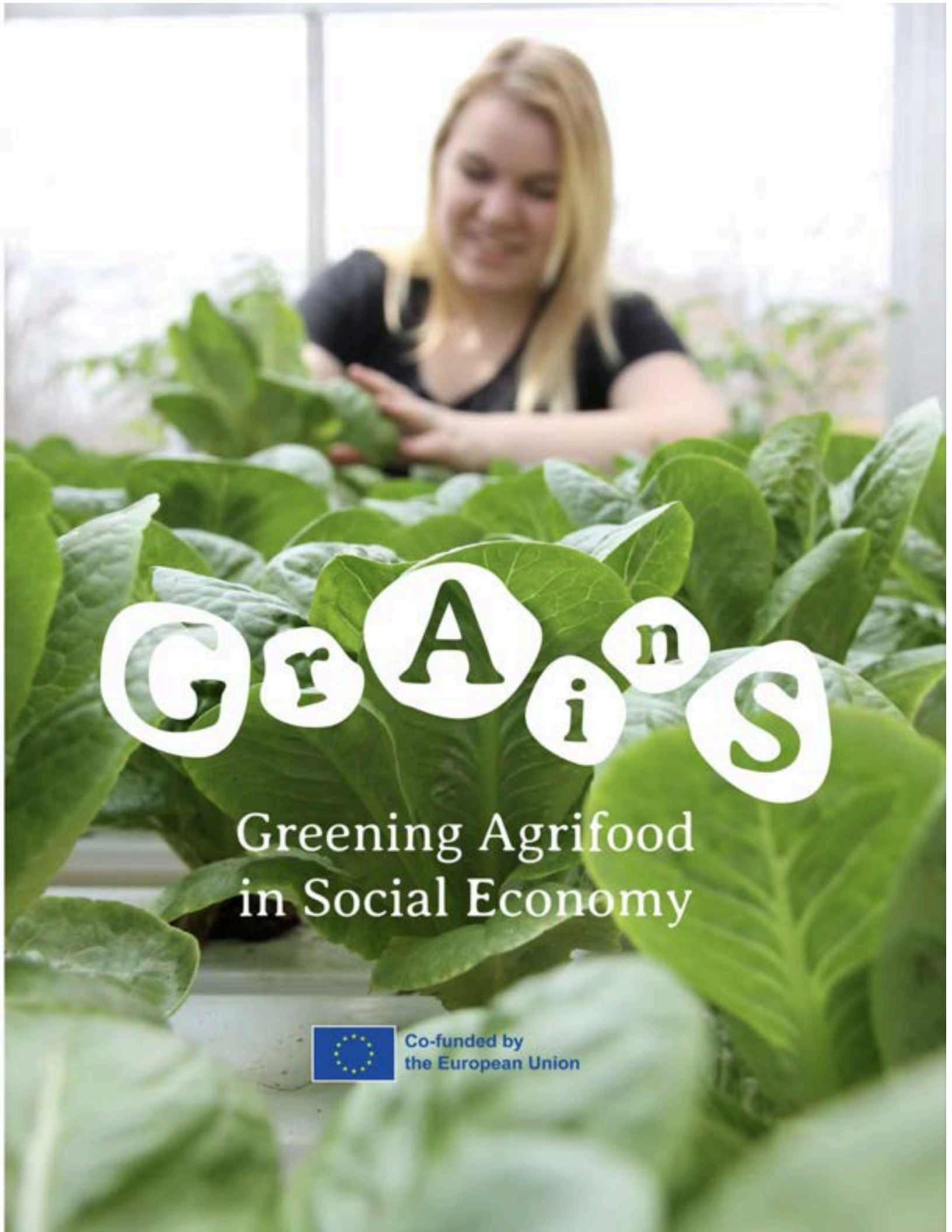

Greening Agrifood in Social Economy

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Access to Technology and Digitalisation for the Green Transition of Social Economy SMEs

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INTRODUCTION

Welcome to a pivotal journey toward the sustainable evolution of your enterprise. In this era, where the pulse of innovation quickens, embracing the dual transition to a greener and more digital economy is not just an option but a strategic imperative for Social Economy SMEs and entrepreneurs like you. This document is designed to navigate you through the complexities of integrating technology and digitalization into your business models for an effective green transition. It aims to serve as a beacon, illuminating the path towards a resilient, competitive, and sustainable future.

The Essence of the Twin Transition

At the core of this transformation lies the twin transition—a seamless integration of green practices with digital innovation. The twin transition represents a harmonious blend where environmental sustainability and digital advancement feed into each other, creating a synergy that propels Social Economy SMEs towards unprecedented efficiency, competitiveness, and environmental stewardship.

Digitalization: A Catalyst for Green Transition

Digital technologies offer powerful tools for SMEs to optimize resource use, reduce waste, and streamline operations. From energy-efficient production processes to blockchain for traceability in the supply chain, digital solutions not only enhance operational efficiency but also enable you to make informed, sustainable decisions. This digital empowerment is pivotal for SMEs aiming to reduce their carbon footprint and embrace a low-carbon economy.

Renewable Energy: Elevating Competitive Edge

Incorporating renewable energy sources into your business operations directly impacts your bottom line by reducing energy costs and safeguarding against fluctuating fossil fuel prices. Beyond economic benefits, it strengthens your brand's commitment to sustainability—a crucial differentiator in today's market. This document will guide you through practical insights on harnessing solar power effectively, addressing challenges such as seasonal variations, and ensuring alignment with your enterprise's energy needs.

Empowering Through Knowledge

Understanding the landscape of EU policies, incentives, and technological advancements is essential for navigating the twin transition. This document synthesizes key information, presenting it in a manner that is accessible yet comprehensive. It aims to equip you with the knowledge to leverage the Social Economy Action Plan, understand the Council's recommendations for social economy framework conditions, and explore the opportunities presented by Europe's Digital Decade.

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Your Role in the Sustainable Future

As leaders in the social economy, you play a vital role in shaping a sustainable future. Your decisions and actions set a precedent for responsible business practices, driving societal change towards greener, more inclusive economies. This document is a testament to your commitment to this journey, offering guidance, inspiration, and practical solutions to ensure your success in the twin transition.

As you delve into the following sections, we invite you to engage with an open mind and a forward-thinking attitude. The path toward a sustainable, digital future is rich with opportunities for growth, innovation, and leadership. Together, let's embark on this transformative journey, paving the way for a greener, more digital economy that benefits us all.

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SECTION 1: DIGITAL EMPOWERMENT FOR SUSTAINABLE GROWTH IN AGRI-FOOD SMES

1.1 The Role of Digital Transformation

Introduction to Digital Technologies in the Agri-Food Sector

In the dynamic realm of the agri-food sector, integrating digital technologies has become essential for achieving sustainable development. This chapter is designed to guide social economy SMEs and entrepreneurs through the impactful role digital innovations play in revolutionizing farming methods and food production processes. These advancements are pivotal in enhancing efficiency, bolstering productivity, and promoting environmental sustainability.

The onset of the COVID-19 pandemic, officially declared by the World Health Organization (WHO) on March 11, 2020, imposed significant hurdles on public health and the worldwide economy, notably affecting food supply chains and overall food systems. The pandemic's challenges, intensified by stringent measures like lockdowns and social distancing, led to labor shortages across the food value chain, thus disrupting established food systems and altering consumer dietary habits. This situation underscored the critical need for adaptability and resilience in ensuring a resilient and sustainable food supply, with a growing emphasis on food safety, quality, and traceability among consumers and producers alike.

In response to the pandemic-induced disruptions, there has been a concerted effort to explore innovative strategies, alternative approaches, and technological advancements to alleviate the pandemic's effects. While the trend towards digitalization in the agriculture and food industry predates the pandemic, the crisis has undeniably accelerated the shift towards digital transformation, emphasizing the importance of digital and automated solutions in enhancing productivity and optimizing resource utilization, aligned with the goals of a more sustainable food system.

Digitalization's essence is intricately connected to Industry 4.0, or the fourth industrial revolution, which is characterized by the fusion of digital, physical, and biological spheres through technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, robotics, 3D printing, and smart sensors. These technologies are at the forefront of creating intelligent digital farms and factories. Although there is no universally accepted classification of Industry 4.0 technologies, the agri-food sector commonly recognizes the significance of

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additional technologies including blockchain, cloud computing, digital twins, and cyber-physical systems in driving forward this digital revolution[1].

