Analysis on the current situation of SMEs members of the clusters from the point of view of their preparation and availability for the green and digital transition

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1 Introduction

Innovation is a key factor for competitiveness and growth in a modern economy. Clusters support the economic development through the specialization of regions in activities within SMEs become more innovative and with opportunities to access new markets.

Romanian-Norwegian cooperation in the field of clusters and SMEs already has a tradition and has materialized through various projects in the field of innovation, research, education, competitiveness, environment and energy, financed by Norway both through the EEA Grants Mechanism and the Norwegian Financial Mechanism. In Romania, Innovation Norway, which is the Fund Operator for the Business Development Program and for the Energy Program, has contributed to the strengthening of bilateral relations by supporting innovative technologies, sustainable business models, the green and digital transition of SMEs and the development of innovative services by clusters for members.

The "Innovative services for twin transition in SMEs and clusters" project presents benefits both for CLUSTERO-Romanian Cluster Association and for Innovation Performance AS from Norway on mutual knowledge of the situation of clusters and SMEs, of their preparation for the green and digital transition in order to ensure sustainability, exchange of good practices and innovative services that can be offered in the context of internationalization and joining global value chains.

The analysis is a collaborative work of the project team and the tasks were to examine the drivers of clusters, to identify comparative advantages that clusters and networks can offer to their member firms and subsequently to the regions hosting them, to describe current policies and initiatives towards clusters and networks in Romania and Norway and to come up with recommendations on innovative services for the twin transition in SMEs and clusters.

This analysis serves as a basic document for the project activities starting from a desk research documentation and a collection of information based on questionnaires and interviews of cluster managers. At the same time, the analysis identifies the needs and

interest of SMEs in the twin transition process and the innovative services that can be offered through the exchange of Romanian-Norwegian best practices.
In order to ensure sustainability, future developments could build on the results of this project. Further developments could include proposals of policy measures and programs, grants targeted at industry research collaboration or joint activities organized within European Cluster Collaboration Platform such as Clusters meet regions, Cluster talks, Green Transition Support, C2 labs or matchmaking events.

2 List of abbreviations

SME -Small and medium-sized enterprise
ESCA-European Secretariat for Cluster Analysis
ECA- European Cluster Alliance
EEN-Enterprise Europe Network
GDP-Gross Domestic Product
NGO-Non-Governmental Organization
ECCP-European Cluster Collaboration Platform
NIC-Norwegian Innovation Clusters; The national cluster program in Norway
NCE-Norwegian Centres of Expertise
GCE-Global Centres of Expertise
DIH-Digital Innovation Hub
CSR-Corporate Social Responsibility
GTZ- German Society for Technical Cooperation
CNIPMMR- The National Council of Small and Medium Sized Private Enterprises in Romania
SDG-Sustainable Development Goals
RIS-Smart Specialization Strategy at the regional level
BIM-Building Information Modelling
EPR-Extended Producer Responsibility
SACET systems (Centralized Thermal Power Supply Systems)
PNRR -National Plan for Recovery and Resilience

3 Executive Summary

Romania has opted for integrated cluster policy in his industrial policy and for using clusters as a tool to enhance the competitiveness and innovative capacity of small and medium sized enterprises.

Romania through the Ministry of Economy-Directorate for Industrial Policy carried out a cluster mapping study during 2009-2010 with the support of GTZ from Germany that showed the clustering potential in the eight development regions of Romania. At the same time, within the Sectoral Research Plan for Industry, the Ministry of Economy carried out the INNOVCluster I and II projects in the period 2009-2012, through which the Guide for the implementation of the innovative cluster concept in Romania was created, the situation of innovative clusters in the European Union was analized and the cluster concept was disseminated in the eight development regions of Romania.

The first regional clusters were created in Romania in 2010, from „bottom-up" with a sectoral approach. Currently, Romania has a number of 78 clusters registered to the Ministry of Economy, Entrepreneurship and Tourism of which 53 clusters are CLUSTERO members with more than 2500 SMEs. (***Annex no.1***) and most of the clusters are awarded with gold, silver and bronze labels. In Romania there are also 6 regional consortia and 6 sectoral networks (textile & fashion; wood and furniture; ITC; healthcare; agrofood and ecological agriculture).[1]

In 2011 the Association of Romanian Clusters-CLUSTERO www.clustero.eu was founded with the object of activity supporting the interests of the members at the national, European and international levels; promoting members through various means and at all levels as well as supporting clusters in development, internationalization, marketing, branding strategies; organizing exchanges of good practices with clusters from the EU; the development of benchmarking analyses, forecasts, strategies for the development of

[1] (Cosnita, Iorgulescu, Leucuta, & Pirvu, 2024)

clusters; specific training courses with the cluster management; organization of the annual conferences of clusters with international participation as well as other promotional events at fairs and exhibitions, economic missions etc; monitoring and evaluating cluster performance based on the ESCA-European Secretariat for Cluster Analysis criteria; consultancy for the establishment, development and collaboration of inter-clusters through the formation of national and international networks; participation in various projects with national and/or European funding etc. CLUSTERO is a founder member of European Cluster Alliance-ECA. CLUSTERO is the organizer of the annual national conferences of clusters. In 2023 the 12th edition of cluster conference took place in Iasi between November 21-23 with a plenary session, panel discussions, co-working workshop with Innovation Performance from Norway, pitching session, matchmaking event and parallel specialized sessions.

The clustering process in Romania is dynamic, with clusters passing through all phases of their life cycle (embryonic, development, maturity and decline). CLUSTERO, as the representative community of practice at the national and international level of clusters, has developed a set of minimum criteria for recognition of cluster status. The CLUSTERO approach is not normative, nor mandatory, nor does it aim in any way to limit the free association of SMEs and the creation of new clusters but it is intended to strengthen the phenomenon of clustering in Romania by introducing qualitative and quantitative standards, based on national and European practices. In addition, CLUSTERO is at the disposal of all those who wish to obtain this recognition with expertise support. The minimum criteria set by CLUSTERO aim for a triple helix/four leaf clover structure consist in the existence of a collaboration agreement, a critical mass of at least ten SMEs, the existence of a management entity and the provision of qualitative and quantitative analysis data that demonstrate the existence of a development and internationalization strategy, the cooperation of members and the achievement of some statistical indicators (turnover, number of employees, exports etc).

SMEs are the weak part of the national innovation system (51,36% of enterprises directed just over 1% of total investment to innovation in 2022)[2].The average number of SMEs in clusters increased from 10 to 30 compared to the European average, which is around 100. Universities, RDI institutes, technology centres, training centres are also members of clusters. There are very big differences between the Romanian develpment regions regarding the performances of clusters (the North West Region of Romania is the leader in innovation and with the most labelled clusters at European level compared to other Romanian regions).

In order to develop the SMEs sector, the Romanian Government -Ministry of Economy, Entrepreneurship and Tourism has issued an Action plan which aims to remove some of the burdens restricting the creation and growth of businesses (company registration and authorization procedures, legal framework, taxes and duties system, access to finance and information).

The strategic lines of action are:

- The creation of a friendly business environment for the setting up and development of SMEs;
- The improvement of SMEs access to foreign markets;
- The development of SMEs productive and innovative activities and the increase of SMEs competitiveness on various markets;
- The promotion of entrepreneurial culture.

The last two action lines above are directly related to the clustering policy that the national government intends to implement within the new industrial policy in the next period.

Competitiveness of Romanian clusters and SMEs depends more and more on their ability to innovate.

