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Public-private partnership as a tool for the EU's twin transition to ensure energy security and to support the development of entrepreneurial structures and social entrepreneurship

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***Abstract.** Europe's economy is becoming more digital and more green. These two trends emerged some time ago, but have received a massive boost in recent years. Digitalization has increased as a result of the pandemic as lockdowns, for example, forced companies to digitalize processes almost overnight. Greening has received a boost from the Russian aggression in Ukraine because, in response, EU countries are trying to move away from dependence on Russian oil and gas as quickly as possible and also to become more independent by expanding renewable energy. Based on integrative review methodology, the study attempts to combine both domains (greening and digital transformation) within the discourse of public-private partnership development involving social entrepreneurship. Social entrepreneurship is shown as a driver for regional development, occupying market niches in which the state fails to offer enough services and the market fails to make enough profits. The potential of PPP based on social entrepreneurship actors inclusion is*



demonstrated with regard to the challenge of heterogeneity of EU regions in their potential for green and digital growth. The study also examines how policy frameworks and institutional support affect the sustainability and operational strategies of social enterprises. Regulatory and policy structures shape SE performance, influencing its ability to access financing, navigate governance constraints, and ensure long-term viability, and future research in this field are expedient within the context of European Green Digital Coalition (EGDC), in particular based on application of Gartner maturity model.

Keywords: *European Green Digital Coalition; green and digital transformation; social entrepreneurship; maturity model; public-private partnership; energy structures.*

**Державно-приватне партнерство як інструмент подвійного переходу ЄС
для забезпечення енергетичної безпеки, розвитку підприємницьких
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Анотація. *Європейська економіка стає все більш цифровою та зеленою. Ці дві тенденції виникли деякий час тому, але отримали значний поштовх в останні роки. Цифровізація посилилася в результаті пандемії, оскільки, наприклад, локдауни змусили компанії майже за одну ніч оцифрувати процеси. Екологізація отримала поштовх від російської агресії в Україні, оскільки у відповідь країни ЄС намагаються якомога швидше відмовитися від*



залежності від російської нафти та газу, а також стати більш незалежними, розширюючи відновлювану енергетику. На основі методології інтегративного огляду літератури, дослідження робить спробу поєднати обидві сфери (екологізацію та цифрову трансформацію) в дискурсі розвитку державно-приватного партнерства, що включає соціальне підприємництво. Соціальне підприємництво показано як рушійну силу регіонального розвитку, що займає ринкові ніші, в яких держава не пропонує достатньо послуг, а ринок не отримує достатньо прибутку. Потенціал ДПП на основі залучення суб'єктів соціального підприємництва демонструється з огляду на проблему неоднорідності регіонів ЄС щодо їхнього потенціалу для зеленого та цифрового зростання. У дослідженні також розглядається, як політичні рамки та інституційна підтримка впливають на сталість та операційні стратегії соціального підприємництва. Регуляторні та політичні структури формують ефективність сталого підприємництва, впливаючи на його здатність отримувати доступ до фінансування, долати обмеження управління та забезпечувати довгострокову життєздатність, і майбутні дослідження в цій галузі є доцільними в контексті Європейської зеленої цифрової коаліції (EGDC), зокрема, на основі застосування моделі зрілості Gartner.

Ключові слова: Європейська зелена цифрова коаліція; зелена цифрова трансформація; соціальне підприємництво; модель зрілості, державно-приватне партнерство, енергетичні структури.

Introduction. The European Green Deal and Europe's digital transformation go hand in hand. Although they may appear to be two different problems, they are actually twin challenges that are equally crucial to the future of Europe.

The EU is pursuing a “twin transition” that will use digital technologies such as AI, IoT, and data spaces to achieve carbon neutrality by 2050. The Digital Decade



Policy Program supports key focal areas such as decarbonizing energy grids, boosting circular economies through digital product passports, and assuring sustainable, energy-efficient data centers by 2030. The key components of the green digital transformation are summarized in Table 1.

Table 1.