As we delve into this chapter, we aim to equip you, the social economy SMEs and entrepreneurs, with a comprehensive understanding of how digital technologies can be leveraged to navigate the complexities of the agri-food sector, fostering innovation, sustainability, and resilience in your endeavors.

Digital Empowerment: Catalyzing Sustainable Growth in Agri-Food SMEs

In today's rapidly evolving digital landscape, agri-food SMEs stand on the brink of transformational growth, powered by cutting-edge technologies. This section delves into how Artificial Intelligence (AI), the Internet of Things (IoT), and Blockchain are pivotal in fostering sustainability and enhancing efficiency within your business operations.

Harnessing AI and Big Data for Informed Decisions

At the heart of digital innovation, AI and big data analytics offer profound insights and solutions to prevalent challenges within the agri-food sector. From public health safeguards to risk mitigation and sustainability efforts, these technologies are reshaping the landscape. AI enhances decision-making, improves yield forecasts, and delivers precise pest and disease control, leading to smarter resource use, reduced waste, and heightened efficiency. The synergy of big data and cloud technologies, particularly post-COVID-19, underscores the need for robust computational infrastructure to manage the vast data generated across the food supply chain. Cloud computing emerges as a beacon, facilitating on-site data generation and real-time analysis, thus streamlining food safety controls and compliance, all while reducing costs[2].

IoT and Smart Sensing: The Eyes and Ears of Precision Agriculture

IoT technology introduces real-time data collection across the food supply chain through advanced sensors, monitoring everything from farm conditions to storage environments. This network of sensors not only predicts product quality and shelf life but also enhances food safety by detecting adulteration. In agriculture, the application of smart sensors for weather, soil quality, and crop monitoring contributes to increased yields and cost savings, marking a significant step towards sustainable farming practices[3].

Blockchain: Ensuring Transparency and Trust

Blockchain technology revolutionizes traceability and transparency in the food supply chain. By creating an immutable record of every transaction, it ensures the integrity of food products from origin to consumer, effectively combating food fraud and minimizing waste. When

[1] A. Fraser, The Digital Revolution, Data Curation, and the New Dynamics of Food Sovereignty Construction. The Journal of Peasant Studies, Vol.47, pp. 1-19 (2020). DOI: https://doi.org/10.1080/03066150.2019.1602522

[2] Jin, C., Bouzembrak, Y., Zhou, J., Liang, Q., van den Bulk, L. M., Gavai, A., et al. (2020). Big data in food safety- a review. Curr. Opin. Food Sci. 36, 24–32. doi: 10.1016/j.cofs.2020.11.006

[3] Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., and Martynenko, A. (2022). IoT, big data and artificial intelligence in agriculture and food industry. IEEE Internet Things J. 9, 1–1. doi: 10.1109/JIOT.2020.2998584

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combined with IoT, blockchain technology enhances real-time visibility and reliability across the supply chain, ensuring food safety and quality[4].

Robotics and Smart Machinery: Automating for Efficiency
The deployment of robotics and smart machinery across agricultural production and processing signifies a leap towards automation. These technologies perform a myriad of tasks, from cultivation to harvesting, and provide valuable data for precision agriculture and optimal breeding choices. Robotics also extend their utility to post-harvest operations, including sorting, packaging, and shipping, replacing manual labor with efficiency and precision[5].

Digital Twins and Augmented Reality: Modeling the Future
Digital twins offer a virtual representation of physical entities, enabling modeling activities that drive productivity, resource, and energy efficiency. While augmented reality (AR) finds applications in various sectors, its role in agriculture and food management is burgeoning, showing potential in areas such as weight management and operational training[6].

Conclusion
The integration of AI, IoT, Blockchain, and other digital technologies not only propels the agri-food sector toward unprecedented sustainability and efficiency but also opens new avenues for SMEs and entrepreneurs to innovate and excel in a competitive market. As you navigate this digital revolution, embracing these technologies can be a game-changer, positioning your enterprise at the forefront of the sustainable agri-food industry.

1.2 Overcoming the Digital Divide in Agri-Food SMEs

The journey towards digitalization in the agricultural and food sectors holds immense promise for sustainability and efficiency. However, this path is fraught with challenges, especially for small-scale farmers, SMEs and social economy entities. Understanding these hurdles and the EU's initiatives to bridge the digital divide is crucial for empowering these stakeholders.

Challenges in Embracing Digital Technologies

Small farmers and social SMEs encounter several barriers when adopting digital and advanced technologies such as AI, IoT, and blockchain. Key obstacles include:

- Infrastructure and Access: A significant lack of adequate digital infrastructure and access to technology hampers the ability of small-scale farmers and food companies to integrate digital solutions.
- High Costs and Investment Needs: The initial investment required for digital technologies often exceeds the financial capabilities of small entities, making it difficult to justify the cost against potential returns.

[4] Attaran Mohsen et al., 2019, *Food Industry,* in M. Attaran, A. Gunasekaran, *Applications of Blockchain Technology in Business*, Springer, Cham
[5] Basso B. et al, 2020, 'Digital agriculture to design sustainable agricultural systems', Nature Research, 3
[6] Chai, J. J. K., O'Sullivan, C., Gowen, A. A., Rooney, B., and Xu, J.-L. (2022). Augmented/mixed reality technologies for food: a review. Trends Food Sci. Technol. 124, 182–194. doi: 10.1016/j.tifs.2022.04.021

- **Skills and Training**: There's a pronounced gap in digital literacy and technical skills among staff and decision-makers within these organizations, limiting their capacity to leverage new technologies effectively.
- **System Integration**: Integrating digital solutions into existing processes and routines poses significant challenges, requiring time and resources that many small operations do not have.
- **Ethical and Privacy Concerns**: Issues related to data privacy, security, and ethical use of technology like AI and big data analytics remain prominent concerns.
- **Regulatory and Socio-economic Barriers**: Diverse regional regulations and socio-economic conditions further complicate the adoption of digital technologies.

Addressing these barriers requires a concerted effort from all stakeholders, including governments, technology providers, and the SMEs themselves[7].

EU's Role in Promoting Digital Inclusion

The European Union recognizes the pivotal role of digitalization in transforming the agricultural sector into a more sustainable, efficient, and competitive domain. Several EU initiatives and policies aim to foster digital inclusion among small farmers and SMEs:

- **The Transition Pathway for Proximity and Social Economy** outlines strategic directions for integrating digital technologies within the social economy, emphasizing support for SMEs in their digital transition Transition Pathway.
- **Europe's Digital Decade** vision aspires to achieve digital sovereignty, laying out clear targets for 2030 that include digital skills, infrastructure, and the digital transformation of businesses, with a focus on the agricultural sector Europe's Digital Decade.

To specifically address the challenges faced by the agricultural sector:

- The "From Farm to Fork" Strategy under the European Green Deal prioritizes the digital and technological transition of agriculture to enhance climate and environmental outcomes. This strategy supports innovation and digital technology as catalysts for sustainable agri-food systems From Farm to Fork Strategy.
- Common Agricultural European Data Space is an ambitious project aimed at facilitating cross-domain data sharing, supported by the Data Governance Act and the forthcoming Data Act, to improve sustainability, productivity, and competitiveness in the agricultural sector.
- The Common Agricultural Policy (CAP) 2023-2027 plays a crucial role in shaping the digital landscape for agriculture across Europe. This policy framework is designed to influence and support the digitalization of agriculture, aiming to actively involve and benefit the broad spectrum of small to medium-sized farmers that define Europe's agricultural landscape. A cornerstone of this policy is the enhanced focus on building Agricultural Knowledge and Information Systems (AKIS). These systems are instrumental in spreading digital skills and knowledge, thus facilitating a grassroots-level adoption of digital technologies across the agricultural and food sectors. The CAP's strategic

[7] Rudenko M. , The Impact of Digital Technologies on Agricultural Production: a Methodical Aspect. Scientific Notes of Taurida National V.I. Vernadsky University. Series: Economy and Management, Vol. 30(69), pp. 30-37 (2019). DOI: https://doi.org/10.32838/2523-4803/69-6-28

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approach emphasizes not just the adoption of digital technologies but also the empowerment of farmers through knowledge and information sharing, ensuring that digitalization benefits reach every corner of the European agricultural sector.

