banks to offer an innovative and distinctive service that attracts environmentally conscious customers.
- **Image enhancement:** demonstrate commitment to sustainability and corporate social responsibility.
- **Customer engagement:** create a stronger link between banks and customers by offering tools and information useful in their daily lives.
- **Growth opportunities:** enable operators to exploit the growing interest in sustainability to develop new products and services.

3. The initiatives of Banca d'Italia

The growing global importance of sustainable finance is proven by the numerous regulatory interventions, principles, standards and best practices aimed at integrating ESG criteria into the financial sector. These interventions, developed at the international, European and national levels, focus on several key areas: setting standards for responsible investment; promoting transparency and reporting; classifying sustainable assets; developing sustainable financial products; and managing climate risk. (see Appendix 3 for key regulatory references).

Banca d'Italia contributes to the regulation of sustainable finance in Italy, fostering a favourable environment for sustainable investments and the transition to a greener and more inclusive economy [5]. In this context, it participates in the:

- ***Tavolo per la Finanza Sostenibile*** **(Table for Sustainable Finance)** [10]: set up by impulse of the Ministry of Economy and Finance, it involves the Ministry of Environment and Energy Security, Banca d'Italia, the Commissione Nazionale per le Società e la Borsa (CONSOB), the Istituto per la Vigilanza sulle Assicurazioni (IVASS) and the Commissione di Vigilanza sui Fondi Pensione (COVIP)[21]; it is a permanent forum for sustainable finance, which brings together representatives of these institutions to discuss and promote initiatives in this field; it published an annual report in 2023, which highlights the main challenges and opportunities for sustainable finance in Italy;
- ***Network for Greening the Financial System*** **(NGFS)** [9]: an international network of central banks and supervisors that shares best practices and developing tools to address climate-related financial risks.

In addition to these collaborations, Banca d'Italia also conducts numerous **research and analysis activities** on sustainable finance, publishing studies and reports that contribute to the debate and the understanding of this sector, and promotes **dissemination and awareness** through events, publications and training initiatives aimed at market operators and the general public.

In line with the United Nations 2030 Agenda for Sustainable Development and the 2015 Paris Climate Agreement, Banca d'Italia has defined five objectives in its Strategic Plan 2023-2025 [2], including one dedicated to "The Bank's commitment to the environment". This objective includes two specific action plans to strengthen the Institute's commitment to "Sustainable finance and the fight against climate change" and "Towards the net zero objective: the reduction of greenhouse gas emissions and environmental footprint". Through these plans, the Institute aims to gradually reduce its environmental footprint and achieve a net zero level of emissions in the long term. Among the courses of action envisaged to achieve this goal, it is worth mentioning: "*Deepening research on issues of ecological transition*" and "*Adopting environmentally friendly IT solutions (green ICT)*."

[21] Respectively: the Italian Companies and Exchange Commission (CONSOB), the authority responsible for regulating the Italian securities market; the Institute for the Supervision of Insurance (IVASS), the supervisory authority for the Italian insurance market; and the Italian Pension Funds Supervisory Commission (COVIP), the body that oversees the pension fund system.

With reference to the Fintech market support activities carried out through its Innovation Facilitators, Banca d'Italia fosters the development of initiatives that integrate sustainability into their business model. This approach is also reflected indirectly in the selection process for admission to the Regulatory Sandbox, and directly in the evaluation criteria for admission to Milano Hub, where, in addition to economic feasibility, the environmental and social sustainability footprint of proposed projects is also assessed.

The data collected through the Fintech Channel interviews are encouraging as they identify positive developments and highlight the growing importance of sustainability in the Italian Fintech market. With reference to the first half of 2024, about 15% of the projects observed would fall into the F4G category.

4. The potential of F4G: prospects and challenges for sustainable finance

The F4G phenomenon is closely related to ESG principles: on the one hand, F4G functions as a driver to enable and incentivise economic activities aligned with sustainability goals, on the other hand, ESG criteria can be considered as a compass that provides a framework to measure the environmental and social impact of an investment. While F4G companies use these standards to evaluate their activities and investments, investors pursuing ESG criteria rely on them to channel funding towards initiatives that operate responsibly. However, the transition to a more sustainable financial system requires a joint and coordinated global effort[22].