Core components of the green digital transformation

Component	Description
European Green Digital Coalition (EGDC)	Companies in this partnership have committed to create methodologies for measuring the net environmental impact of digital solutions and accelerating the deployment of green technology.
Key areas of action	Focus areas include developing a digital twin of the Earth for climate monitoring, fostering smart, sustainable mobility, and improving building energy efficiency.
Sustainability of infrastructure	The goal of regulations is to make sure that telecommunications networks and data centers use renewable energy to become energy-efficient and environmentally neutral.
Data spaces and circularity	Digital product passports will facilitate product tracking, enhancing sustainability and opening the door to a circular economy.
Digital spine concept	This strategy minimizes the need for new, bulky physical infrastructure by optimizing the use of renewable energy across sectors using decentralized intelligence and cutting-edge digital technologies.
Policy support	In order to increase competitiveness, the Green Deal Industrial Plan expedites investment in clean-tech production within Europe.

Source: [3]

With an emphasis on digital skills, privacy, and making sure that digital technologies support rather than impede the EU's environmental aims, the transformation highlights a human-centric approach.

In order to use digital technologies to speed up the EU's green and digital ("twin") transition, 26 CEOs of ICT companies formed the European Green Digital Coalition (EGDC) in March 2021 with backing from the European Commission. It



is a “phenomenon” of industry-driven sustainability, in which tech executives pledge to quantify and reduce the environmental impact of digital technologies while optimizing their enabling impact on other industries. A key element of the EU’s larger “twin transition” strategy, the EGDC seeks to harmonize the goals of the Digital Decade with the European Green Deal, which calls for carbon neutrality by 2050. It acknowledges that although digital technologies use energy, they are crucial for maximizing resources and cutting emissions throughout the economy [2].

PPPs are essential for closing the investment gap, and the European Commission and private organizations work together to carry out projects:

- Digital Infrastructure & Services: PPPs are used to improve data and computer infrastructure. They make sustainable public services like digital public administration and telemedicine possible.
- Sector-Specific Coalitions: The EGDC collaborates to develop standards for greening industries such as building and energy.
- Investment Mechanisms: The Next Generation EU fund, which is a portion of the EUR 1.85 trillion 2021–2027 budget, provides loans and grants to encourage the use of digital technologies and green energy [5].

For Europe’s future, technology offers both tremendous opportunities and difficult difficulties as a driver for social and economic development. In order to maximize the former and lessen the latter, EU institutions have created a series of digital initiatives over the past few decades. In addition to ensuring that digital transformation is in line with European values and interests, these initiatives seek to increase the EU’s competitiveness in the global market.

Consequently, the function of entrepreneurship structures in these PPPs is evolving and changing. In particular, securing a sustainable supply of materials essential for both transitions is the goal of the planned “Raw Materials for the Green and Digital Transition” partnership, which is anticipated to begin in 2026. Social entrepreneurship is given particular attention. As a catalyst for inclusive, localized,



and sustainable economic growth, social entrepreneurship is essential to the EU's twin transition - the concurrent green and digital transformation. The European Social Economy Action Plan for 2021–2027 identifies social enterprises as crucial players in ensuring that everyone is included in the shift to a digital and carbon-neutral economy.

While there are a huge number of programs and initiatives in the field of PPPs in twin transition, and crucial role of entrepreneurship in them, this phenomenon yet did not receive proper attention in scholarly investigation, that is, this phenomenon is still not well systematized and comprehended.

Literature review.

In their analysis of the relationship between environmental sustainability and digital transformation, Fernandez et al. [7] concentrate on how digital technologies might help achieve the goals of the EU's Green Deal. Digital technologies provide effective ways to improve energy efficiency, monitor emissions, maximize resource use, and promote innovation in green businesses as Europe strives for climate neutrality by 2050. The article asserts that in order to guarantee coherence with sustainability goals, the environmental impact of digitalization itself must be addressed concurrently. The authors demonstrate how green digitization contributes to a competitive and sustainable European economy by looking at opportunities, dangers, and policy.

Kovacic et al.'s analysis [12] is based on interpretive text analysis of high-level EU policy papers regarding the twin green and digital transition as well as the recovery and resilience strategies of Member States. The study evaluates the political and socioeconomic environment as a key element that explains how the combination of the green and the digital is perceived as desired. Our findings demonstrate how innovation related to the digital imaginary is employed to discursively redefine conflicts between the goals of sustainability and economic policy as complementary. The promise of win-win solutions is not the only source of legitimacy; governmental



institutions are also said to be able to lead the twin transitions in the right direction while avoiding known hazards. By framing the need to recover from the COVID-19 epidemic as a chance to expedite the green and digital transitions, the twin transition logic directed the allocation of funding in terms of implementation. Therefore, the digital imaginary combines innovation governance with environmental governance.