The twin transition (green and digital) is a challenge and an opportunity for all SMEs. Applying **twin transition by SMEs** members of Romanian clusters involves a number of **critical factors for success:**

(CNIMPR, 2023)[2]

-*Open communication* between SMEs, research and development entities, public administration and catalysts that serves as a platform for exchange ideas on potential solutions to overcome the inherent challenges;

-*Agreement on objectives* of twin transition by a set of guidelines that define a common understanding of issues;

-*Adequate financial instruments* available to SMEs (i.e credit guarantee arrangements, venture capital funds, incentives etc) instead of providing just public subsidies;

-*Involvement of cluster management organization* as facilitator between ITC enterprises/cluster and non-ITC enterprises/cluster within or outside of regional Digital Innovation Hubs (DIHs);

-*Contacts with public administrations* allowing them to adapt the infrastructure of the cluster to the SMEs needs;

-Cluster SMEs are obliged to *develop innovative strategies* including green and digital activities and to build in the necessary capacities to implement them; in a cluster, SMEs voluntarily or involuntarily learn from each other or copy each other;

-Clusters that have been able to *develop a brand name* bring to their SMEs a valuable tool to market their digital and green products and services;

-*Access of SMEs to the right skills and expertise* in view to engage in more sustainable practices, digitization and innovation within specific training sessions;

-Encourage SMEs *to have a profile on EEN page* in view to exchange information and best practices on green and digital solutions to their needs; Since 2022, the EEN is also equipped with Sustainability Advisors, who will guide SMEs in their sustainability transition. Additionally, measures supporting research and development and simplifying the regulatory framework for SMEs, such as the SME Test, will have positive spillover effects in enabling the economic and legal environment for the sustainability transition of SMEs;

-*Stimulating demand for green products and services of SMEs* members in clusters in the transition to sustainability is supported by the European Cluster Collaboration Platform (ECCP)- Green transition support where are presented practical examples, tools and points of contact to support businesses transitioning towards greener practices.

-Support to *create innovation labs* that employ a broad range of tools and methods to experiment and develop new products and services. Smaller companies can develop new products and services in less time than large companies. Innovation labs simultaneously apply methodologies such as design thinking, idea management processes, open innovation, crowdsourcing and human-centric design. These tactics help the community ideate, guide discussions, and prototype. To encourage cross-collaboration a company can make use of an idea management platform. This is because such a software connects people and competencies across organizations, ensures transparency and feedback flows; additionally, the investment in an idea lab represents a way of developing in-house competencies. Instead of outsourcing to agencies, companies can foster that expertise internally.

In Romania a significant share of SMEs has already *started the sustainability and digital transition*. More and more SMEs are investing in sustainable technologies and digital solutions and are acquiring the skills and knowledge to transform their businesses to become more sustainable and remain competitive. More than half of all SMEs members of Romanian clusters have already invested or are planning to invest in reducing emissions and tackling the impact of climate change and are already engaged in resource efficiency activities, mostly by minimizing waste or saving energy.

SMEs may benefit from the synergistic effects of the green and digital transition. Digitalization offers the potential to make SMEs more productive and to reduce their environmental impact. While the aggregate environmental benefit of digitalization remains difficult to assess, some solutions, for example, ICT tools to reduce the need to travel, provide significant co-benefits to the sustainability transition. To fully leverage the potential of digital solutions for SMEs, both public and private actors should provide technical advisory services and knowledge platforms that enable SMEs to better understand the opportunities of digital solutions and how to implement them in their specific business. Through the specialized DIH-digital innovation hubs, existing in each development region of Romania, SMEs have the opportunity to learn how to become “green innovators” and improve their digital skills.

Despite the good progress SMEs have made in their sustainability transition, it should be noted that some of the key characteristics of SMEs, such as limited resources (financial and human), operation in economic or geographic niches and in uncertain markets and policy environments, present ***challenges for their sustainability transition.*** Insufficient access to finance (including payment delays, constrained liquidity, and access to loans) limits the ability of SMEs to finance investments into cleaner technologies. Romanian SMEs have limited human resources (including expertise and skills), which may imply a lack of information and awareness of opportunities, environmental regulations and support options. The fact that SMEs member of clusters often operate in niche markets implies that SMEs must build their own transition paths, which are specific to their niche market, and can only to a limited extent rely on best practices established by firms in other markets. Uncertainties about the feasibility of adopting sustainable technologies and about the policy environment may cause SMEs to under-invest in sustainable technologies.

The sustainability transition of SMEs is made more complex by the fact that financing the green economy is generally capital intensive and/or risky. As a result, SMEs access to finance as a key barrier, although several solutions are currently available. These are via the market (mostly loans and bank overdraft facilities) and via the public sector in Romania.

Based on the CLUSTERO analysis on clusters elaborated in 2024, a set of recommendations have been derived, aimed at improving policy support to accelerate the sustainability transition of SMEs:

Firstly, there is a need for policies to specifically focus on SMEs and clusters. Sustainability policies should take note of the unique and specific challenges faced by SMEs. Recently, the National Council of Small and Medium Sized Private Enterprises in Romania concluded a Memorandum of Understanding with SMB Norge for an Investment Fund for SMEs, initiative appreciated by the Innovation Norway for opening joint activities in the future. The Department of Sustainable Development of the Romanian Government elaborated Romania's Strategy for Sustainable Development 2030[3] and the National Strategy for the Circular Economy[4] in Romania with the Action Plan adopted in September 2023 that provides a framework for transition but specific guidelines for SMEs are needed in view to implement the sustainable development goals and those of circular economy. Romania has also the Strategy for Green Jobs and the Program for Digitalization of SMEs within the National Recovery and Resilience Program.The cluster policy is a strategic component of the National Strategy for Competitiveness 2021-2027 and of the Industrial Policy document.

[3] (Romanian Government, Romania's Sustainable Development Strategy 2030, 2023)
[4] (Romanian Government, National Strategy for Circular Economy, 2022)

Secondly, the regulatory framework should facilitate the sustainability transition of SMEs and strengthen their resilience, while minimizing the administrative burden of reporting requirements**.** New proposals need a solid SME test to ensure that the obligations are proportionate and manageable for SMEs.

Thirdly, SMEs also need technical assistance and capacity building programs to support them in adopting sustainable business models, a circular economy approach and new ways to boost resource efficiency. In particular, policymakers should consider leveraging and expanding the capabilities and resources of the Sustainability Advisors of the European Enterprise Network and of the Department for Sustainable Development of the Romanian Government. For example, since 01.01.2020, a number of 570 SMEs from Romania were supported with technical assistance by Enterprise Europe Network.

Fourthly, it is important to consider that SMEs differ across industrial ecosystems, regions and are often part of supply chains. Policies addressing large enterprises within these supply chains also impact SMEs. This has two implications. First, the indirect impact of reporting obligations for large enterprises should be properly managed in order to avoid that these requirements are unfairly passed on in the supply chain to SMEs (this can range from requests of sustainability information to a shifting of liability). Secondly, while exempting SMEs from specific obligations can be justified in some cases, legislation should consider simplified voluntary tools and mitigating measures that allow SMEs to demonstrate their sustainability commitments. Such policies could include simplified and proportionate standards for SMEs, non-binding model contractual clauses, lower frequency for certain obligations, tailor-made guidance, one-stop-shops, or helpdesks).

Fifthly, by providing incentives for SMEs to tap into green markets through innovative products and services, SMEs can become an important driver of the sustainability transition. Examples of such incentives include green prizes and certifications (i.e. In 2020 the award for climate change went to Green Energy cluster from Sfantu Gheorghe-Covasna County-Central Region of Romania).

Some policies supporting SMEs in the sustainability transition may create win-win scenarios.

Firstly, support for energy efficiency measures, green certifications and prizes, and technical assistance not only accelerate the sustainability transition but also provide benefits in the form of business cost reductions, reputation improvements and capacity building.

Secondly, self-assessment and diagnostic tools help SMEs to understand their environmental footprint and the means available to reduce it. At the same time, these tools establish a much broader database that can serve as a basis for future policy decisions.

However, other policies face trade-offs between accelerating SMEs' sustainability transition and other policy goals. Firstly, sustainability reporting requirements for SMEs facilitate the sustainability management of SMEs, raise awareness of sustainability issues, and promote credible monitoring processes. Secondly, regulatory measures introduce both benefits and drawbacks, depending on their specific nature. While measures such as environmental production standards might lead to the universal adoption of sustainable practices, they might also reduce the international competitiveness of SMEs. In contrast, regulatory measures could also take the form of tax incentives, reduction of the administrative burden, or simplified intellectual property rights for sustainability-related innovations. While these measures all contribute to an increase in SME competitiveness and incentivize sustainability action, they might also lead to legal uncertainties and challenges in the classification of sustainable innovations and investments. Thirdly, financial support should ideally be combined with technical assistance, awareness raising and advisory services, since SMEs often do not possess the necessary skills and knowledge to undertake green transformation processes. Including technical assistance in financial instruments can thus enable SMEs to better exploit the opportunities of the sustainability transition, but might also make financing more expensive and complex to implement.