A recent research conducted by the University of Oxford [80], based on the "OECD Climate Actions and Policies Measurement Framework (CAPMF)" database [69], the largest harmonised international database on climate mitigation policies, examined the effectiveness of 1,500 climate policies implemented in 41 countries between 1998 and 2022. The study identified the countries that have demonstrated the greatest success in reducing emissions and analysed the policies adopted, providing useful information on which interventions are actually effective in combating climate change and promoting sustainable development. It emphasises the importance of adapting policies to the specific context and actively engaging citizens in the transition to a sustainable future. The multi-sectoral approach adopted by the study can potentially also be applied to F4G.

Although there is an ongoing interest in sustainable finance, a decline in ESG activism has been observed over the past two years[23]. For instance, support for shareholder resolutions focusing on ESG criteria at large US multinationals has fallen significantly[24]. According to the *Financial Times*,

[22] This concept has been emphasised also by Paolo Angelini [4], a member of the Executive Board of Banca d'Italia. Mr Angelini mentioned the important work carried out by the NGFS, of which Banca d'Italia is a member (see section 3, "The initiatives of Banca d'Italia"). This example illustrates how the joint efforts of all actors can contribute to greater transparency and a better understanding of the risks and opportunities of sustainable investments.

[23] ESG activism refers to the set of strategies and initiatives aimed at promoting more sustainable and responsible business practices in terms of environment, society and *governance*. ESG investors, particularly large investment funds, use their shareholder power to influence corporate decisions on issues such as climate change, labour rights, diversity and transparency.

[24] The decline in interest in ESG has been particularly evident in the United States; however, there have also been signs of a slowdown in other parts of the world, albeit to a lesser extent and with different dynamics.

support for such proposals dropped to about 20 per cent in 2023, well below the levels seen in 2021. This decline in engagement raises significant concerns about the effectiveness of ESG activism in promoting sustainable business practices. This slowdown can be attributed to several interconnected factors. First, there is a shift in investment strategy on the part of large asset managers such as BlackRock and Vanguard[25]. Historically among the main proponents of this approach, they now seem to favour more passive investment strategies in pursuit of short-term profit maximisation. The difficulties of ESG activism are further compounded by some unfavourable market trends: an example is provided by the recent positive performance of sectors traditionally considered "non-ESG", such as fossil fuels and the arms industry. Spurred on by the conflict in Ukraine, this trend has led many investors to favour these sectors, despite being aware of their negative impact on the environment and society.

Despite the widespread adoption of environmental and social criteria among different stakeholders in the Fintech landscape, their effectiveness in promoting truly sustainable practices remains a matter of debate, especially given their mainly voluntary application. Beyond these limitations, several other challenges hinder the ability to maximise the positive impact of the F4G phenomenon:

- **lack of harmonised regulation and consequent variability in business practices:** despite the most recent efforts of supranational institutions**,** the current application of sustainability principles is characterised by significant heterogeneity and fragmentation; this fosters variability in business practices and a lack of transparency, making it difficult to distinguish between genuine commitments and greenwashing practices [28][32]; the integration of climate and environmental risks into capital requirements also for banks, as required by the ECB, is complicated by the lack of common standards for assessing and reporting on these risks;
- **challenge related to the energy footprint of key technologies such as AI and DLT**: the high computational power required for the training and use of AI models, as well as the consensus mechanisms of some DLTs (e.g. those used for certain crypto-activities sometimes employed in F4G), can generate significant energy consumption; this poses a potential conflict with environmental and climatic sustainability goals that the F4G aims to achieve, making the adoption of appropriate technological and infrastructural countermeasures crucial (see Appendix 2);
- **conflict between economic incentives and sustainability**: companies, driven by short-term profit motives, often favour immediate economic goals at the expense of long-term sustainable choices; the absence of regulatory obligations allows firms to perpetuate strategies that, although profitable in the short term, generate environmental and social risks [30];
- **greenwashing and reduced investor and consumer confidence**: the absence of a clear regulatory framework and independent verification mechanisms means that companies' social and environmental impact statements often remain self-referential, thus fuelling the risk of greenwashing, which creates confusion among investors and consumers, undermining trust in sustainability criteria and hindering the flow of capital to truly sustainable initiatives [66];

[25] A case in point is the Exxon Mobil affair, in which Vanguard opposed the ESG shareholder campaign to promote a greater commitment to combating climate change. Similarly, Vanguard's opposition to employee representatives joining the board of Starbucks, at the initiative of trade unions, further highlights this change of direction.