Herman and Georgescu [9] try to determine if EU nations can strike a balance between the SDGs and digital business transformation. The findings show significant differences between the member states, with the northern and western nations at the top and the southern and eastern nations near the bottom. Regression analysis reveals a negative correlation with SDG 13 and a high positive correlation between digital business transformation and SDG 9. Cluster analysis highlights the need for customized policy responses by identifying six groupings of nations with differing degrees of sustainability and digital performance. There is evidence that many EU nations have a digital-green trade-off, although this problem can be lessened by deliberate policy convergence. The results highlight the significance of focused investments in ICT skills, digital infrastructure, and research and development, especially in underperforming areas. To guarantee that digital business transformation is in line with inclusive and sustainable growth throughout the EU, customized measures are necessary.

The dynamics of PPPs in advancing digital transformation and circular economy initiatives in developing country public sectors are examined by Tanveer et al. [19]. The research examines how complementary resources, collaborative processes, trust and governance, mutual benefits, and value creation influence the success of these partnerships using Collaborative Advantage Theory (CAT) and a multiple-case study design involving ten public and twelve private organizations across five cases. In order to promote long-term public service innovation and sustainability, the report offers practical suggestions for policymakers and leaders in the private sector to enhance the governance, resilience, and scalability of PPPs.



For the twin transition, Santiago and Joel [17] look at fostering entrepreneurial ecosystems. The authors examine how sustainability transitions and digital transformation interact, emphasizing both their advantages and disadvantages. Building on this basis, the study presents a conceptual framework that highlights important aspects for developing entrepreneurial ecosystems that can take advantage of the potential presented by both shifts.

The role of the social entrepreneur in sustainable heritage-led urban revitalization is examined by Scaffidi et al. [18]. This article highlights the importance of social entrepreneurs as catalysts for sustainable urban expansion in rural areas and offers fresh perspectives on urban planning and architecture. To test the research premise, the author looks at 17 European examples of social enterprises managing regenerated industrial legacy.

In the meantime, two sets of literature - one on digital entrepreneurship and the other on sustainability-oriented entrepreneurship - have surfaced within the realm of the entrepreneurial ecosystem. Despite developing concurrently, these streams are still mainly isolated.

Aim of the study. The study aims to systematize state-of-the-art and vectors of development in the landscape of PPP in the field of the EU twin transition, and investigate role and models of entrepreneurship, including social entrepreneurship, in appropriate PPPs.

Methodology. The methodological basis of the research is systemic-structural analysis. The research tool is integrative literature review, which allowed organic combining of digital and green domains of the EU policies of transformation, as well as PPP development.

Results and Discussion. The way that digital technologies may act as strong facilitators and accelerators of the green transition, enabling the creation and use of creative sustainable solutions across a range of industries, reflects the interdependence of the digital and green transitions. On the other hand, the need to



solve urgent environmental issues can lead to the development of innovative digital tools and apps that support environmental conservation and restoration initiatives, thereby influencing the course of digital innovation [1][21]. For example, digital technologies can improve environmental resource management and monitoring, allowing for more effective energy and material use [15], as well as improved environmental risk predictions and mitigation [13]. Additionally, digitalization reduces transaction and communication costs, which facilitates connections between suppliers, partners, and customers, increasing the reach and effect of sustainable enterprises [4]. The influence of sustainable business models is further increased by the ability of digital technologies to unite many actors in co-creation and community development activities.

Digital tools' capabilities, such as better data analytics, automation, and decision-making, can be used to accelerate the development and deployment of new solutions vital to the green transition. These solutions include circular business models, corporate greenhouse gas monitoring and reporting, smart cities, sustainable supply chains, and mobility solutions that cut emissions and encourage environmentally friendly modes of transportation [1][11].

At the heart of this dynamic interplay between digital and green transformations are entrepreneurs and their capacity to identify, produce, and scale creative solutions. Digital technologies enable sustainable entrepreneurs to create value propositions that include environmental, social, and economic value, thereby appealing to a larger customer base. Digital platforms, in particular, provide effect complementarities, in which the capture of one type of value (e.g., financial) corresponds to the capture of another type of value (e.g., social or environmental). In recent years, a number of corporations have pushed to produce sustainable versions of their products, or whole new items, to cater to environmentally sensitive customers. Incidents in which corporations deceptively portray their products as environmentally benign have increased customer distrust (known as



‘greenwashing’) [6]. Digital solutions, such as blockchain and radio frequency identification (RFID) technologies, improve supply chain transparency and traceability, fostering trust among consumers concerned about product sustainability [17].