SMEs are supported also in their digital transformation in Europe by a network of up to **240 Digital Innovation Hubs** (DIHs), in each region of Europe, underpinned by investment from the Digital Europe Program and from Structural Funds.

In Romania, clusters and SMEs are members of Regional Digital Innovation Hubs. (**see Annex 2)**

The 2023 European Commission Strategic Foresight Report[5] identifies 10 key areas of actions for a successful twin transition:

1. Strengthening **resilience and open strategic autonomy** in sectors critical for the twin transitions via for instance, the work of the EU Observatory of Critical Technologies.
2. Stepping up **green and digital diplomacy,** by leveraging the EU's regulatory and standardization power, while promoting EU values and fostering partnerships.
3. Strategically managing **supply of critical materials and commodities**, by adopting a long-term systemic approach to avoid a new dependency trap.
4. Strengthening **economic and social cohesion**, by for instance, reinforcing social protection and the welfare state, with regional development strategies and investment also playing an important role.
5. Adapting **education and training systems** to match a rapidly transforming technological and socio-economic reality as well as supporting labor mobility across sectors.
6. Mobilizing **additional future-proof investment** into new technologies and infrastructures – and particularly into R&I and synergies between human capital

[5] (European Commission, Strategic Foresight Report, 2023)

and tech –with cross-country projects key to pooling EU, national and private resources.

7. Developing **monitoring frameworks** for measuring wellbeing beyond GDP and assessing the enabling effects of digitalization and its overall carbon, energy and environmental footprint.
8. Ensuring a **future-proof regulatory framework for the Single Market**, conducive to sustainable business models and consumer patterns, for instance, by constantly reducing administrative burdens, updating our state aid policy toolbox or by applying artificial intelligence to support policymaking and citizens' engagement.
9. Stepping up **a global approach to standard-setting** and benefitting from the EU's first mover advantage in competitive sustainability, focused around a 'reduce, repair, reuse and recycle' principle.
10. Promoting robust **cybersecurity and secure data sharing framework** to ensure, among other things, that critical entities can prevent, resists and recover from disruptions, and ultimately, to build trust in technologies linked to the twin transitions.

CLUSTERO as a representative organization at national and European level, supports the green and digital transition of SMEs members of clusters through training sessions, matchmaking events, the promotion of good practices in the newsletters and at various events, supporting SMEs within the Enterprise Europe Network, the involvement of clusters and SMEs in projects etc.

The "Innovative services for twin transition in SMEs and clusters" project presents benefits both for CLUSTERO-Romanian Cluster Association and for Innovation Performance AS from Norway on mutual knowledge of the situation of clusters and SMEs, of their preparation for the green and digital transition in order to ensure sustainability, exchange of good practices and innovative services that can be offered in the context of internationalization and joining global value chains.

4 Rationale and methodology

The analysis has been elaborated as part of the project "Innovative services for twin transition in SMEs and clusters" within the EEA and Norway Grants Program 2014-2021.

Clusters are based on relationships among enterprises. The relationships can be built on common or complementary products or services, production processes, core technologies, natural resource requirements, skill requirements and/or distribution channels. Clusters include enterprises that both cooperate and compete among themselves. The links between firms are both vertical through buying and selling chains and horizontal through complementary products or services and use similar specialized inputs, technologies and other linkages.

The scope of the project is to increase the competitiveness of Romanian SMEs within focus area Green Industry Innovation by a close cooperation between Romanian Cluster Association-CLUSTERO and Innovation Performance AS from Norway.

The project team started with a research that is based on the latest documents published in European Commission reports and similar documents on innovative clusters and their services to members that are available on various websites, data obtained from questionnaires sent to clusters and SMEs members of CLUSTERO and the outcomes of the interviews with cluster managers. The documents are listed as references and the questionnaires on existed services and the needs of companies are presented in annexes.

A total of 30 responses from clusters and SMEs were obtained and considered for the analysis as representatives for the twin transition. The majority of these clusters with SMEs members are labelled by ESCA with gold, silver or bronze. The main sectors to which the surveyed SMEs belong are represented are: biomass, energy, textiles, wood processing, green technologies, ICT, healthcare, sustainable constructions, agro-food, waste management. The questionnaire aimed to collect data to identify the stage of digitalization and the needs for the future as well as the activities of green growth and sustainable development. Clusters and SMEs are supported to increase their knowledge about various topics in fields such as business models, eco-innovation, circular economy, internationalization, Corporate Social Responsibility (CSR) through exchange of best practices with Norwegian partners and training sessions carried out within the project.

The brochure "Support services for green and digital transformation of clusters and SME's." will be elaborated by the project team till the end of the project and it will be an useful tool for all Romanian clusters and SMEs that want to enter in such innovative networks.

5 Overview of cluster and SME policies (Romania and Norway)

5.1 Cluster concept

The economic success of a region depends on its ability to create favorable conditions for the private sector to develop profitable businesses. In this context, one of the basic tools currently used to stimulate the factors of regional competitiveness and intelligent economic specialization are the initiatives for the development and consolidation of clusters.

In the economic theory there are many definitions of the cluster, but the established definition belongs to professor Michael Porter who in 1990 in the work “The Competitive Advantage of Nations[6]” defines clusters as “Groups of interconnected companies (especially SMEs) and associated institutions from a certain specific field, located in a geographical proximity, linked by similar or complementary activities”. Clusters comprise a group of specialized suppliers, service providers, companies from related industries, universities, research institutes and trade associations, local public administrations from specific fields, which compete but also cooperate.

[6] (Porter M, 1990)

The common elements of the definitions given to clusters are: “concentration” of one or more sectors in a certain area region, “specialization” in a certain specific or cross-sectoral field, “critical mass” ensured by key enterprises and the emphasis on “networking” and “cooperation” between companies and institutions.The life cycle of a cluster goes through four phases: emergence, development, maturity and decline or transformation. In Romania, experience has shown, however, that the 3 natural partners of Michael Porter’s “triple helix” model do not cooperate in most cases. That is why it was necessary to adapt the “triple helix” model and transform it into a “Four leaf clover” model, the fourth actor being represented by catalyst organizations-entities specialized in the field of technological transfer and innovation, companies of consulting or the “quintuple helix” model which also includes banks as cluster members.

The cluster is led by a management entity that is an NGO (association/foundation) or a consulting company. Clusters can be initiated both by the economic environment and by research entities or local administration, the approach being “bottom-up” or “top-down”. Clusters are unique, differing in their level of sophistication, objectives, strategy, number of members, structure, management excellence, funding etc. The clusters are active in different main fields of activity (agri-food, energy, ITC, wood-furniture, tourism, creative and cultural sectors, constructions, textiles, tourism, healthcare etc) but also related ones that emerged as a necessity due to global challenges (digitalization, green economy, social innovation etc). Clusters are part of regional digital innovation ecosystems and European networks. Today, attracting young entrepreneurship to the cluster has become a major objective for the cluster management.

5.2 European and Romanian cluster policy

The European Union pays a special attention to clusters both at the community level as well as at the regional and national levels. This fact is due, on the one hand, to the need to act quickly on external fluctuations in order to compete on the basis of excellence and on the other hand to the need to overcome internal economic crisis situations.

The aim of the European cluster policy is to promote the development of world-class clusters with competitivie industrial value chains and a cross-sectoral approach. EU cluster policy works as a kind of catalyst for regional and innovation policies by addressing European value chains and positioning in global value chains. Cluster policies also provide support for SMEs to implement smart specialization strategies and to promote cooperation between regions, countries and sectors. Within the broader framework of cluster policies, five prority areas of intervention for cluster initiatives can be identified: industrial modernization and value chains linkages; investment in smart specialization; entrepreneurship (start-ups and scale-ups); growth of SMEs; excelence in cluster management for better support SMEs; inter-regional, international and trans-sectoral collaboration.