- **absence of sanctions for non-sustainable behaviour**: the voluntary nature of the application of ESG criteria means that there are no sanctions applicable to companies that do not comply with them; the absence of concrete deterrents allows companies to escape their responsibilities and perpetuate non-sustainable behaviour without fear of significant consequences, except for possible reputational risks that could undermine stakeholder trust and negatively impact their business [60].

These factors highlight the need for a more robust and harmonised regulatory framework at an international level, capable of filling existing gaps and promoting truly sustainable business practices. The current regulatory landscape, characterised by heterogeneity and fragmentation, and the absence of a clear and defined framework, can make it difficult to distinguish between genuine commitments and greenwashing practices. This lack of common standards encourages variability in business practices and creates confusion among investors and consumers, undermining trust in sustainability criteria. Furthermore, the lack of common standards for assessing and reporting on climate and environmental risks poses a challenge for their integration into capital requirements.

The analysis conducted in this research suggests that the absence of a specific and widely recognised taxonomy, especially at the European level, represents a major challenge. In addition, the scarcity of academic studies on the subject highlights how the definition of a specific and widely accepted taxonomy of F4G would facilitate a better understanding of the sector, making it easier to identify the main actors and to classify the different initiatives, enabling a more accurate assessment of their impact and potential. However, it is crucial that the development of such a framework carefully considers the dynamic nature of the sector and the potential risk of stifling innovation, balancing the need for clear rules with the flexibility required by a rapidly evolving market. A pragmatic approach could be based on a continuous monitoring of the market, also making use of cognitive tools such as the periodic surveys conducted by Banca d'Italia on supervised and unsupervised Fintech operators, in order to promptly identify any emerging risk and calibrate regulatory interventions in a targeted and proportionate manner.

In conclusion, the facts outlined in this note stress the fact that a more robust and harmonised regulatory framework, together with the development of a shared taxonomy, can contribute to:

- **ensure transparency and accountability** of the actors involved;
- **counteracting greenwashing** by promoting truly sustainable financial practices;
- **creating a level playing field** for F4G companies, fostering competition and innovation;
- **promoting the mobilisation of** private **capital** towards sustainable and profitable investments.

In this scenario, sustainable finance, acting as a compass for responsible investment, would become a prerequisite for operating in the global market. The F4G, as a driver of the promotion of sustainable economic practices, could thus lead the transition to a more responsible future, fuelling equitable, inclusive and resilient growth over the long term.

5. Conclusions

This note provides an initial exploration of the complex phenomenon of F4G, analysing its emerging characteristics and its potential role in fostering sustainability. Given the scarcity of quantitative data currently available, the analysis relied mainly on qualitative information to outline its opportunities and challenges, in preparation for future in-depth studies.

The analysis highlights that F4G has several facets, including Green Fintech and Climate Fintech, and is characterised by its intentionality in generating a positive impact, its additionality compared to traditional players and the need to measure results.

The analysis has shown, through purely illustrative examples selected on the basis of public information, how F4G solutions can contribute both to financial inclusion and the achievement of social goals (e.g. easier access to payments, credit and insurance services), and to advancing environmental sustainability (e.g. the support for green investments, circular economy and ecological footprint monitoring). This note has also attempted to propose an initial operational distinction between "F4G by design" operators, which were born with an impact mission, and "F4G by product" operators, which have progressively integrated sustainability into their offerings; such a dichotomy deserves verification on the basis of future in-depth studies.

Despite the considerable potential of F4G as a catalyst for responsible and inclusive finance, its full realisation faces significant challenges. These include the need to address the trade-off between technological innovation and the energy consumption of some solutions (such as AI and DLT) and the difficulty in distinguishing genuine impact from greenwashing in the absence of shared standards.

Finally, the analysis revealed how the limited availability of quantitative data is still an obstacle to fully grasping the dimension of the F4G phenomenon, underscoring the potential role of ongoing institutional surveys to improve knowledge of the sector.