- The 2019 Declaration on a Smart and Sustainable Digital Future for European Agriculture and Rural Areas marks a significant commitment by nearly all EU Member States towards the digitalization of agriculture. This declaration underscores the collective resolve to harness digital technology for tackling economic, social, climatic, and environmental challenges facing the sector. By fostering collaboration on digital advancements, the declaration sets the stage for a unified approach to transform European agriculture into a more efficient, sustainable, and socially inclusive industry.
- The 2019 Global Forum for Food and Agriculture brought together 74 Ministers of Agriculture who collectively recognized the transformative power of digital agriculture. Through their resolutions, they committed to four primary objectives aimed at leveraging digitalization for enhancing agricultural efficiency, sustainability, and rural livelihoods. These objectives include:
    - Identifying and exploiting the full potential of digitalization to streamline agricultural practices and improve living conditions in rural areas.
    - Broadening farmers' access to digital technologies via comprehensive training programs, ensuring they possess the necessary skills for the digital age.
    - Enhancing the management and security of digital data, affirming the sovereignty and ownership rights over data produced by farmers.
    - Utilizing digital technologies to manage structural changes within the agricultural sector, thereby revitalizing rural areas and addressing the challenge of depopulation.

To support these digital transitions, the EU is committed to achieving 100% access to fast broadband internet in rural areas by 2025, recognizing the critical role of digital infrastructure in enabling the adoption of advanced technologies in agriculture.

Conclusion

For agri-food SMEs navigating the digital transition, understanding both the challenges and the comprehensive support framework provided by the EU is vital. By leveraging EU initiatives and policies, SMEs can overcome barriers to digitalization, ensuring their competitive edge in a rapidly evolving market. The collective effort towards digital inclusion promises not only to enhance the sustainability and efficiency of the agricultural sector but also to ensure its resilience against future challenges.

1.3 Practical Applications and Innovations

Transformative Digital Technologies in Agriculture and Food Production

As you navigate the evolving landscape of the social economy SMEs, understanding the practical applications of digital technologies in agriculture and food production becomes imperative. These technologies are not just innovations but tools that redefine how food reaches our tables, enhancing both sustainability and quality.

Precision Agriculture and Smart Farming: The integration of artificial intelligence (AI), Internet of Things (IoT), smart sensors, and drone technology into agriculture has given rise to precision agriculture and smart farming. These technologies allow for more efficient farming practices by enabling precise monitoring and management of crop health, soil conditions, and water usage. For instance, AI can forecast agricultural outputs by analyzing current and historical data, minimizing risks like pest infestations and diseases. IoT devices, on the other hand, play a significant role in soil and crop monitoring, livestock management, and farm equipment optimization, elevating the productivity and sustainability of farming operations[8].

Drones and Robotics: The deployment of drones and robotics in agriculture is streamlining tasks that were previously labor-intensive or challenging, from soil analysis to planting, monitoring, and harvesting crops. Robots equipped with AI and machine learning algorithms can now accurately perform tasks like picking fruits or planting seeds, reducing the manual labor required and increasing efficiency[9].

Precision Livestock Farming: This approach uses digital technology to monitor the health and well-being of livestock, leading to better productivity and animal health. Smart sensors and AI analyze data from various sources (e.g., cameras, microphones) to monitor livestock conditions, ensuring optimal health and production levels[10].

Despite the clear benefits, the adoption of smart farming technologies faces challenges, including the need for infrastructure, skills training, and overcoming barriers related to cost, privacy, and data security.

Digital Technologies for Smart Factories

The concept of the "smart food factory" embodies the application of automation and digitalization to enhance food production efficiency, safety, and quality. Among the different Industry 4.0 innovations, robots, AI, big data, cloud computing, blockchain, and smart sensors are considered the main contributors to the smart food factory.

Key technologies driving this transformation include:

Robotics and AI Integration: The food sector is increasingly relying on robotics for a variety of operations from sorting to intricate processing tasks. AI plays a crucial role in augmenting these robots' abilities to undertake complex functions and make decisions independently. For instance, the integration of smart sensors and the Internet of Things (IoT) allows for the identification of production anomalies and the swift adjustment of environmental conditions

[8] Musa, S. F. P. D., and Basir, K. H. (2021). Smart farming: towards a sustainable agri-food system. Br. Food J. 123, 3085–3099. doi: 10.1108/BFJ-03-2021-0325

[9] Rejeb, A., Rejeb, K., and Keogh, J. G. (2021). Enablers of augmented reality in the food supply chain: a systematic literature review. J. Foodserv. Bus. Res. 24, 415–444. doi: 10.1080/15378020.2020.1859973

[10] Bao, J., and Xie, Q. (2022). Artificial intelligence in animal farming: a systematic literature review. J. Clean. Prod. 331, 129956. doi: 10.1016/j.jclepro.2021.129956

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within production lines. Another area of notable advancement is the use of compact smart sensors employing spectroscopy to continuously monitor the quality of food products[11].

3D Food Printing: This technology stands at the forefront of food manufacturing innovation, attracting attention for its capability to fabricate foods in intricate shapes or from unconventional protein sources like insects, fungi, and algae. The advancement in AI and related digital technologies has unlocked the potential for 3D printing to revolutionize food design and production.

Blockchain for Enhanced Supply Chain Visibility: Blockchain technology is transforming the agri-food supply chain by bolstering transparency and traceability, ensuring the integrity of food from production to consumption. This not only secures food safety and quality but also empowers consumers with detailed insights into the origins and journey of their food. When blockchain is synergized with IoT and big data, it significantly elevates food safety transparency and enhances the satisfaction of both businesses and consumers by providing dependable information on the provenance and handling of food products[12].

IoT in Reducing Food Waste: The application of IoT in managing food waste showcases the potential of digital technologies to tackle sustainability challenges head-on. By delivering instant data on food production and waste, these innovations promote the more judicious use of resources and help in minimizing waste[13].

The Significance of Industry 4.0 in Transforming the Agri-Food Landscape

The infusion of Industry 4.0's core tenets—interconnectivity, automation, artificial intelligence (AI), and the utilization of real-time data—is revolutionizing the agri-food domain. This transformative wave is ushering in an era of precision agriculture and intelligent manufacturing facilities, propelling the sector towards more robust and eco-friendly food systems.

Influences of Industry 4.0: The embracement of Industry 4.0's suite of technologies is pivotal in elevating food standards, safety, and traceability while also boosting profitability and curtailing waste alongside operational costs. The strategic deployment of robotics, the Internet of Things (IoT), and advanced sensing technologies plays a critical role in refining agricultural practices, safeguarding food quality, and augmenting the visibility across supply chains.

Agriculture 4.0: A Digital Renaissance: Mirroring Industry 4.0, Agriculture 4.0 epitomizes the seamless integration and digitalization of farm operations. It signifies a digital ecosystem where all facets of farming are interconnected, facilitating streamlined communication with stakeholders and automated data analytics. The advent of internet-based platforms supports

[11] Dzedzickis, A., Subaciute-Žemaitiene, J., Šutinys, E., Samukaite-Bubniene, U., and Bucinskas, V. (2022). Advanced applications of industrial robotics: new trends and possibilities. Appl. Sci. 12, 135. doi: 10.3390/app12010135

[12] Zhang, Y., Chen, L., Battino, M., Farag, M. A., Xiao, J., Simal-Gandara, J., et al. (2022). Blockchain: an emerging novel technology to upgrade the current fresh fruit supply chain. Trends Food Sci. Technol. 124, 1–12. doi: 10.1016/j.tifs.2022. 03.030

[13] Rykovska O. and Fraier O. , Digital Technologies in Rural Economic Activity. In Inclusive Rural Development in Ukraine. Kyiv, Institute for Economics and Forecasting, NAS Ukraine, pp. 89-98 (2020).

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the management and analysis of extensive data sets, fostering collaboration within and outside farm boundaries[14].

Emergence of Smart Agriculture and Digital Farming: Underpinned by smart technologies, these paradigms represent the next frontier in agricultural innovation. Equipped with sensors, actuators, and advanced connectivity, these smart systems are at the forefront of redefining traditional farming practices.