The main European platforms of know-how in the field of clusters and SMEs are the following: European Cluster Alliance-ECA; European Cluster Collaboration Platform-ECCP; European Secretariat for Cluster Analysis-ESCA; Enterprise Europe Network-EEN.

The European Union faces the challenge of becoming a fair and prosperous society based on a modern, competitive and resource-efficient economy. The mobilization of industrial actors towards a clean, green and circular economy through in-depth cooperation along value chains as well as the use of new technologies, sustainable solutions and disruptive innovation are critical in achieving the above-mentioned objective as highlighted and in the European Green Deal. Competitiveness was strongly influenced by the economic situation caused by the COVID 19 pandemic and the war in Ukraine. A key component of the EU's efforts to support Member States and regions to find a way out of the recession is smart specialization-an innovative strategy for economic transformation at local, regional and national level. The development of research and innovation strategies based on the concept of smart specialization is one of the essential conditions for accessing structural funds in the period 2021-2027. Clusters are models of smart specialization that do not lose sight of the purpose of innovation: to bring innovative solutions to the market and thus generate growth and jobs.

At European level, clusters collaborate with digital innovation hubs which are support facilities for member companies to become more competitive by improving their business as well as products and services through digital technology. The European Commission emphasized in Communication 102 final/10.03.2020, „ A new industrial strategy for a global, green and digital Europe" and COM 103 final/10.03.2020, a SME strategy for a sustainable and digital Europe[7], the importance of clusters in trans-national and trans-sectoral collaboration and the support given by them to SMEs in the process of economic growth and internationalization.

EU cluster policy uses clusters to implement EU priorities such as: **EUROCLUSTERS** that are cross-sectoral, interdisciplinary and trans-European strategic initiatives gathering industry clusters and other economic actors to implement the EU Industrial Strategy create new business opportunities for SMEs and integrate them better in European and global strategic value chains. **ECCP**-European Cluster Collaboration Platform that helps clusters and SMEs members through dedicated services, including Clusters meet regions, Cluster talks, Green Transition Support, C2 labs and matchmaking events. **European Cluster Panorama** that is a report on characteristics of clusters in the European regions identifies also those clusters that are active in green and digital activities. **European cluster partnerships** are EU wide consortia that work concretely together on initiatives supporting their industrial ecosystems and, in particular, their SMEs. Partnerships can focus on internationalization, innovation, smart specialization investments or excellence. **ClusterXchange** is an EU program for clusters, SMEs and scale-up support organizations implemented by the European Cluster Partnership Excellence. These are some of the EU actions regarding the clusters and SMEs

[7] (European Commission, Communication COM/2020/103 final -An SME Strategy for a sustainable and digital Europe, 2020)

completed by **the programs Horizon Europe, Digital Europe, COSME, INTERREG etc**. An useful instrument for clusters and SMEs is the recommendation report of the European expert group on clusters that advised the European Commission, EU countries and regions on how to strategically utilize clusters for industrial policy, interregional collaboration and integration of SMEs into EU and global value chains. In this report there are also recommendations on employing clusters to boost the green and digital transitions.

Romania, through the Ministry of Economy-General Directorate of Industrial Policy initiated the cluster policy in 2009 as a component of the industrial policy.In the framework of Romanian-German bilateral technical cooperation, in 2010, the Ministry of Economy collaborated with the German Society for Technical Cooperation-GTZ on the elaboration of the Romanian Cluster Mapping (identification of the clustering potential in the eight development regions of Romania) and the implementation of the new European concepts of industrial policy such as the competitiveness cluster and cluster policies to increase competitiveness and innovation. At the same time, within the Sectoral Research Plan for Industry, the Ministry of Economy carried out the INNOV Cluster I and II projects in the period 2009-2012 through which the Guide for the implementation of the innovative cluster concept in Romania was created, the situation of innovative clusters in the European Union was analyzed, the cluster concept was disseminated in the 8 development regions of Romania and the clustering potential in Romania was identified.

The first regional clusters were created in Romania in 2010, from „bottom-up" with a sectoral approach. Currently, Romania has a number of 78 clusters registered to the Ministry of Economy of which 53 are CLUSTERO members and most of the clusters are awarded with gold, silver and bronze labels. Romania also has 6 regional consortia and 6 sectoral networks (textile&fashion; wood and furniture; ITC; healthcare; .agrofood and ecological agriculture).

In 2011 the Association of Romanian Clusters-CLUSTERO www.clustero.eu was founded with the object of activity supporting the interests of the members at the national, European and international levels; promoting members through various means and at all levels as well as supporting clusters in development, internationalization, marketing, branding strategies; organizing exchanges of good practices with clusters from the EU; the development of benchmarking analyses, forecasts, strategies for the development of clusters; specific training courses with the cluster management; organization of the annual conferences of clusters with international participation as well as other promotional events at fairs and exhibitions, economic missions etc; monitoring and evaluating cluster performance based on the ESCA-European Secretariat for Cluster Analysis criteria; consultancy for the establishment, development and collaboration of inter-clusters through the formation of national and international networks; participation in various projects with national and/or European funding etc.

SMEs are the weak part of the national innovation system. Average number of SME in clusters increased from 10 to 30 compared to the European average which is around 100. Universities, RDI institutes, technology transfer centers, training centres etc are also members in clusters (e.g.Institute of Forecasting Economics of the Romanian Academy is a member in 3 clusters). In Romania there are very large differences between the development regions regarding the cluster performance (the North West Region is the leader in innovation and with the most awarded clusters at the European level). Romania’s cluster policy supports the transformation/renewal of existing value chains and the development of new ones for emerging cross-sectoral industries and, secondly to support the development of industrial and non-industrial clusters to become world-class clusters.
The objectives proposed for cluster policy in Romania[8] are the following:

[8] (Strategia Industriala a României 2023-2027, 2023)

-Supporting the development of emerging, developing and mature clusters to become excellent clusters (immature clusters without innovation and business model will not be supported);

-Stimulating association in clusters to increase the innovation capacity of enterprises, especially SMEs and to boost technological transfer;

-The adoption of digital and green technologies and the development of clusters in services for the modernization of Romania's industry and the development of new emerging industries;

-Promoting industrial innovation and investments in the industries of the future;

-Supporting the internationalization of clusters, including inter-cluster collaboration at the national level and the access of SMEs members to foreign markets; networking at national, regional, European and international level;

-Strengthening collaboration between central and regional/local authorities regarding cluster financing programs.

5.3 Entrepreneurship and SMEs

European Industrial Strategy, whose aims include supporting the sustainable and digital transition ("twin transition") is accompanied by a dedicated SME strategy which emphases the sustainability transition, acknowledging the challenges SMEs face and providing the instruments to overcome these challenges. Among these instruments are the Enterprise Europe Network, promoting cluster and SMEs collaboration and knowledge transfer, the European Innovation Council, promoting green tech innovation, and the SME policy windows of Invest EU, which include promoting access to finance in the area of sustainability. In short, the concrete impact of the European Green Deal, related policies and actions on SMEs are currently fairly limited.

SMEs are highly heterogeneous, ranging from one-person retail stores to export-oriented manufacturing enterprises with up to 250 employees[9]. Nonetheless, some key defining

(CNIMPR, 2023)[9]

characteristics can be identified that hold true across a wide range of SMEs and distinguish SMEs from large enterprises:

1. SMEs tend to operate in a geographic and product niche, with limited diversification.
2. SMEs have limited access to resources, including access to finance, expertise, skills and human resources.
3. SMEs are often owned and managed by the same person, and consequently depend on the ambitions, beliefs and values of the owner-manager.
4.SMEs have limited influence on the wider business environment (e.g., through lobbying or advocacy activities) and supply chains.

Entrepreneurship is considered one of the most important sources of competitive advantage for all countries. The development of entrepreneurship has important benefits, both from an economic and social point of view.The relevance of entrepreneurship for the national economy is expressed by prof.Michael Porter „Invention and entrepreneurship are at the center of the national advantage".The ability to face challenges and learn from any defeat is a component of the entrepreneurial spirit that signifies innovation, flexibility, adaptability to change, dedication, self-discipline, initiative and vision.