Overcoming these challenges and enabling F4G to fully express its role in the transition to a sustainable economy hinges on the development of a supportive ecosystem. This requires a joint commitment from public institutions and private operators, to define a clear and harmonised regulatory framework and a taxonomy that balances transparency, protection and the stimulus for innovation. It also requires enhancing the monitoring of the sector, including through cognitive tools such as the above-mentioned surveys.

Ultimately, the future development of Fintech for Good will require a cautious and pragmatic approach, which harnesses its transformative potential without neglecting the need to mitigate its risks and verify its actual impact.

Appendix 1 - Climate Tech

Climate Tech, or climate technology, refers to a broad set of technologies, services and innovations designed to address the global challenge of climate change and promote environmental sustainability. It is not just about renewable energy, but an expanding ecosystem of innovations ranging from sustainable agriculture to electric mobility, from carbon capture and storage to energy efficiency and even debris removal in space[26]. These emerging solutions not only promise to mitigate the effects of global warming, but also offer economic opportunities, creating new jobs and stimulating sustainable growth.

Despite a slowdown in investment in 2023, the world's top 20 climate tech unicorns[27] boasted a combined valuation of more than USD 140bn at the beginning of 2024. These companies come from different parts of the world, with a strong presence from China, the US and India[28]. Their diversity demonstrates the breadth of the climate tech sector and its growth potential. Their business focuses mainly on electric mobility, renewable energy, sustainable food production, circular economy, mobility services and sustainable agriculture.

In Europe, the majority of Climate Tech companies are in the UK (40%), followed by France (22%), Germany (18%) and Italy (7%), with the latter's share rising from previous years (4%). In particular, within the universe of the 200 most promising European start-ups in 2023 in the climate technology sector [56], the companies most oriented towards specific business models for climate finance and sustainability are:

- **Carbonplace** (UK): a company that provides a platform for carbon offsetting and enables companies to buy carbon credits to counterbalance their emissions.
- **Ecolytiq** (Germany): provides "sustainable personal finance" solutions that enable customers to monitor the environmental impact of their spending and make more informed financial decisions[29];
- **Pledge** (UK): a platform that facilitates fundraising for sustainability projects and enables companies to offset carbon emissions.

[26] On 5 October 2023, the innovative financial initiative "Space Debris Retrieval Insurance Bonds" (SPADRIBs) was launched to keep space *clutter-free*. Developed in collaboration between several organisations, including the European Space Agency (ESA), SPADRIBs functions as an insurance mechanism for debris removal missions: investors buy bonds that offer a financial return if the mission is successful in removing a predetermined amount of space debris. At present, SPADRIBs is still in the development phase but has attracted great interest as it offers a potential model for tackling the growing problem of space debris in a sustainable and cost-effective way.

[27] A start-up is called a unicorn when it reaches a valuation of more than USD 1 billion, a valuation achieved through funding rounds, mainly through venture capital.

[28] The others are based in Sweden, Estonia, UK, France and South Korea.

[29] For more details see "BOX 2".