Digital Agriculture's New Horizons: The digitalization of agriculture, propelled by the interconnected and data-driven ethos of Industry 4.0, opens up unprecedented prospects. This digital leap forward is characterized by the pervasive integration of sophisticated computational technologies, setting the stage for a data-rich agricultural environment.

Agri-Food 4.0: Bridging Innovation and Agriculture: This concept extrapolates the technological advancements of Industry 4.0 to the agricultural sphere, emphasizing the critical role of digital solutions in tackling the contemporary challenges of farming and food production. By concentrating on smart farming, streamlined logistics, and enhanced transparency, Agri-Food 4.0 highlights the imperative of adopting digital technologies for improved farm management and consumer engagement[15].

In conclusion, the adoption of Industry 4.0 innovations within the agri-food sector transcends mere trend-following; it is an essential strategy for ensuring global food security and ecological sustainability. For you, the entrepreneurs and SMEs in the social economy, this transition not only promises operational excellence but also paves the way for achieving sustainable growth and environmental stewardship.

1.4 Strategic Guidance for Amplifying Green and Digital Startups

To navigate the complex landscape of digital transformation and bolster food sustainability, we recommend a strategic approach centered on inclusivity and innovation. This pathway is particularly critical for social economy SMEs and entrepreneurs aiming to make significant strides in the green and digital sectors. Here are four pivotal strategies to guide this journey[16]:

1. Cultivating a Digital Mindset and Skillset: At the core of digital integration into agriculture and the food industry lies the transformation of mindsets coupled with the enhancement of digital competencies. Priority should be given to designing and implementing training initiatives that foster knowledge exchange and continuous learning among all stakeholders. This foundational step is critical in preparing the ground for a seamless incorporation of digital solutions.

[14] Colantoni A. et al, 2018, 'Smart Machines, Remote Sensing, Precision Farming, Processes, Mechatronic, Materials and Policies for Safety and Health Aspects', in Agriculture, 8(4)
[15] Lattanzi P., 2017, 'L'agricoltura di fronte alla sfida della digitalizzazione. Opportunità e rischi di una nuova rivoluzione, Rivista di diritto agrario, 4, 1
[16] Digital innovation ecosystems in agri-food: design principles and organizational framework. Available: https://www.sciencedirect.com/science/article/pii/S0308521X22001949?via%3Dihub

2. Building Robust Digital Infrastructure: The acceleration of digital transformation, especially in less developed regions, hinges on establishing comprehensive digital infrastructure and services. This endeavor demands significant investment and support from governmental bodies, alongside active engagement from policy makers. Ensuring universal access to digital tools and services is a cornerstone for leveling the playing field and fostering equitable growth.
3. Fostering Interdisciplinary Collaboration: The synergy between different scientific disciplines and the collaboration between the public and private sectors are indispensable for unlocking the full potential of digital agriculture. This holistic approach aligns with the ethos of Industry 4.0, advocating for a cross-sectoral collaboration that spans across borders, involving a wide spectrum of participants from the agri-food ecosystem. Encouraging such partnerships can catalyze the adoption of innovative technologies and practices.
4. Implementing Effective Data Governance: In an era where food production systems are increasingly data-driven, establishing robust data governance and cybersecurity measures is paramount. This ensures that data can be shared and utilized effectively, paving the way for informed decision-making and enhanced operational efficiency.

Five Principles for Nurturing Digital Innovation Ecosystems[17]:

1. Embrace the Multi-Actor Approach: Creating environments that foster experimentation and trust, such as living labs and sandboxes, is crucial. Innovation should be agile, responsive, and rooted in local contexts while being connected to broader networks for scalability.
2. Pursue Technical Interoperability: Developing a common technical framework with open standards is essential. This requires concerted efforts from standardization bodies, governmental support for public-private data integration, and the development of guides showcasing the practical application of these infrastructures.
3. Adopt a User-Centric Design: Innovations should be driven by the needs and insights of end-users, aiming for equitable and collaborative business models. The value of data sharing within a data economy context, along with ethical considerations, should be integral to the design process.
4. Engage Stakeholders Effectively: Strategic engagement of partners throughout the innovation cycle is key. Leveraging local Digital Innovation Hubs (DIHs) and sector-specific organizations can facilitate access to resources, insights, and investment, driving sustainable growth.
5. Articulate a Shared Vision: A unified strategy supported by key stakeholders, adaptable to the rapid evolution of digital technologies, is vital. This approach should foster synergies across projects and sectors, ensuring collective progress towards sustainable innovation.

Conclusion

Digital solutions hold immense promise for advancing sustainability in the agri-food sector. However, the challenge lies not in the technology itself but in orchestrating a cohesive and

[17] Navigating the Twilight Zone Pathways towards digital transformation of food systems. Available: https://edepot.wur.nl/552346

effective digital innovation process. By adhering to these strategic and operational principles, stakeholders can enhance the adoption of digital technologies, driving meaningful change in the green and digital landscapes.

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SECTION 2: INCREASING COMPETITIVENESS AND SUSTAINABILITY THROUGH RENEWABLE ENERGY

2.1 Overview of Renewable Energy in SMEs: Enhancing Competitiveness through Cost Reduction

In today's economic environment, characterized by fierce competition and narrow profit margins, small and medium-sized enterprises (SMEs) increasingly recognize the necessity of cost-efficiency strategies. Among these, renewable energy, particularly solar power, is gaining traction as a sustainable avenue for reducing operational expenses and bolstering business competitiveness. Solar energy, with its wide accessibility, scalability, and considerable potential for lowering costs, is particularly appealing for SMEs aiming to diminish one of their most substantial variable expenses: electricity costs.

Leveraging Solar Power for Financial Efficiency

The shift towards solar energy offers SMEs an excellent opportunity to significantly curtail their electricity expenses, which are a considerable burden on their finances. The upfront cost of procuring and installing solar panels is quickly offset by the enduring savings on energy bills, rendering this a sound investment for businesses seeking to enhance their financial performance.

Solar Energy: A Catalyst for SME Competitiveness[18]

- Autonomy from Energy Providers: Solar energy affords SMEs greater independence from the unpredictable nature of energy prices and utility providers. By producing their electricity, businesses can protect themselves against unforeseen spikes in energy costs, thus gaining more control over their operational expenses.
- Sustainability as a Market Differentiator: In an era where consumer preferences are increasingly skewed towards environmentally conscious businesses, SMEs that adopt solar energy can distinguish themselves in the marketplace. This commitment to sustainability can attract a broader base of eco-aware customers, improving market competitiveness.
- Brand Value and Customer Appeal: In today's market, a company's commitment to sustainability can be a strong differentiating factor. SMEs that invest in green energy solutions often experience a positive shift in brand perception, appealing to a growing segment of eco-conscious consumers. This alignment with sustainability can enhance customer loyalty, attract new clients, and even open doors to partnerships with like-minded businesses. In essence, green energy adoption not only contributes to the planet's well-being but also builds a brand image that resonates with contemporary values.

[18] Gąsior A.,Grabowski J., Based on Eco-Innovation as a Determinant of the Energy Efficiency of the Economy, https://www.mdpi.com/1996-1073/15/19/6965

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- Incentives and Governmental Support: Various incentives, including tax benefits, rebates, and grants, are available to support renewable energy adoption. These incentives not only make the transition to solar energy more economically feasible but also underscore government backing for businesses at the forefront of sustainable practices.
- Predictability and Reliability: The reliability and low maintenance associated with solar power systems contribute to more predictable energy costs for SMEs, unlike the volatility of traditional energy sources. This predictability aids in more accurate financial planning and budget management, enhancing business resilience.

Embracing Technological Progress

The evolution of solar technology has led to the development of more efficient, cost-effective solutions. Innovations in photovoltaic (PV) panels, energy storage, and management software have made solar energy an increasingly advantageous option for SMEs. By keeping pace with these technological advancements, businesses can optimize their solar energy systems, further diminishing energy costs and reinforcing their competitive advantage.

European SMEs, vital for economic growth, innovation, and job creation, have faced challenges due to fluctuating fossil fuel prices. There's a growing demand for substantial investments in local renewable energy projects, alongside support for SMEs to generate their power. Additionally, there's a call to eliminate administrative hurdles to enable SMEs to implement solutions that build resilience and rejuvenate their operations[19].