However, sustainable entrepreneurship differs fundamentally from traditional entrepreneurship in terms of planned impact and actual outcomes, as well as the fact that their success is dependent on the help of others [10]. While entrepreneurship can be defined as a combination of attitudes, resources, and infrastructure that leads to the exploration and exploitation of new opportunities, sustainable entrepreneurship is motivated by the desire to address critical societal concerns such as climate change and social unfairness. Sustainable entrepreneurship activities aim to address basic societal concerns that are consistent with the UN Sustainable Development Goals (SDGs), which cover economic, environmental, and social domains. The paradigm of social entrepreneurship is now integrated into the sustainable entrepreneurship paradigm.

The digital and green transitions should ideally work well together. For instance, material tracing can make use of distributed ledger technology, which supports blockchain and cryptocurrencies, thereby advancing the circular economy through better upkeep and recycling. Additionally, among other things, Digital Twins - virtual replicas of the real world - can model traffic to enhance traffic flows, reduce congestion, and reduce emissions.

The two transitions could, however, sometimes conflict. Electricity is necessary for digitalization, and a lot of digital technologies use a lot of resources and produce waste. Users of hybrid cars may drive more because they are less expensive, which is an example of an unintended consequence. While teleworking might result in a smaller workspace, it could also cause workers to set up separate workspaces at home and use more space for heating or cooling than they would if they were in an office.



Proactive and integrated management will be necessary to maximize the twin transition. The private sector will spearhead the digital revolution due to its vast economic potential. To optimize its advantages for greening while reducing its drawbacks, state and civil society involvement will be necessary. The creation of public-private partnerships is clearly implied by this.

Interoperability between public and private enterprises, or the smooth flow of data, knowledge, and technological capabilities, has emerged as a critical enabler of long-term digital changes. Interoperability, which is based on Collaborative Advantage Theory (CAT), depicts the processes of resource integration and shared value generation that are required to achieve collaborative advantage and improve partnership resilience [19]. In particular, PPPs involving social entrepreneurs use collaborative, typically local, initiatives to solve social issues, enhance service delivery, and stimulate innovation in fields such as education, healthcare, and community development. These models entail the sharing of risks and resources between government and commercial or non-profit enterprises, with the goal of achieving both social effect and financial viability.

Digital and green social entrepreneurship integrate the use of digital technologies (AI, IoT, blockchain) with eco-friendly business strategies to address environmental and social issues. These businesses, which are frequently early adopters of digital tools, seek to produce long-term value by optimizing resource usage, increasing efficiency, and facilitating a “just transition” that assures inclusive green growth. However, the sector confronts several obstacles, including high initial, resource-intensive production costs, limited access to green digital infrastructure, and the need for new, sustainable business models. Thus, PPP procedures are the best alternative for such entrepreneurship’s operation and development.

Long-term, sustainable, and technology-driven infrastructure is given priority in European PPP models in the green and digital sectors, which are frequently motivated by the European Green Deal. Build-Operate-Transfer (BOT) schemes for



energy, waste management, and smart city projects are important examples, as are contractual PPPs (cPPPs) for R&D (e.g., in digital and manufacturing, transport) [8]. Table 2 summarizes sectoral uses, financing strategies for green technology through PPPs, and economic/social consequences.

Table 2.

Green technology through PPPs: financing models, sectoral applications, economic/social impacts

<i>PPP-Based Green Technology Financing Models</i>
Green Bonds: Issued by businesses or governments, green bonds provide funding for environmentally beneficial initiatives. When included within PPP frameworks, they enable private investors to take part while governments offer guarantees and regulatory control.
Blended finance lowers investment risks in expensive green projects by combining commercial private capital with concessional state financing.
Risk-Sharing Mechanisms: Tools like insurance, tax breaks, and credit guarantees reduce uncertainty and draw in private investors.
Pay-for-Performance Models: These models link incentives with long-term objectives by rewarding private partners based on sustainability results attained.
<i>Sectoral Applications</i>
Renewable Energy: Large-scale solar and wind farms have been funded by PPPs; private companies provide technology and operations, while governments supply land and incentives.
Smart Cities: PPPs have made green infrastructure possible, including waste-to-energy facilities, energy-efficient buildings, and electric public transit.
Sustainable Transportation: PPP-led projects in rail systems, electric vehicles, and charging infrastructure show how emissions can be cut while generating revenue.
<i>Effects on the Economy and Society</i>
Employment Creation: New jobs in operations, manufacturing, and research and development are produced by investments in renewable energy and green infrastructure.
Technology Transfer: PPPs enable international innovation, giving developing nations access to cutting-edge green technologies.
Economic Resilience: Green investments improve national economic stability by lowering long-term expenses related to the effects of climate change.
Inclusivity: PPPs that include community involvement guarantee advantages that are fair to all social groups.