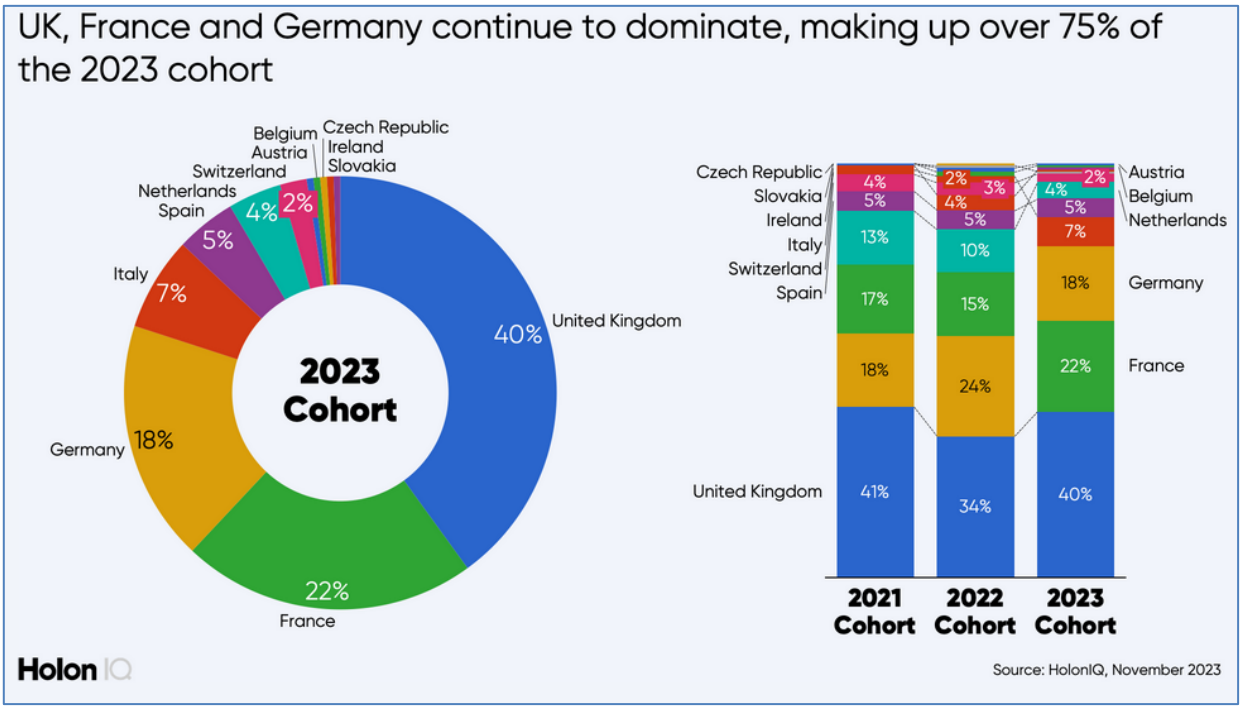

Figure 2. Geographical distribution (percentage shares per country) of the top 200 European climate tech start-ups identified for the years 2021, 2022 and 2023.
(Source: HolonIQ, November 2023)

As far as total funding (equity, debt and grants) is concerned, in Italy it amounts to approximately EUR 322 million. Of these, the energy subsector, which is the primary driver for reducing emissions, receives the largest share (37.9%), followed by agri-food (20%), essential for the sustainability of food supply chains. However, per capita investments remain lower than in other European countries and amount to EUR 3.8 million, compared to 43.2 million in France, 38.8 million in UK, and 27 million in Germany[23].

Appendix 2 - Corporate Sustainability in the Age of AI: From Social Responsibility to Green Data Centres

AI is emerging as a powerful tool for companies, also to address the challenges of sustainability, social responsibility and corporate governance. According to recent studies on the subject (*The role of AI in achieving the Sustainable Development Goals, Springer Nature Sustainability Community*), it can act as an enabler for 79% of the 2030 Agenda goals by transforming the way companies operate and creating long-term value for all stakeholders. In particular, with regards to social responsibility, by harnessing innovative technologies, companies could monitor employee welfare and promote inclusive cultures, identify social impact opportunities and make more informed decisions regarding ESG strategies. AI allows companies to assess more accurately the possible impacts of their actions on the environment, society and overall business performance.
Future research on AI and sustainability could investigate the following four key areas:

1. **developing** innovative AI technologies: creating new AI algorithms and applications specifically designed to support ESG initiatives, such as monitoring environmental compliance, assessing social impact, and managing sustainable supply chain;
2. **assessing** the impact of AI: measuring the actual influence of AI on firms' ESG performance, considering both positive and negative aspects, to fully understand the potential of this technology;
3. **addressing** ethical and legal challenges: identifying and resolving the ethical and legal issues associated with the use of AI for ESG, ensuring transparency, accountability and respect of human rights and privacy;
4. **formulating** guidelines for its responsible use: defining clear and shared guidelines for the responsible use of AI in the ESG arena, promoting ethical and transparent practices that maximise benefits and minimise risks.

The joint effort of companies, researchers and policymakers in exploring these areas is crucial to unlock the full potential of AI in promoting sustainability and corporate social responsibility.