Securing a Competitive Edge through Sustainability

The adoption of solar power transcends environmental advocacy, representing a strategic business move with the potential to enhance the competitiveness of SMEs significantly. Through cost savings, energy autonomy, improved market position, and leveraging government incentives, solar energy presents a comprehensive solution to the economic hurdles SMEs face. By committing to renewable energy, businesses not only contribute to a greener future but also cement a more robust, resilient standing in the competitive arena, aligning with initiatives like the Social Economy Action Plan, Council recommendations for social economy framework conditions, the transition pathway on proximity and social economy, and Europe's Digital Decade, which collectively advocate for sustainable, inclusive economic growth.

2.2 Adapting to Solar Energy's Seasonal Dynamics: Strategies for Social Economy SMEs

Deciphering Solar Energy's Seasonal Fluctuations

Embarking on a journey with solar energy unveils unique challenges, particularly the pronounced seasonal variations in energy output. The capacity of solar installations to generate power can diminish significantly during the winter months, at times by up to eightfold compared to summer outputs. This stark variability necessitates strategic planning to ensure your business remains operationally efficient and energy-reliant throughout the year.

[19] Cooper, D. (2018), “Energising agriculture value chains for sustainable business in remote areas”, http://minisites.ieep.eu/assets/2367/En-Ag_nexus_-_COP24_DCooper.pdf

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Strategic Approaches to Optimize Solar Utilization

Addressing these fluctuations demands a holistic strategy aimed at bolstering energy efficiency and securing a consistent energy supply. Key strategies include:

- Integration of Energy Storage Technologies: Counteracting seasonal variability is achievable through energy storage solutions. Storing excess energy during periods of peak production ensures a reliable energy supply during times of diminished solar output, thus maximizing the efficacy of your solar investment.
- Demand Side Management (DSM): Aligning your energy consumption with periods of high solar availability can significantly bolster efficiency. Planning high-energy activities during peak solar hours and minimizing use during low production periods is streamlined with smart energy management systems, allowing for real-time adjustments based on solar output.
- Hybrid Renewable Solutions: Combining solar energy with renewable sources, like wind energy, creates a more reliable and diversified energy supply. This strategy offsets low solar production periods, ensuring continuous energy provision.
- Implementation of Energy Efficiency Measures: Reducing overall energy demand through efficiency initiatives helps alleviate the impact of seasonal variations. Adopting energy-efficient technologies and optimizing business processes reduces your energy requirements, making solar energy a more viable option year-round[20].

Opportunities for Innovation through Collaboration

The inherent variability in solar power production also unveils opportunities for creative collaboration and energy coordination. Engaging in energy-sharing programs or becoming part of local energy cooperatives facilitates the exchange of surplus energy, bolstering network resilience and efficiency. These collaborative efforts not only mitigate the challenges posed by seasonal shifts but also foster community engagement and collective benefit.

Harnessing Digital Technology for Enhanced Energy Coordination

Digital innovation is pivotal in advancing energy coordination efforts. Smart grids and IoT-enabled devices provide invaluable real-time data on energy generation and consumption, facilitating the efficient management of energy resources. Such technologies enable the precise balancing of energy supply with demand, optimizing solar energy use across all seasons[21].

Conclusion: Transforming Seasonal Challenges into Strategic Gains

The seasonal variability of solar power, while challenging, also propels opportunities for strategic energy management, innovation, and operational optimization. By leveraging storage solutions, DSM, hybrid energy systems, and energy efficiency measures, your enterprise can navigate these challenges successfully. Further, embracing digital innovations and collaborative

[20] CEEW (2018), "Solar for irrigation: A comparative assessment of deployment strategies", www.ceew.in/sites/default/files/CEEW-Solar-for-Irrigation-Deployment-Report-17Jan18_0.pdf.
[21] Inutu Lukonga, Harnessing Digital Technologies to Promote SMEs and Inclusive Growth in the MENAP Region, file:///Users/usa/Downloads/wpiea2020135-print-pdf.pdf

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models enhances your sustainability efforts, positioning your business as a resilient and forward-thinking player in the renewable energy landscape.

Understanding and mitigating the impact of environmental factors, time of day, and seasonal shifts on solar energy output is crucial. By adapting to these dynamics, your business can ensure a steady and sustainable energy supply, contributing to the broader goals of energy resilience and sustainability outlined in the EU's Social Economy Action Plan, Council recommendations, and the Transition Pathway for the Proximity and Social Economy.

2.3 Practical Insights and EU Policy Context: Maximizing Returns from Solar Investments

Assessing Solar Energy Investments for Enhanced Financial Outcomes

Transitioning to solar energy represents a strategic investment that promises significant financial returns for your business. This segment provides a clear pathway to understanding the financial implications and benefits of integrating solar energy solutions, focusing on the crucial aspects of Return on Investment (ROI) analysis.

Critical Factors for ROI Assessment

- Upfront Investment: This encompasses the purchase and installation costs of solar panels, potential modifications to your facility, and grid integration expenses.
- Operational Cost Savings: Post-installation savings on electricity bills are pivotal. It's important to project these savings over time, considering the rising costs of traditional energy sources.
- Government Incentives: Acknowledge the impact of tax benefits, rebates, and feed-in tariffs that can significantly reduce initial capital outlay.
- Maintenance Expenditure: Account for the minimal yet essential maintenance costs of keeping your solar power system at peak efficiency.
- Asset Depreciation: Considering the 25-30 year lifespan of solar panels, depreciation becomes a financially advantageous element, offering tax benefits over time.
- ROI Formula: To ascertain ROI, the formula encapsulates the net financial gains from a solar investment against the total investment cost, expressed as a percentage[22].

EU Support Framework for Solar Energy Transition

Energy efficiency and renewable energy use have been on the EU's policy agenda since the 1990s, gaining particular prominence over the past fifteen years. The current framework is ambitious, committing the European Union to a 55% reduction in CO2 by 2030 and climate neutrality by 2050. Familiarity with EU directives and support mechanisms can substantially benefit your financial planning and strategic decision-making.

[22] Tinsley E and Agapitov N., Private SectorSolutions to Helping Smallholders Succeed. Social Enterprise Business Models in the Agriculture Sector, https://documents1.worldbank.org/curated/en/851711521095180329/pdf/124304-WP-PUBLIC-AgriBookMar.pdf

- Social Economy Action Plan: Aimed at fostering a sustainable and inclusive economy, this plan includes provisions for financial assistance to social economy enterprises investing in green technology. Social Economy Action Plan
- Council Recommendation on Social Economy Framework Conditions: Offers guidelines for financial support and an enabling environment for sustainable practices within the social economy sector. Council Recommendation
- Transition Pathway for Proximity and Social Economy: Part of the broader European Green Deal, this pathway delineates the crucial role of the social economy in achieving a sustainable economic overhaul, spotlighting renewable energy investment opportunities. Transition Pathway
- Europe's Digital Decade: While primarily focused on digital transformation, this policy emphasizes the synergy between digital and green innovations, offering insights into support structures for SMEs navigating this dual transition. Europe's Digital Decade
- The Green New Deal for Europe stands out as a comprehensive framework that addresses the climate crisis with vigor and innovation. Introduced by EC President Ursula von der Leyen in 2019, The Green New Deal integrates three pivotal pillars: Green Public Work, The Environmental Union, and the Environmental Justice Commission, setting a dynamic and proactive response to climate challenges. The Green New Deal for Europe.

Energy Efficiency Directive (EED) and Its Impact on SMEs

A cornerstone of the EU's energy policy, the Energy Efficiency Directive (EED), established measures to improve energy efficiency across the Member States, setting ambitious targets to be met by 2020 and extended to 2030. The directive plays a critical role in shaping the energy performance of SMEs through:

- Energy Audits and Management Systems: Article 8 mandates developing programs encouraging SMEs to conduct energy audits and implement energy management systems. These audits offer valuable insights into energy consumption patterns, identifying opportunities for efficiency improvements and cost savings.
- Continuous Improvement: The focus on energy management systems supports SMEs in adopting ongoing practices that enhance energy efficiency, directly contributing to the operational sustainability and financial viability of solar investments.