Source: [8]

Naturally, these initiatives also entail a high degree of digital transformation, which leads to the emergence of a synergy between digital and green development.



Consequently, entrepreneurship in such ventures becomes social entrepreneurship (SE) due to clear societal impacts. Blockchain, digital platforms, and artificial intelligence are examples of emerging technologies that have been recognized for their potential to improve SE operations [16]. Technological innovation has become a crucial enabler of scale, efficiency, and inclusion as SEs get more involved with the SDG framework. Technology enables SEs to promote progress across several SDGs by reaching underserved people, streamlining operations, and monitoring impact in real time.

The fact that different parts of Europe are not equally prepared for the twofold revolution of the economy also determines the significance of PPPs including social entrepreneurship in the green and digital sectors. The European economy is changing in two ways: digitally and environmentally. This is a chance for cities and high-tech areas. For others, it could be a burden.

The green transition is a Herculean effort for places that mine coal or generate other fossil fuels, steel, basic chemicals (such as ethylene and ammonia), or cement. Because these sectors are highly energy-intensive, they are also facing the most severe changes, necessitating significant funding. However, these investments may not always enhance overall output. Instead, they primarily ensure that the same level of production may be maintained while emitting fewer greenhouse gases. As a result, many companies face significant expenses that, if environmental expenditures displace others, will have little or no positive impact on economic growth [14]. Figure 1 displays green growth readiness among EU areas.

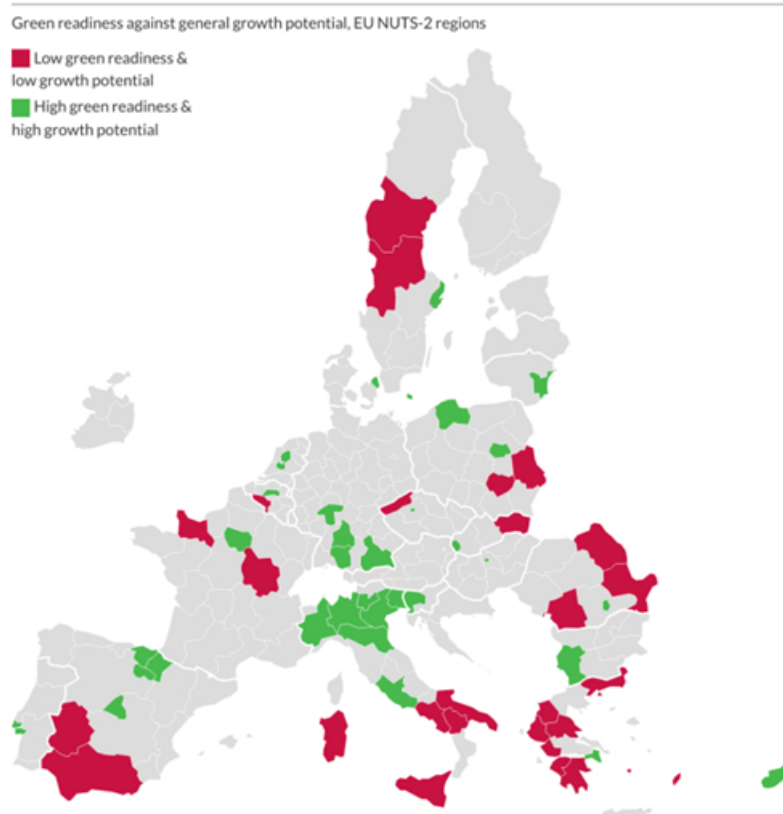


Fig. 1. Green growth readiness (potential) across the EU regions

Source: [14]

The digital growth potentials of EU areas vary similarly (see Fig. 2). Wealthy and highly urbanized regions, such as Northern Italy, Southern Germany, and Catalonia, are likely to outperform less developed regions. Thus, acquiring the capacity to benefit from digitalization may be costly, particularly in less developed countries. Automation, for example, eliminates certain employment while creating other high-skilled professions. The dilemma is that employment losses may occur in one place while new jobs are created in another.