It should be noted that the current pace of progress in generative AI makes it even more difficult to predict how this technology will affect the economy, business and society in general. However, it is possible to reason about how AI will affect the three key components of economic growth, namely capital, labour and productivity.
In terms of capital, the immense volume of investment required to fuel innovation in the field of generative AI is creating an environment in which only a small group of companies with access to large amounts of capital can realistically compete. BigTechs, thanks to their dominant position, enjoy a *de facto* monopoly that allows them to bear the huge costs required to develop, train and maintain LLMs.
With regards to the impacts on employment, it is difficult to make predictions, as there is uncertainty as to which sectors will be most affected and what knock-on effects this technology will trigger. In fact, recent studies, such as that of the IMF [75], highlight how exposure to AI varies considerably between advanced and emerging countries and between different groups of workers (e.g. by income level), suggesting potential polarising effects with risks of human labour substitution, but also opportunities linked to a possible complementarity between AI and some jobs.

Early indications on the impact of AI on long-term efficiency and productivity are encouraging. For example, a 2023 study [20] conducted on a sample of 5,000 workers found that the adoption of AI tools led to an average increase in productivity of 14 per cent, with an increase of as much as 34 per cent for less experienced workers.

According to the 6th Annual Nutanix Enterprise Cloud Index (ECI)[30] the 1,500 companies surveyed are implementing concrete sustainability actions, including modernising their IT infrastructure, driven by the use of AI techniques (e.g. for resource optimisation and process automation) and data management. 88 per cent of respondents agreed that sustainability is a priority for their organisation. In contrast to the previous report in 2023, where concrete actions were limited, many organisations indicate that they are already taking active steps to implement various sustainability initiatives[31], including increasing investments to support their AI strategy. 37 per cent of respondents considered this priority to be a significant challenge in terms of investments and choices in environmental sustainability.

To mitigate and overcome this challenge, organisations are likely to prioritise the deployment of edge infrastructure, based on a distributed computing model that brings data processing closer to the source, reducing network traffic and energy consumption. In this sense, there is an increasing use by corporate organisations of Green Data Centres, facilities designed to minimise environmental impact by using energy-efficient technologies such as low-power servers, optimised cooling systems and renewable energy sources. The global Green Data Centre market is set to grow significantly in the coming years [45]. In particular, the IT and telecommunications sector accounted for the largest share (USD 15.25billion) in 2022. It is estimated that it will continue to account for the largest market share until 2030, followed by the banking, financial and insurance sectors.

[30] Global research study examining the state of enterprise cloud deployments, IT infrastructure and data management initiatives and challenges.

[31] For example, in terms of sustainability trends by region, the EMEA (Europe, Middle East and Africa) and APJ (Asia-Pacific and Japan) regions show a priority for implementing remote working in support of sustainability, while in the Americas this priority ranks only fifth.

Appendix 3 - Main regulatory references on sustainable finance

Given the inherent breadth and complexity of the regulatory landscape, this appendix provides a non-exhaustive collection of the main laws and regulations relevant to the sector under review. It is crucial to emphasise that this section is designed to provide a guiding overview of the most relevant regulations at the time of writing, rather than a comprehensive and detailed review of the entire body of legislation. The aim is to facilitate an initial understanding of the legal foundations underlying the area covered in the research, providing a starting point for further study.

International references

- **United Nations Principles for Responsible Investment (PRI)** [77]: published in 2006, the PRI are a set of six voluntary principles that provide a framework for integrating environmental, social and *governance* (ESG) factors into investment decisions for institutional investors who wish to adopt a responsible approach based on common standards;
- **Task Force on Climate-related Financial Disclosures (TCFD**) [46]: created by the Financial Stability Board (FSB) in 2015, the TCFD developed recommendations for climate-related financial disclosures by companies; more and more these recommendations are being adopted globally and are becoming a standard for corporate climate reporting;
- **United Nations Sustainable Development Goals (SDGs)** [64] : adopted in 2015, the SDGs provide a global framework for addressing social, economic and environmental challenges; although the SDGs are not, strictly speaking, a form of legislation, they are influencing investment policies and practices globally, promoting a greater focus on sustainability.