The concept of smart specialization is based on the idea that regions must identify a series of technological and knowledge domains through entrepreneurial discovery processes and initiatives in order to build competitive advantages. The process of entrepreneurial discovery is complex and is based on different approaches at the micro, mezzo and macro levels of innovation environments, on the stakeholders involved in the different phases of this process and on the measurement of results.

Entrepreneurship in Romania is a challenge with many obstacles. The main barriers in the development of a business are related to the lack of financial resources and investments in innovation, bureaucracy, insufficient qualified skills, the lack of necessary information regarding smart specialization, the lack of managerial culture and education, legislative instability and the lack of an environment favorable to the development of entrepreneurial skills. *Self-financing remains the only way of financing SMEs in a dominant proportion of 75%.*

Clusters are also addressed today in Romania as tools for implementing regional smart specialization strategies**.** The ability of Romanian regions to innovate depends on many factors such as: business culture, the skills and competences of the workforce, the existence of effective education and training institutions, innovation support services, technology transfer mechanisms, research and innovation entities, ICT, infrastructure, business incubators, local creative potential etc. Good governance is essential. All strategic documents in Romania, as the basis for the 2023-2027 programming period, focus mainly on encouraging all types of innovation by strenghtening regional research and innovation capacity, on the importance of clusters for regional development, on business-based innovation, on access SMEs on skills, financing and global value chains and on strenghtening the attractiveness of regions for investors and employees by supporting key sectors of smart specialization.

Romania faces serious difficulties in reaching the critical mass of entrepreneurs within the clusters and regions that would achieve such a level of excellence and adequate adaptation to the requirements of businesses, especially SMEs. SMEs represent the weak part of the national innovation system and clusters.Building trust is essential for cooperation and involves focusing on strengths, adding value and connecting the right people in certain areas of expertise.The smart specializaion of clusters appears as a key element not only in relation to financing for the current period but also as an opportunity to generate competitiveness and jobs through the well known phenomenon of entrepreneurial discovery.

One of the key challenges for the regional clusters in Romania was keeping the added value in the region. Entrepreneurial discovery is actually the key to attract new activities that should continuously reinvent the specialization model, diversify the economy and generate competitiveness and jobs. This was possible in the regions of Romania with a dynamic and participatory business environment and where clusters are an important part of the innovation ecosystem. In the North West Region, the Agro Trnasylvania cluster labelled with gold played a catalytic role in transposing the concept of smart specialization. The management of the cluster focused on four selection criteria: the direction of the options, the presence of a competitive advantage, the existence of a potential or existing critical mass and the ability to establish intra-and interregional cooperation. They involved entrepreneurs from the begining of the strategy development through the co-creation process.

Collaboration between SMEs and research-innovation entities is still limited in other regions such as South East, South Muntenia or South West as well as collaboration between innovative SMEs members of clusters that are considered to have a positive impact on specialization clusters in the region. Access to skills and competences is seen as a major problem by regional stakeholders in Romania in different sectors and clusters.Companies and small entrepreneurs in the regions are often unable to successfully outline their needs in terms of skills and face recruitment difficulties.

The process of entrepreneurial discovery in the regions of Romania leads to the gathering of information about regional challenges and the needs of interested parties, to the review of selected areas of specialization, to the exploration of new technological and market opportunities to a faster cooperation between regional actors, to the identification of new niche sectors and projects. The clusters in Romania strongly support the entrepreneurial discovery process in the regions.

In the context of the smart specialization process, the main challenges for Romanian entrepreneurship are focused on: digitization, innovation, high performance management, green economy, internationalization and integration of SMEs in value chains and clusters, entrepreneurial education. The development of entrepreneurship requires a joint effort of entrepreneurs, public administration, schools, support organizations, businesses, investors, the media etc.

According to the data from the Trade Register the Romanian economy had in 2020 around 2000 large companies and over 800000 SMEs; the big players generate 55% of the turnover, but only 39% of the profit. SMEs provide 61% of the profit and 64% of the labor force in the enterprises. SMEs represent the largest share in the total number of local companies, they have the largest employed workforce in the economy and are the most profitable but they are in the minority when it comes to turnover. In terms of revenues, large companies win by far. Unlike large companies, small companies can be much more flexible and can make decisions in a much shorter time than large companies in order to be able to withstand the new changes in the market. However, large companies are better capitalized, which allows them to survive a difficult period from an economic point of view, which is a significant advantage.

5.4 Norwegian Innovation Clusters (NIC); The national cluster program in Norway

Norwegian Innovation Clusters (NIC) is a multilevel national cluster development program (the national cluster program in Norway) aimed to support activities in industrial business clusters composed of companies competing internationally[10].

The national cluster program in Norway was established in June 2014. NIC program continues the supply of services that until then had been given through the individual programs Arena (since 2002) and Norwegian Centers of Expertise (NCE) (since 2006), as well as introducing a new program called 'Global Centers of Expertise' (GCE). The aim

[10] (Innovation Norway, 2017)

of NIC program is to set up and strengthen cooperative innovation projects in business clusters, focusing on increasing companies' ability to innovate and their competitiveness. NIC program is a cooperation between Innovation Norway, SIVA and the Norwegian Research Council. NIC program contributes with funding, competence services, advisory services, networking services and promotional services. It supports clusters at three levels:

1. Regional clusters in an early phase, for three years (Arena);
2. Regional and national clusters, for five years (Arena Pro);
3. Well established clusters with a global position, for 10 years (Global centers of expertise, GCE).

The 11 regions = 11 counties of Norway support clusters before, during and after, entering and leaving the national cluster programs. Most regions/counties provide both cluster management funding, project funding and regional support services (regional cluster organization networking, training, mentoring) to cluster organizations in their regional portfolio of cluster organisations.

More specifically***, the Arena program*** targets regional business communities that have a high concentration of companies within one industry, value chain or area of expertise, and that have relevant competence centers. There must be a potential for increased innovation and value creation by way of increased collaboration between these parties. Arena is a three year program while **Arena Pro**, introduced in 2019, provides support for five years. The program offers financial and professional support for implementation of projects. The Arena program can co-finance activities in process management, analysis and strategy processes, network building arenas, communication initiatives, early-phase idea and project development and learning initiatives. The financing can cover up to 50% of the costs of a project, normally NOK 1.5 million to 3 million a year (€190,000 to 310,000). Professional assistance is also offered through methods and tools for cluster development, workshops and courses, project advice and more.

The Global Centers of Expertise program (GCE) targets clusters with a considerable potential when it comes to growth in markets both nationally and internationally. The program is limited to 10 years.

NCEs (National Centers of Expertise) was a separate 10 year program similar to Arena, aiming to develop the most important regional industrial clusters in Norway - those with good resources and established competitive advantages. NCE and GCE are no longer a program, but a brand name clusters previously in the NCE program, can qualify for. To qualify to use NCE/GCE brand after the max. 10 years funding period is over, the cluster must hold a valid ECEI Gold Label quality certification.

The main focus areas of the NCE/GCE programs was increased innovation, goal-oriented internationalization, increasing attractiveness as hosts for participating companies and access to tailored competence. Each NCE is knowledge-based, and includes development and financial actors who support the core companies 'development.

The ARENA program consists of 7 cluster projects as of December 2023. 12 clusters have Arena Pro status, 3 clusters hold the right to use the GCE brand and 11 clusters hold the right to use the NCE cluster brand. (***see the Annex no.3)***

The Norwegian Innovation clusters program has moved its focus gradually from straightening regional cluster organisations to motivate the establishment of stronger national superclusters capable of successfully supporting internationalization of the clusters and its members. These superclusters is typically based on existing and/or new regional cluster nodes merged/reorganized into a strong national supercluster with local cluster office presence in multiple regions. This trend of consolidation of regional clusters into national superclusters with a strong presence with regional activities and offices in multiple regions is expected to be even stronger in 2024. This is also an opportunity for Romanian clusters and cluster members with a industry focus that fit the green and digital transformation challenges of Norway.