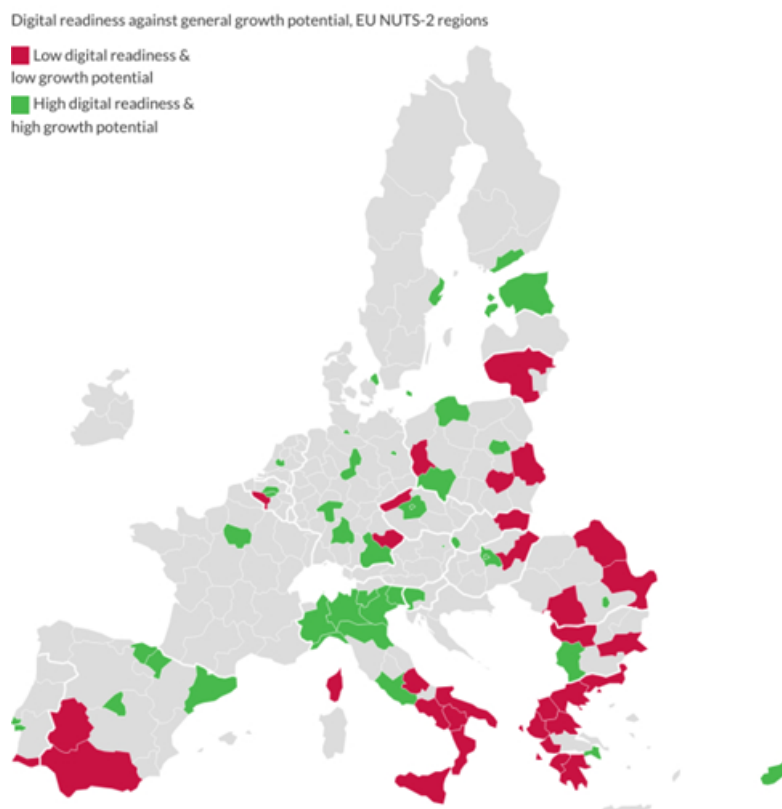


Fig. 2. Digital growth readiness (potential) across the EU regions

Source: [14]

Applying the Gartner maturity model appears sensible under these circumstances. From ad hoc ventures to standardized, strategic partnerships that may be mapped to maturity models like those created by Gartner, PPPs frequently follow a path of sophistication. The concepts of transitioning from reactive to optimized processes closely relate to the maturing of a government's PPP program, even though Gartner's primary focus is on IT, data, and business process maturity. Four to five levels - Aware, Reactive, Proactive, Managed, and Optimized - are frequently highlighted in Gartner models. In the context of PPP, this means:

- Aware/Reactive: PPPs are only used by governments when they have no other option (e.g., severe financial restrictions).
- Proactive: Governments engage the market early by methodically evaluating possible projects for PPP suitability.



- Managed/Optimized: The emphasis switches to portfolio management, overseeing the 20–30 year lifecycle of several projects, concentrating on performance, and handling hand-back at contract termination.

By combining effectuation theory to study decision-making under uncertainty and stakeholder theory to evaluate governance structures and multistakeholder partnerships, future research might expand on these discoveries.

Conclusion. The capacity of social entrepreneurship to address economic and social injustices and accomplish goals of shared interest has been acknowledged by European institutions. It is the cornerstone of the European social market model, according to the European Parliament. Due to its connection to a number of autonomous development policies, including social inclusion, employment policy, the social economy, and civil society, the EU is interested in social entrepreneurship. However, the idea of a double transition - green and digital - provided a fresh boost to social enterprise. As a key tactic for sustainable growth, the European Union is utilizing the “twin transition”, which is the meeting point of digital and green transformation and heavily incorporates social entrepreneurship through Public-Private Partnerships (PPPs). Social entrepreneurship gains the essence of sustainable entrepreneurship within suitable PPP models, and PPPs featuring sustainable entrepreneurship have the potential to become an effective tool for integrating the highly varied green and digital potential of the EU regions.

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