The amendment of the EED as part of the Clean Energy for All Europeans package, aligned with the ambitious goals of the European Green Deal and the "Fit for 55%' package", underscores the EU's commitment to a 32.5% improvement in energy efficiency by 2030—a target subject to further upward revisions. This legislative framework not only propels SMEs towards more sustainable energy use but also provides a conducive backdrop for integrating solar energy solutions, amplifying the environmental and economic benefits of such investments.

Maximizing EU Support for Solar Energy Transition

The EU extends various financial aids and advisory services to bolster SMEs' solar energy adoption journey. These include grants, loans, and project development assistance, significantly easing the financial hurdles associated with solar energy projects.

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Direct Funding & Stimulating Investment

In the wake of the COVID-19 pandemic, the European Union has launched the Recovery and Resilience Facility, a strategic initiative designed to fortify Europe's economic resilience and promote sustainability. With an allocation of 673 billion EUR in loans and grants, the Facility earmarks at least 37% of its funds for climate-focused investments and reforms. Each EU Member State has crafted a National Recovery and Resilience Plan, outlining targeted reforms and investments across seven key areas, notably renewable energy projects under "Power Up" and building renovations under "Renovate." These plans include mechanisms to assist SMEs in transitioning towards more ecological and energy-efficient operations.

Beyond this immediate response mechanism, the European Structural and Investment Funds stand as vital resources for long-term investments, particularly in supporting SMEs. The European Regional Development Fund prioritizes low-carbon economic advancements, emphasizing "a greener, carbon-free Europe" for the 2021-2027 period. The Cohesion Fund targets support for regions with a gross national income per capita below 90% of the EU average, financing energy projects that yield environmental benefits, enhance renewable energy use, or boost energy efficiency. This Fund also plays a crucial role in realizing the Energy Union, facilitated by the Energy and Managing Authorities Network.

Complementing these established funds, the EU has developed novel financial tools under the European Green Deal Investment Plan (EGDIP). This plan integrates portions of the EU budget with the InvestEU Programme, aiming to attract private investments by offering guarantees to financial intermediaries that back SMEs. The European Green Deal framework introduces the Just Transition Mechanism, encompassing the Just Transition Fund, the InvestEU Just Transition Scheme, and a Public Sector Loan Facility from the European Investment Bank. The Just Transition Fund specifically aids regions heavily impacted by the transition to a low-carbon economy, supporting the economic diversification of businesses and enabling SMEs to modernize carbon-intensive facilities. Member States are tasked with formulating Territorial Just Transition Plans, which require the European Commission's approval to access these funding instruments.

These initiatives represent the EU's comprehensive approach to not only recover from the pandemic's economic impacts but also to ensure a sustainable, inclusive future for its economies, particularly benefiting SMEs in the social economy sector.

Addressing market barriers

The EU's Financial Instrument for the Environment (LIFE) program stands as a cornerstone in the union's funding strategy, particularly for environmental and climate action projects. This initiative, which has a rich history of supporting the European environmental policy framework, is specifically designed to bolster SMEs and corporations in their green transition efforts. For the 2021-2027 cycle, the LIFE program is set to play a pivotal role in facilitating the shift towards a low-carbon economy. Within its "Clean Energy Transition" sub-program, the focus will be on overcoming market obstacles to expedite the adoption of innovative technologies, digital transformation, novel services and business models, while also boosting the market's professional competencies in energy efficiency and renewable energy solutions on a smaller scale. The inaugural calls under this program are anticipated to launch in 2021.

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In addition, the EU is rolling out the Single Market Programme (SMP), a successor to the COSME program, crafted to enhance the competitive edge of SMEs. The SMP aims to streamline access to financing and international markets for small and medium-sized enterprises, offering tailored advice on navigating the low-carbon transition. This support is extended through the Enterprise Europe Network, ensuring SMEs are well-equipped to adapt and thrive in an evolving market landscape focused on sustainability.

These initiatives reflect the EU's commitment to not only advancing environmental goals but also to ensuring that SMEs are central to this transformative journey. Through targeted support and resources, these programs are designed to empower entrepreneurs in the social economy space to innovate and lead in the transition towards a more sustainable and low-carbon future.

Technical assistance and knowledge sharing

In addition to the financial backing available, a broad spectrum of advisory services stands ready to assist. Among the most notable is the European Local Energy Assistance (ELENA), a facility offering grants for technical assistance to both public and private entities. This support encompasses the development of technical studies, execution of energy audits, and provision of legal consultation. Furthermore, the European Commission extends Technical Assistance for the effective implementation of Commission-funded programs. This aid is accessible upon request by Member States within their European Regional Development Fund (ERDF), Cohesion Fund (CF), and European Social Fund (ESF) Operational Programmes, aimed at enhancing the capabilities of authorities and beneficiaries in managing and utilizing the funds more efficiently. This suite of advisory services is designed to empower social economy SMEs and entrepreneurs, providing them with the tools and knowledge necessary to navigate the complexities of funding utilization and project implementation.

Conclusion: Strategic Financial and Environmental Synergy

In the quest for environmental sustainability within the agri-food sector, the integration of renewable energy stands out as a financially astute and strategically beneficial move. This initiative aligns perfectly with the European Union's vision for a sustainable and robust economy, demonstrating that investing in renewable energy not only champions ecological stewardship but also heralds a sound financial strategy.

A critical challenge confronting the global agri-food system is the inefficiency marked by the startling fact that approximately one-third of all food produced is never consumed. This inefficiency translates into a colossal waste of energy throughout the food supply chain, contributing significantly to environmental degradation. The irony of food waste piling up in landfills, where it emits methane—a potent greenhouse gas—without any energy recovery, underscores the urgency of rethinking our energy use in food production, storage, and distribution.

Renewable energy, particularly through innovative food-energy systems, offers a comprehensive solution. These systems not only bolster energy and food security but also create employment opportunities, support gender equality, and enhance climate resilience.

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The synergy between renewable energy and the agri-food sector is pivotal for achieving the Sustainable Development Goals and fulfilling the Paris Agreement on Climate Change.

The adoption of renewables in the agri-food sector can significantly mitigate its environmental impact. For instance, decentralized cold storage powered by renewable energy can dramatically reduce food loss and waste by preserving perishables for smallholder farmers and isolated fishing communities. Moreover, renewable energy sources like solar and wind can power environmentally friendly packaging processes, reducing the carbon footprint of food packaging.

Sustainable bioenergy plays a crucial role in this transition. Agri-food by-products, such as crop residues and livestock manure, can be transformed into valuable sources of bioenergy, providing electricity, heat, and transport fuels. This not only utilizes waste effectively but also reduces dependency on fossil fuels, closing the loop in a truly circular economy.

The decentralized nature of renewable energy solutions means they are uniquely suited to meeting the diverse energy needs of the agri-food sector sustainably, affordably, and securely. From powering irrigation systems to processing facilities, renewable energy can transform the entire value chain.

By embracing renewable energy, agri-food SMEs and entrepreneurs can achieve substantial socio-economic benefits, addressing the twin challenges of climate change and food security. Furthermore, investing in renewables offers a path to financial sustainability. Through careful return on investment analysis and tapping into EU support mechanisms, businesses can confidently transition to solar energy and other renewables, ensuring long-term profitability and environmental stewardship.

In conclusion, leveraging renewable energy in the agri-food sector is not merely an environmental imperative but a strategic financial decision. This transition promises to reduce waste, lower emissions, and foster a more resilient and sustainable food system. As we move forward, the integration of renewable energy into agri-food practices will be crucial for building a greener, more sustainable future.

2.4 Best Practices and Case Studies: Shining Examples of Renewable Energy in SMEs

The transition to renewable energy is not just a trend; it's a strategic move towards sustainability, cost reduction, and enhanced business resilience. Within this landscape, numerous SMEs have emerged as pioneers, demonstrating that renewable energy is not only viable but also profitable. Let's explore some illustrative examples and distill the best practices that have steered these enterprises towards success.

Case studies: Increasing the competitiveness and sustainability of enterprises through the implementation of renewable energy sources.