Romanian-Norwegian cooperation in the field of clusters and SMEs already has a tradition and has materialized through various projects in the field of innovation, research, education, competitiveness, environment and energy, financed by Norway both through the EEA Grants Mechanism and the Norwegian Financial Mechanism. In Romania, Innovation Norway, which is the Fund Operator for the Business Development Program and for the Energy Program, has contributed to the strengthening of bilateral relations by supporting innovative technologies, sustainable business models, the green and digital transition of SMEs and the development of innovative services by clusters for members. The list of economic sectors in which there are similar Romanian-Norwegian clusters is presented ***in Annex no.4.***

6 Chapter 2- Green and digital transition: a challenge and an opportunity for SMEs and clusters

6.1 Concept of twin transition

The Twin Digital and Green transition has been adopted by the European Union in 2021 as part of its European SME[11] strategy and the European Green Deal, which aims to use climate-neutral resources and an efficient digital economy in European SMEs.

The concept of the digital and green transition defines a comprehensive societal transformation in which all sectors adopt relevant technologies that contribute to a low carbon society. The green and digital transition is to assist SMEs in becoming more sustainable using climate neutral resources and decrease the use of waste, water, and energy. This can only be realized by the application of digital tools to plan, measure, analyze, and monitor the use of resources. The digital and sustainable transition can help these companies with cost savings, can provide competitive advantages, and offers opportunities for the development of new products and services.

The green and digital transition has specific goals such as:

-The climate crisis and the loss of biodiversity are clearly linked to human activities. The consequences of this crisis pose an existential threat globally. Some of these changes are already felt today and will be felt even more in the future. With the active engagement

[11] (Joint Research Centre, 2022)

of the European Union, international commitments for climate action and sustainability have been made, such as the Paris Agreement and the UN's Sustainable Development Goals. Efforts continue, and a majority of countries have pledged to reduce greenhouse gas emissions, to help those who are already affected to adapt to climate change, and to provide financing for action.

-The way out lies in a swift and inclusive transition to environmentally sustainable lifestyles and economies**.** The green transition refers to the fundamental shift in production and consumption patterns to allow us to live within planetary boundaries. It means mitigating climate change by introducing climate-friendly lifestyles and taking environmental costs into account. It includes addressing the loss of biodiversity and its multiple ecosystem services that are crucial to healthy living and to resilient societies. At the same time, the green transition must be fair and inclusive.

-The European Union is a leader in climate and environmental action. The European Union was the first global player to present a long-term vision that aims for climate neutrality by 2050. In 2019, the European Commission presented the European Green Deal, which sets out a new sustainable growth strategy and addresses some of the most important environmental and climate-related challenges. It sets the goal of transforming the European Union into a modern, circular, resource efficient, and competitive economy, in line with the goals of competitive sustainability. Following this blueprint, the European Union has adopted a European Climate Law to establish the legally binding target of reaching net zero greenhouse gas emissions in the European Union by 2050. The European Commission has also proposed a legislative package to reach an increased climate ambition by 2030. Furthermore, the Commission has adopted several strategies in support of its environmental targets, such as the Farm to Fork Strategy, the Sustainable Blue Economy Strategy, the Climate Adaptation Strategy, and the New Action Plan on Circular Economy.

-The green transition is an opportunity to unlock economic and societal benefits. Green technologies can provide economic and environmental win-win situations for both societies and economies. The green transition is an opportunity to transform today's unsustainable activities towards a just future. One that overcomes societal challenges such as growing disparities, and opens up avenues for competitive advantages of economic activities that provide solutions without exceeding the planetary boundaries.

-The digital transition is an ongoing process that is shaping the future of societies and economies. The changes triggered by the digital transition have the potential to increase prosperity and solve many societal challenges. At the same time, increasing digitalization entails many risks, for example social disruptions and polarization of opinions, increasing inequality, security risks, or mis- and disinformation. Today, the European Union faces risks stemming from its dependence on non-European technologies and service suppliers and globally there is a reliance on a few big technology companies. Much of the data produced in the European Union is stored and processed elsewhere, which poses both a security risk and a potential loss of the value of European data. At the same time, the reach of digital innovation is expanding and could transform our society and economy even further. Emerging technologies such as advanced robotics, automated mobility, or digitally-enabled biotechnologies are crossing digital, physical, and biological spheres.

-To make the digital transition a success, the European Union needs to establish a secure, trustworthy, and resilient digital infrastructure. It needs a strong digital education and training ecosystem, so that the European Union's citizens and workforce are fully equipped for the digital age. The digital transition requires policies that harness the benefits of technologies, reduce the negative impacts of technological change, and avoid falling behind global competitors. The European Commission has presented a strategy to harness the benefits of the digital transition. The Digital Decade Compass outlines targets for 2030 and sets a path towards empowering "people and businesses to seize a human-centred, sustainable, and more prosperous digital future". Furthermore, the European data strategy aims to take the opportunity of increased data availability to address individual needs and create value for society and the economy. These initiatives aim to introduce a fully functioning Digital Single Market, an efficient European Cloud, global leadership in trustworthy Artificial Intelligence, and a secure digital identity for all. In this way, the European Union aims to make sure that digital tools enable citizens' rights and freedoms and strengthen democracies.

There are many links between green and digital transition such as:

-While both transitions will transform our societies and economies, they are different in nature and in their dynamics**.** The green transition is driven by the need to reach the aims of climate neutrality and sustainability, and to reach them quickly. It will not happen on its own and requires a political and societal push. In contrast, the digital transition is an ongoing process of technology-driven change, with the private sector as one of the primary drivers. Therefore, steering and support are important to make sure that the digital transition becomes a powerful instrument for achieving a fair and just green transition.

-In many areas, the green and digital transitions can reinforce each other, but they do not necessarily always align**.** Digital technologies can be key enablers for reaching the European Green Deal objectives. There are many contextual factors that a crucial horizontal issue for the green and digital transitions such as:

Social factors

-The twin transitions require the buy-in and support of people**.** Citizens will not only feel the effects of the transitions, they are for a large part the key players in them. European citizens are well aware that climate change is a serious problem and agree with the target of a climate-neutral European economy by 2050. At the same time, the actions to meet this goal will take many forms, and a lack of social acceptance of them has the potential to be a serious barrier. Acceptance is the precondition for societal commitment and behavioral change, and both commitment and change are required in many areas for the green and digital transitions. For this study, social acceptance is deemed to cover three dimensions, namely socio-political, market, and community acceptance. Socio-political acceptance indicates that citizens and policymakers need to be convinced and have the will to act. Market acceptance refers to the openness to adopt new technologies, or the willingness-to-pay of businesses, consumers, and investors. Finally, community acceptance is the acceptance of local communities regarding new technologies and innovations. Community acceptance often depends on whether communities feel that they can trust the information and the intentions behind proposed changes The openness of the decision making process, the involvement of all stakeholders, and a perception of fair sharing of costs and benefits are crucial factors for promoting community acceptance.

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-A central challenge for the twin transitions is to make sure that the transitions are fair, inclusive, and just. This means protecting the people that may be adversely affected by the necessary shifts. It also means making the benefits of the twin transitions accessible to all to ensure social justice. A perception of fairness and transparency is a significant factor in social acceptance. For example, a successful digital transition requires that connectivity is accessible to all, regardless of location, income, education-level, or age. The just transition also encompasses ethical concerns related to the twin transitions.

-Technology acceptance is a determining factor for successful green-digital solutions. Looking at the digital transition and at the information society, researchers have examined technology acceptance to analyze and predict the potential acceptance or rejection of a technology. The key variables identified are whether potential users believe that a technology will improve their lives and require little effort to use. These assessments of the potential user are in turn affected by the user's demographics, personality, and past experiences. The willingness of people to take up and learn new methods and technologies may also depend on their habits, lifestyle, culture and community. Such factors are essential to consider when assessing workable solutions and policies for the twin transitions.

-Solutions and policies need to take possible unintended consequences into account. Unintended or unexpected consequences of new solutions or technologies are also referred to as 'rebound effects'. Rebound effects are for example when reduced energy costs due to energy efficiency improvements lead to increased consumption in other areas. Or when people use electric vehicles more extensively due to lower operating costs. These kinds of behavioral effects need to be considered when designing technologies and policies at the level of the citizen and user, but also at the wider level of society. Otherwise, there is a risk of cancelling out savings on emissions in one area it increased emissions in another. Digital technologies have the potential to help address this issue by increasing citizens' awareness of their behavior and of available alternatives, or by changing their role in the decision-making process, for example through automation.