European references

- **Action Plan for Sustainable Finance** [37]: a set of initiatives by the European Commission to redirect capital flows towards sustainable investments, manage financial risks arising from climate change, and promote transparency and long-term vision in economic activities;
- **Regulation (EU) 2019/2088 (SFDR) on Sustainability Disclosures in the Financial Services Sector** [41] this Regulation defines harmonised rules for financial market participants and financial advisors on transparency regarding the integration of sustainability risks and the consideration of adverse sustainability impacts in their procedures and in the disclosure of financial product information;
- **EU Taxonomy Regulation** [42]: a classification system to define which economic activities can be defined as "sustainable" with respect to six environmental objectives, identified in the taxonomy itself; it aims to give certainty to companies seeking financing for investment plans and represents the first guideline of the Action Plan on Financing Sustainable Growth launched by the European Commission in 2018[32];

[32] On this topic, please note the "Public Consultation Report on Taxonomy extension options linked to environmental objectives" presented to the Fintech Committee on 20 July 2021 by Dr. P. Marullo Reedtz, member of the Expert Group on Sustainable Finance for the European Commission.

- **EU Benchmark Regulation** [40]: introduces two new types of climate benchmark indices, i.e. the EU Climate Transition Benchmarks and the EU Paris-aligned Benchmarks;
- **ECB Climate Risk Stress Test** [35]: the ECB launched a stress test in 2022 to assess how prepared banks are for financial and economic shocks from climate risk; the results revealed that institutions have a significant exposure to carbon-intensive sectors, as well as a lack of comprehensive information on climate risks and shortcomings in their management; therefore, one of the ECB's supervisory priorities for the period 2024-2026 is to accelerate action to address the shortcomings in the governance and management of climate and environmental risks; banks are required to integrate climate and environmental risks into their risk management practices, including credit, operational and reputational risk assessments; furthermore they must ensure that their lending activities are consistent with environmental sustainability objectives;
- **Corporate Sustainability Reporting Directive (CSRD)** [44].: an extension of the Non-Financial Reporting Directive (NFRD), which will require more companies to disclose sustainability information;
- **Non-Financial Reporting Directive (NFRD**) [39]: this Directive obliges large companies to disclose information on environmental, social, governance, human rights and anti-corruption issues; it is currently being revised to strengthen sustainability reporting requirements [26][58];
- **Regulation on European Green Bonds (EU GBS**)[43][77]: this regulation aims to define a common European standard for issuers of green bonds wishing to use the designation "European Green Bond" (EuGB), in order to facilitate the development of this market, increase its transparency and promote the comparability of such financial products [8][26] [19];
- **Revision of Markets in Financial Instruments Directive (MiFID II)** [38]: introduces important innovations to integrate sustainability considerations into the financial sector by requiring financial intermediaries to integrate their clients' sustainability preferences and related risks into their processes; full implementation of these provisions is a gradual and ongoing process, with regulators providing further guidance and clarification to ensure consistent application across the European financial sector.

National References

- **Legislative Decree No. 59 of 14 May 2023**: implements EU Regulation 2019/2088 (SFDR) on sustainability disclosure in the financial services sector;
- **Corporate Governance Code**: includes recommendations on sustainability and corporate social responsibility for listed companies;
- **supervisory expectations of Banca d'Italia on climate and environmental risks** [5]: in line with the European framework and the ECB's priorities, Banca d'Italia requires financial intermediaries to integrate climate and environmental risks into corporate governance, risk management systems and disclosures, as part of its commitment to sustainable finance and in adherence to its supervisory mandate; an initial set of "supervisory expectations" was

published in April 2022, containing non-binding guidance on the integration of climate and environmental risks into the corporate strategies, governance and control systems, risk management frameworks and disclosures of supervised banking and financial intermediaries;

- **initiatives of *Commissione Nazionale per le Società e la Borsa* (CONSOB)** [26]: this Authority has launched several initiatives to promote sustainable finance, including the creation of a Sustainable Finance Observatory and the publication of communications and guidelines for market participants; in its Strategic Plan 2022-2024, it outlined an integrated approach to address the challenges and opportunities related to AI and sustainability in the financial sector, recognising the importance of AI as a tool to improve supervisory effectiveness and counter emerging risks, such as greenwashing; concurrently, it is committed to promoting sustainable finance, ensuring transparency of information and fostering the development of sustainable financial products and services.

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