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Farming enterprise 'Veles Vita'

In a pioneering initiative, Veles Vita, an esteemed farming enterprise, embarked on a journey to revolutionize its energy consumption through the integration of renewable energy sources. This case study exemplifies how renewable energy, specifically solar power, can significantly contribute to greening the agri-food sector, delivering both environmental and economic benefits.

Project Objectives: Veles Vita set forth an ambitious goal to reduce its reliance on conventional electricity by harnessing the power of the sun. The primary objective was to construct a solar power plant capable of generating 60 kW, with a future expansion option to 120 kW. This initiative aimed not only to fulfill the internal energy requirements of the farm but also to set a benchmark for sustainability in the agri-food sector.

Implementation Process:

1. Needs Assessment and Technical Evaluation: The initial phase involved a comprehensive analysis of Veles Vita's specific needs and the technical feasibility of the project. Understanding the unique energy requirements of the farm and assessing the terrain conditions were crucial for tailoring a bespoke solution.
2. Design and Planning: A custom-designed solar power solution was developed to align with the farm's operational needs and the geographical layout. Special attention was given to optimizing the solar field's placement on a pitched roof to maximize sunlight capture.
3. Regulatory Compliance and Documentation: Navigating the legal landscape, we secured all necessary documents and permits, ensuring the project adhered to regulatory standards and received the green light for construction.
4. Installation and Testing: The solar panels were meticulously installed on the facility's roof, followed by the system's connection and integration. Rigorous testing was conducted to fine-tune the setup for optimal performance and reliability.
5. Innovation in Lighting: Recognizing the specific requirements of agri-food operations, we developed and tested unique lamps suitable for food facilities. These lighting solutions passed stringent sanitary and epidemiological evaluations, marking a significant advancement in farm lighting technology.

Amplifying Green Benefits:
The Veles Vita project serves as a beacon of how renewable energy can revolutionize the agri-food sector. By transitioning to solar power, the enterprise not only slashed its carbon footprint but also paved the way for a more sustainable and cost-effective energy solution.

This greening effort:

- Reduces greenhouse gas emissions, contributing to global efforts to combat climate change.
- Lowers energy costs, translating into financial savings and improved competitiveness in the agri-food market.

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- Demonstrates a commitment to environmental stewardship, enhancing the brand's reputation and appeal to eco-conscious consumers.
- Promotes energy independence, reducing vulnerability to fluctuations in energy prices and supply disruptions.

In total, the SPP project took 18 working days to complete and the technical specifications of the plant were as follows:

- Power of the SPP (inverter) - 100 kW;
- Solar field capacity - 60 kW;
- The area of solar modules is 280 sq.m;
- Power of one module - 550 W;
- Type (module) - Monocrystalline;
- Additional load on the roof - 13kg/m.sq;
- Tilt angle - 20 degrees;
- Orientation - South

Conclusion:
Veles Vita's successful integration of solar energy underscores the vast potential of renewable energy in fostering sustainable agri-food systems. For social economy SMEs and entrepreneurs, this case study illustrates the tangible benefits of embracing green energy solutions. By investing in renewable energy, agri-food enterprises can achieve not only environmental and economic gains but also position themselves as leaders in sustainability. The Veles Vita project is a compelling example of how innovation, when aligned with sustainability goals, can create resilient and eco-friendly agri-food systems for the future.

Greenhouse farm 'Plantex'

In a landmark project aimed at ushering in a new era of sustainability, Plantex LLC embarked on a transformative journey to integrate renewable energy into its operations. This case study highlights the pivotal role that solar power plays in advancing the greening of the agri-food sector, showcasing the environmental and economic benefits of such initiatives.

Project Overview:
Plantex LLC set forth with a clear vision to reduce its dependence on traditional energy sources by harnessing solar power. The project's ambitious goals were twofold:

1. Construction of Two Solar Power Plants:
    - A 32.4 kW plant operating under a green tariff, designed to directly offset a portion of the company's electricity demand without solar power storage.
    - A 50 kW hybrid power plant equipped with battery storage, offering enhanced flexibility and energy security.

Execution Highlights:

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1. Strategic Planning and Design: A meticulous analysis of Plantex's specific needs and the site's characteristics laid the groundwork for a tailored solar power solution. This step was critical in designing systems that perfectly align with the greenhouse farm's operational requirements and spatial constraints.
2. Legal and Regulatory Compliance: Navigating the intricacies of legal and regulatory requirements, we secured all necessary documentation and permits, ensuring a smooth transition to solar energy.
3. Installation and Optimization: The solar panels were strategically installed on the facility's pitched roof, maximizing exposure to sunlight. Subsequent testing and fine-tuning of the systems ensured their optimal performance and reliability, setting a benchmark for efficiency in renewable energy applications in agriculture.

Amplifying Green Benefits:
The integration of solar energy into Plantex's greenhouse operations marks a significant stride towards sustainable agri-food production. This initiative not only demonstrates a commitment to environmental stewardship but also yields tangible benefits:

- Reduced Carbon Footprint: Transitioning to solar power significantly lowers greenhouse gas emissions, aligning with global efforts to mitigate climate change.
- Operational Cost Savings: Leveraging renewable energy translates into substantial savings on energy costs, enhancing the financial sustainability of agri-food operations.
- Energy Independence: The adoption of solar power, especially with the hybrid system's battery storage, fosters resilience against energy price volatility and supply disruptions.
- Sustainability Leadership: Plantex sets an exemplary standard for the agri-food sector, illustrating the feasibility and advantages of green energy solutions in agricultural settings.

In total, it took 14 working days to implement the Green Tariff project and the technical specifications of the station were as follows:

- SPP (inverter) power - 27 kW;
- Solar field capacity - 32.4 kW;
- The area of solar modules is 140 sq.m;
- Power of one module - 540 W;
- Type (module) - Monocrystalline;
- Additional load on the roof - 13kg/m.sq;
- Tilt angle - 20 degrees;
- Orientation - South

It took 18 working days to implement the Hybrid Station project and the technical characteristics of the station were as follows:

- Power of the SPP (inverter) - 50 kW;
- Solar field capacity - 50 kW;
- Battery capacity - 5.12 kwh
- The area of solar modules is 160 sq.m;
- Power of one module - 540 W;

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- Type (module) - Monocrystalline;
- Additional load on the roof - 14kg/m.sq;
- Tilt angle - 20 degrees;
- Orientation - South

Conclusion:
The Plantex greenhouse farm case study underscores the transformative potential of renewable energy in the agri-food sector. For social economy SMEs and entrepreneurs, this narrative serves as an inspiration and a guide on integrating sustainable practices into their operations. By embracing renewable energy, agri-food enterprises can achieve environmental goals, realize economic gains, and position themselves as frontrunners in the journey towards a more sustainable and resilient food system. The success of Plantex illuminates the path for others in the sector to follow, promising a greener future for our planet.

Key Takeaway: Diversify your energy portfolio with solar power to reduce costs and appeal to a broader customer base. The commitment to renewable energy can become a unique selling proposition that differentiates your brand in a crowded market.

Case studies: Reducing energy consumption and reducing electricity bills through the implementation of automated systems for collecting and analyzing detailed data in energy management at agri-food enterprises

Lviv Bread Plant No. 1 'Concern Khlibprom' PJSC
https://hlibprom.com.ua/

Lviv Bread Plant No. 1, under 'Concern Khlibprom' PJSC, embarked on an ambitious project to enhance its energy efficiency and integrate sustainable practices into its operations. This initiative, spanning two phases in 2016 and 2017, exemplifies the profound impact of integrating renewable energy solutions and advanced metering systems in greening the agri-food sector. Tailored for social economy SMEs and entrepreneurs, this case study sheds light on the transformative benefits of adopting green technologies.

Project Implementation:
The project unfolded in two strategic phases, each aimed at incrementally enhancing the plant's energy management systems:

- Phase One: Focused on establishing an advanced electricity metering infrastructure, the first phase involved:
  - Crafting detailed project documentation for system construction.
  - Installing 50 multifunctional FRER electricity meters and integrating them into a unified computer network.
  - Developing and deploying a Vijeo Citect SCADA system configuration (now AVEVA Plant SCADA) alongside requisite workstation software, including a

PostgreSQL database and Jasper Report Server BI system for comprehensive energy consumption monitoring.