-The twin transitions call for high ambitions that are in the interest of society. Societies all over the world are working on formulating ambitions and adapting norms along the lines of sustainability and positive change. The shift towards a sharing economy, or the de-coupling of economic growth from resource consumption and emissions, are two examples of these ambitions. The shifts in behavior that can help to realize the twin transitions can be achieved in many ways. For example, the narrative of the twin transitions being necessary and in everyone's best interests is a crucial factor to mobilize society. Clear evidence-based communication of this narrative can help to overcome misperceptions, such as the feeling that the twin transitions come at the cost of wellbeing.

Economic factors

-The costs associated with the twin transitions can be a significant barrier to change. In many areas, there are significant sunk costs associated with the transformation of sectors. For example, businesses may be reluctant to abandon the infrastructure, or the methods (e.g. established procedures) that they have invested in. These create path dependencies and lock-ins, which give existing technologies an advantage over new technologies. To move beyond this path dependency, financing of the changes needed in the economy should be linked to the long-term potential in the context of the twin transitions.

-Technological innovation can create new economic opportunities. As the transitions progress, increasing returns from economies of scale and scope for green and digital technologies could create new markets. With green and digital technologies becoming more widespread, they can open up new development paths and lead to more innovation. Industry networks can expand activities around a green-digital solution through supply chains, infrastructure, and complementary technologies. This expansion can lead to new business opportunities. The expected shifts between sectors because of the twin transitions indicate how the economy could adapt.

-The impact of the twin transitions on employment and skills needs are also central issues. In the European Union, the green transition is estimated to lead to a net increase of up to 884,000 more jobs by 2030. Each economic sector will be impacted differently, and many of the new technologies and methods require skills and labor that is not readily available in today’s economy. Examples of skill gaps are digital skills, or building renovation skills. Some sectors may lose jobs and some regions of the European Union will be more affected than others. Reskilling is therefore an essential factor to bring workers into new or changing sectors.

-Financing is an essential element for the twin transitions. Financing can be the determining factor for whether green-digital solutions see the light of day. Many of the technologies and solutions needed have reached ‘technological readiness’, but will need various complimentary funding sources and mechanisms to succeed. Investments are being directed towards the green and digital economy today, but much capital still flows into the old economy. This is in part due to investment incentives that follow market prices, which do not account for social and environmental long-term costs. Sustainable finance has the potential to drive the green transition. The EU taxonomy for sustainable activities acknowledges this fact and provides definitions and standards for environmentally sustainable economic activities.

Political factors

-Policymakers and governing institutions are main players in the green transition. Policies and political targets are strong drivers of the progress towards net-zero emissions and environmental protection. Policies, standards, and regulations are influencing the development and use of digital tools and technologies, and have the potential to do so even more in the future. As digital tools develop and expand, the political frameworks need to keep up to ensure that citizens and businesses can benefit from them. The European Commission's sector inquiry into the Internet of Things and the role of competition policy are examples of how political frameworks are being adapted to new developments. The political factors of transitions involve not only policymakers and governments, but also local organizations, non-governmental organizations, and the private sector.

-The global and geopolitical dimension of the twin transitions is of the utmost importance. Global cooperation is necessary for achieving the goals of the green transition and, to a slightly lesser degree, of the digital transition. Similarly, the twin transitions will be influenced by global developments. As examined in the context of the European Union's open strategic autonomy, there are many factors to consider, for example dependence on raw materials The twin transitions are an opportunity to diversify and strengthen Europe's energy sources, and to build a higher capacity and independence in data storage and processing in Europe. The aspect of energy independence plays a particularly important role when considering Russia's military aggression, which has provided yet another reason to accelerate the phase-out of fossil fuels. Moving forward it will be equally important to build and maintain resilient critical infrastructure, including digital infrastructure.

-The digital economy is crucial for the competitiveness of the European Union and can help to drive the green economy**.** There is a strong political commitment to deliver on Europe's 'digital decade' by harnessing the full potential of the digital transition. However, new policies will be required to steer this process and align it with the goals of the green transition. A thriving digital economy is instrumental not only for the competitiveness of the European Union, but also for the green transition. Digital technologies can be an enabler for the transition towards a green economy, which is sustainable, fair, and inclusive. It is essential to keep building on the global momentum and rethinking policies for a digital and green economy.

The digital technology landscape has been rapidly evolving over the past three decades. The main drivers of the digital transformation are companies, particularly in the computing and internet. The evolution of digital technologies is driven on one the hand by a technology push to improve the performance of electronics and on the other hand by the demand from users for digital technologies.

Emerging digital technologies have a lot of future potential for the green transition**.** Looking towards 2050, DNA-based digital data storage offers the possibility of storing data much more efficiently, with information densities ten million times higher than the storage options available today. For the green transition, this efficiency coupled with lower cooling requirements of DNA-based data storage results in a much lower energy consumption. Quantum computing and novel approaches to computing promise computing power far beyond the capabilities of current computers. This leap in computational power opens up new possibilities and could allow for the optimization of many current practices. It can, for example, compute and simulate molecular behavior to find viable options to create next generation batteries or more efficient processes to produce nitrogen-based fertilizers, which are needed for the agriculture sector. Quantum computing can provide simulations of large complex molecules, which could, for example, lead to discoveries of new and more efficient catalysts for carbon capture. The twin transitions can also help European Union Member States to meet their commitments to develop climate resilient and low carbon health systems.

Solutions and innovations may lie in the combination of digital technologies**.** Digital technologies are not independent of one another, there are several connections and interdependencies between them. In fact, the combination of different digital technologies and tools could in itself be an impactful innovation for greening. The Internet of Things is an example of the combination of several different digital technologies with breakthrough potential. Here, devices, sensors, and wearables have been adapted following the mass usage of smartphones and other devices that are now used as a gateway to connect to the internet. This change is fueling the uptake of Internet of Things connected devices, which is projected to exceed 75 billion already by 2025. The Internet of Things thus relies on smartphones, geolocation technology, and constant and secure internet connectivity. It is therefore important to look not only at emerging digital technologies, but also at new combinations and applications of the existing digital technologies available to us already today.

Contextual factors such as regulation, trust, and behavior can determine the future of digital technologies. Policies, legislation, and regulations are being put in place to ensure data protection, and digital platforms are receiving more oversight from governments in many countries. Data sharing and analysis can be enabled by standards for data collection and processing. Such political measures are needed to help build a digital landscape that society can trust and that reflects their fundamental values. Secure data governance is also vital to prevent cybercrime and cyberattacks. Social factors also need to be considered to assess the future paths of digital technologies A similar hesitation can exist for businesses, where a lack of knowledge can often mean that the benefits of digital solutions are not understood. Relevant geopolitical factors include the stability of global supply chains, and access to the components and materials needed to build digital technology and infrastructure.

Digital technologies have to be adapted to be useful in a variety of different circumstances. The potential contribution of digital technologies to the green transition depends on the context and the maturity of the technology. For example, providing assistance for improving digital literacy and support with digital tools available at the community level would facilitate a better use of digital technologies across society.

Digital technologies provide functions that can catalyze the green transition. To understand in practical terms which roles digital technologies could play to facilitate the green transition, The focus here is on the basic capabilities with which digital technologies could support or speed up the green transition.

The overview is non-exhaustive, given the ongoing rapid development of digital technologies. There are synergies, overlaps, and combinations of capabilities between the different functions. As an example, cybersecurity and the reliability of the digital systems is fundamental to all of these functionalities.

An innovative benchmarking exercise was elaborated in 2022 by the Lisbon Council, a non profit organization founded in 2003, involving in this analysis all the 27 EU Member States. The Green Digital and Competitive SMEs Index is based on 9 indicators divided in three pillars (green, digital and competitiveness) and made up of 21 sub indicators[12].
The Romania's fiche is presented in the **Annex 6.**

6.2 Innovative services for SMEs in clusters and Digital Innovation Hubs

Clusters are interested in participation at the activities of the project "Innovative services for twin transition in SMEs and clusters" and they specified the services already offered

[12] (European Commission, Digital Economy and Society Index 2022, 2022)

by CLUSTERO in which SMEs also participated such as brokerage events, conferences of clusters, workshops and seminars, training sessions, B2B events with foreign companies, partnerships with local partners, capacity building webinars for SMEs, clusters meet regions events, creating a supportive ecosystem for SMEs by including them in Digital Innovation Hubs, promotion of best practices and success stories in newsletters, shared platforms for discussions, green transition support, C2labs etc.