- Phase Two: Aimed at broadening the scope to include gas and heat metering, this stage encompassed:
    - Preparing project documentation for the system's expansion.
    - Integrating additional meters for gas (18) and heat (4) into the system.
    - Enhancing the SCADA server with additional screens and reports for a more granular analysis of gas, heat, and production metrics.

Outcomes and Benefits:
The project's successful implementation yielded significant results, setting a precedent for sustainable practices in the agri-food industry:

- Enhanced Resource Management: By facilitating distributed metering of electricity, gas, and heat consumption, the plant can now accurately attribute energy costs to specific products, fostering greater transparency and accountability in energy use.
- Operational Efficiency: The system's granular reporting capabilities empower the plant to identify and mitigate excessive energy consumption areas without compromising production processes.
- Strategic Energy Consumption: The ability to analyze energy consumption patterns enables the plant to optimize its production schedule according to time-differentiated energy pricing, resulting in substantial cost savings and more environmentally conscious operations.

Amplifying Green Benefits:
This case study underscores the pivotal role of renewable energy and efficient metering in greening the agri-food sector. By adopting such technologies, agri-food SMEs and entrepreneurs can significantly reduce their environmental footprint, enhance operational efficiency, and contribute to a more sustainable food system. Moreover, these initiatives align with global sustainability goals and consumer expectations for eco-friendly practices, bolstering the competitive edge of businesses in the agri-food sector.

In conclusion, the Lviv Bread Plant's proactive approach to energy management and sustainability serves as an inspiring model for the agri-food industry. By leveraging renewable energy technologies and advanced metering, businesses can achieve not only economic benefits but also advance their sustainability agenda, paving the way for a greener, more resilient future in agri-food production.

Key Takeaway: Implementation of technological solutions in energy management involving digitalisation of processes allows to reduce production costs and heat energy emissions.

For up-to-date best practices, case studies, and guidance on renewable energy implementation within SMEs, consider exploring the following sources:

1. International Renewable Energy Agency (IRENA) Publications: IRENA offers a wealth of reports and case studies on renewable energy across various sectors, including SMEs.

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Their resources can provide insights into successful implementations of renewable energy projects around the world.
    - Visit: https://www.irena.org/publications
2. European Commission - Energy: The European Commission's energy section provides information on policies, funding opportunities, and best practices for renewable energy in the EU, focusing on supporting SMEs in their transition to green energy.
    - Visit: https://ec.europa.eu/energy/
3. Clean Energy for EU Islands Secretariat: While focused on islands, this initiative offers inspiring examples of renewable energy projects that SMEs can learn from, demonstrating innovative approaches to energy independence and sustainability.
    - Visit: https://euislands.eu/
4. The Business Renewables Centre (BRC) Europe: BRC Europe provides tools, resources, and a platform for businesses, including SMEs, to engage in renewable energy projects, offering case studies and best practices.
    - Visit: https://www.brc-europe.com/
5. Sustainable Energy for All (SEforALL): This organization works with leaders in government, the private sector, and civil society to drive further, faster action toward the achievement of Sustainable Development Goal 7 (SDG7), which includes ensuring access to affordable, reliable, sustainable, and modern energy for all.
    - Visit: https://www.seforall.org/

Crafting Your Path to Renewable Success

These case studies illuminate the path for SMEs considering renewable energy solutions. Here are actionable strategies inspired by these success stories:

1. Conduct a Feasibility Study: Before embarking on your renewable energy journey, assess the specific needs of your business and the potential return on investment. Consider factors like location, available space for installations, and local government incentives.
2. Leverage Financial Incentives: Many governments offer subsidies, tax breaks, or other incentives to encourage renewable energy adoption. Explore these opportunities to offset initial setup costs.
3. Engage Your Stakeholders: Communicate your sustainability goals and achievements to your customers, employees, and partners. This not only boosts your brand but also encourages a culture of environmental responsibility.
4. Monitor and Adapt: Renewable energy technology is rapidly evolving. Stay informed about new advancements and be prepared to adapt your strategy to incorporate more efficient solutions over time[23].

Conclusion

The journey towards renewable energy adoption is unique for every SME. Yet, the underlying principles of strategic planning, leveraging incentives, engaging stakeholders, and staying adaptable are universally applicable. By drawing inspiration from these case studies, you can

[23] Renewable Energy as a Path to Resilience. SME Perspectives on the Energy Crisis July 2023, https://beyondfossilfuels.org/wp-content/uploads/2023/07/BFF_SME-EnergyCostsSurvey_Final.pdf

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navigate the complexities of renewable energy implementation and position your business as a leader in sustainability and innovation.

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SECTION 3: NAVIGATING THE GREEN TRANSITION: A ROADMAP FOR SOCIAL ECONOMY SMES AND ENTREPRENEURS

Understanding the Green Economy Transition

The shift towards a green economy marks a deliberate move to intertwine environmental sustainability with economic activities and social well-being. This transition is characterized by efforts to lower carbon emissions, enhance resource efficiency, and shift towards renewable energy sources. Its goal is to achieve a symbiotic relationship between economic progress and environmental stewardship.

The Advantages of Embracing a Green Economy

The journey towards a green economy is laden with benefits that span environmental, economic, and operational dimensions:

- Environmental Impact: By curbing reliance on fossil fuels and investing in renewables, we contribute to climate change mitigation, ecosystem preservation, and biodiversity protection. This proactive stance ensures a healthier planet for future generations.
- Economic Innovation: The green economy spurs innovation and opens up new avenues for sustainable technology development. This transition not only catalyzes job creation in renewable energy, eco-construction, and waste management but also propels long-term economic resilience and growth.
- Operational Efficiency: Companies that adopt green practices realize significant cost savings through improved resource use, waste reduction, and energy efficiency. Embracing circular economy models not only trims operational costs but also bolsters competitive advantage[24].

The SME Perspective: Challenges and Opportunities

For SMEs, the path to greening involves unique challenges and opportunities. These entities often grapple with limited awareness and understanding of environmental impacts and green practices. Additionally, the initial costs and uncertainties associated with environmental technologies can be daunting, compounded by a general focus on short-term gains and a constrained capacity for implementing necessary changes.

However, SMEs inherently possess agility and a capacity for rapid adaptation, potentially outpacing larger enterprises in adopting innovative technologies. The key hurdles include a limited understanding of the benefits tied to green investments and the perennial challenge of accessing finance for such ventures.

Strategic Recommendations for Facilitating Green Transition

1. Enhancing Access to Green Finance: Streamlining access to funding for green initiatives is vital. This entails developing efficient financial mechanisms, such as green loans and

[24] Gribincea C., Gribincea A., Gribincea A. "GREEN ECONOMY" – THE FUTURE OF WORLD ECONOMY", December 2019, Market economy modern management theory and practice 18(3(43)):42-52, DOI:10.18524/2413-9998.2019.3(43).183630

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incentives, and fostering partnerships with financial institutions that understand the unique needs and potential of SMEs in the green sector.

2. Promoting Green Markets and Value Chains: Governments can stimulate demand for green products and services through green public procurement policies and by encouraging sustainable corporate value chains. Tax incentives and tariff reductions for sustainable equipment investments can further bolster the business case for green practices.
3. Navigating Risks and Regulations: Transitioning to a green economy involves upfront investments in sustainable technologies, infrastructure upgrades, and workforce retraining. Strategic planning and engagement with regulatory frameworks are essential to mitigate these risks and capitalize on the long-term benefits of sustainable investments[25].

Mitigating Transition Risks

While the shift towards a green economy is laden with promise, it is crucial to acknowledge and manage inherent risks. High initial costs, the need for strategic realignment, and compliance with evolving regulatory landscapes are significant considerations. Yet, with thoughtful planning and a commitment to sustainability, these challenges can be navigated successfully.

Conclusion:

The transition to a green economy presents a transformative opportunity for businesses, especially SMEs, to drive environmental sustainability, economic growth, and social well-being. Despite the challenges, the potential rewards — from operational efficiencies to innovation and market expansion — are immense. As such, both businesses and policymakers must collaborate to forge an enabling environment that encourages and supports the green transition, ensuring a sustainable and prosperous future for all.

[25] GREEN ECONOMY TRANSITION APPROACH 2021-2025, EBRD, file:///Users/usa/Downloads/GET%202021%20-%202025%20Document.pdf

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