Clusters and SMEs are members of Regional Digital Innovation Hubs. The list of the Romanian Digital Innovation Hubs is presented as follows:

Nr crt	Digital Innovation Hubs	Regional Development Agency
1	ANAMOB	București-Ilfov
2	CiTyInnoHUB	South-East
3	CyberSecurityHub CSH	București-Ilfov
4	Danube DIH	South-East
5	Digital Innovation Hub South East Romania	South-East
6	Digital Innovation Zone	North-East
7	DIGIVEST	West
8	DIH LAB4COM	Central Region
9	FIT – DIGITAL INNOVATION HUB	Central Region
10	Green DIH	București-Ilfov
11	DIH4Society	North-West

12	HUB Digital Innovativ OLTENIA	South-West Oltenia
13	RENEW DIGITAL INOVATION HUB	North-East
14	Ro Tech Nation DIH	București-Ilfov
15	SMART eHUB (Digital Innovation SMART eHUB)	București-Ilfov
16	Technology Enabled Construction	București-Ilfov
17	Transilvania Digital Innovation HUB	North-West
18	Wallachia HUB	South Muntenia

The eDIHs are the following: DIH4Society; Transilvania Digital innovation Hub; FIT EDIH; Wallachia Hub; CiTyInnoHub; eDIH-DIZ and DIGIVEST.

Digital Innovation Hubs offer to SMEs members or non-members of clusters some guidelines on how they could overcome challenges for adopting and implementing new digital solutions as follows:

Digital Maturity Assessment

A digital maturity assessment involves evaluating initial the current state of a company's digital infrastructure, identifying areas for improvement. This is an important first step to identify the actual needs of the company and the adequate technology to resolve the challenges. It is important to highlight that this assessment also helps to make a first self-reflection on the level of maturity, since there are different dimensions and degrees of maturity, and the SME can see where they are and where they could be.

Moreover, they serve as a benchmark for measuring progress and inform strategic planning, aiding SMEs in aligning digital initiatives with overall business strategy. In essence, digital maturity assessments provide a structured, data-driven approach to assess, plan, and execute digital transformation initiatives, ultimately helping SMEs stay competitive and thrive in the digital age.

In summary, a digital maturity assessment not only helps SMEs understand where they stand in their digital journey but also empowers them to make informed decisions, manage risks, allocate resources efficiently, and align digital strategies with overall business objectives. This comprehensive understanding is essential for the success and sustainability of digital transformation efforts in a rapidly evolving digital landscape.

Developing of a roadmap

The technology adoption roadmap is the result of an in-depth interview of one (or more) technology experts with an SME.

During this stage, all aspects of the company's operation are discussed: management, production, quality, maintenance, etc. Also, aspects of sustainability and human centricity. The SMEs representative details their needs, strategy, and vision regarding digitalization. During the conversation the technology expert asks targeted questions to get a detailed view on the processes or systems that can be optimized by introducing digital technology. The technology adoption roadmap starts from the current maturity level of the SME and summarizes their vision towards digitalization.

The technology expert describes the actions that are needed to uplift the digital maturity of the company, while considering their specific needs. The suggested actions are prioritized to indicate which steps are crucial to complete before continuing with other actions, or which actions are optional. Where applicable, the roadmap includes a step-by-step plan for solving a specific problem of the SME, including specific goals, milestones, and metrics for measuring progress and success. The roadmap helps SMEs to prioritize their implementation steps and ensures that they have a clear understanding of the necessary tasks, timelines, and resources required for successful implementation. For every suggested action, technology providers or existing technology solutions are proposed, always suggesting local providers where possible.

The roadmap is providing the main essential elements as Current state assessment; Needs and vision articulation; Identification of optimization opportunities; Action plan development; Problem-Solving solutions; Technology recommendations; Resource allocation; Continuous improvement; Alignment with business strategy is a vital tool that provides SMEs with a structured plan for embracing digitalization. It combines a thorough assessment of the current state, clear objectives, and actionable steps to help SMEs prioritize their digital transformation efforts, implement technology solutions effectively, and achieve measurable success in their journey toward becoming more competitive and sustainable in the digital age.

Collaboration with trustworthy partners

An initial external investigation of which technologies are necessary in the company workflow should be conducted and it is crucial for the sustainable development of SMEs. This assessment will have an impact on productivity, efficiency, competitiveness and sustainability in the market in the short and long term. It is advisable to collaborate with knowledgeable technology partners, eco-systems participants, business associations and partners of clusters and ask for assistance and recommendations.

Also, in an era of increasing and fast-paced digitalization, staying informed about technological innovations is a key driver for improving production processes, enhancing working conditions, and conserving resources over the medium- and long-term. Keeping abreast of the latest technological advancements allows businesses to adopt more efficient and sustainable practices, leading to increased productivity, cost savings, and a healthier work environment. This proactive approach not only helps companies remain competitive in a rapidly evolving landscape, but also positions them to contribute positively to sustainability and innovation-driven growth.

Setting up an action plan

An action plan means turning knowledge into action, with a plan outlining action needed to reach one or more goals and having answers for the following questions: Why, What, How, Where, Who, When? An action plan will encompass the following components:

Feasibility study:

It is recommended before starting to develop an action plan in order to determine a company's need and what kind of new technologies and/or solutions need to be implemented/executed.

Creating a detailed project plan:

Identifying responsible department/employee: define roles of employee and others involved.

Setting ng of goals and objectives: what company is expecting to achieve, what aspects can be greatly improved, prioritize tasks.

Resources needed planning:

Identification of the funding and resources required to implement the project. This may involve securing budgetary approval, allocating staff and equipment resources, and identifying external partners or contractors if needed.

Setting up a completion date:

Establish deadlines and milestones.

Developing a risk management plan:

Identify potential risks associated with new project and develop a risk management plan to mitigate them. This may involve addressing potential technical challenges, management issues, resistance from employees and ensuring regulatory compliance.

Analysing the local ecosystem.

Summarizing the responses to the questionnaire send to clusters members of CLUSTERO and SMEs ***(see ANNEX no.5) ,*** a number of key needs for a successful green and digital transition were identified by the Romanian clusters and SMEs:

a.The portfolio of service provision for twin tansition to various types of firms differs from region to region depending on the characteristics of the economical structure of the region and the potential for innovation and technology based growth. Designing a package of SME policies should be based on a rigorous analysis of the strengths and weaknesses of the region and fine tuned to the specific economic and sector structure.

b.In the longer term the present business support network, which is formed by a mix of national and regional organizations, would need a more serious streamlining. There should be a clearly branded and limited number of publicly funded support organizations which can provide a set of support schemes to all targets groups (e.g. established businesses, high-tech, micro-firms, start-ups) which cannot be provided by private sector organizations. While there is a need for nationally set quality standards and performance criteria, on the regional level there should be sufficient room for man -oeuvre to adapt the package of support and information services to the local needs.

c.There is an urgent need for joint capability building in the design, implementation and evaluation of SMEs and entrepreneurship policies. The national and regional authorities could play a vital role in supporting the regional development organizations with training, coaching and exchange of experience. The regional authorities should be open to exchange their experiences with the other regions and national agencies on reskilling and upskilling of the labour force to fully exploit the potential of digital and green technologies.

d. The dialogue between regions and national authorities on financing the twin transition of SMEs and clusters should be organized more systematically. First promising steps in that direction have been taken by the Ministry of Economy, Entrepreneurship and Tourism mostly on a bilateral basis. Rather than having discussions in terms of demarcation lines, a culture of partnership needs to be built up between the regional and national authorities. This will need time to build up. The implementation of cluster policies could be a good case to start with as this policy area does not have strong legacies in either the regions or national policy domains.

e. There is a need to make entrepreneurship development more explicitly central to the economic development policy agenda at the national and regional levels. At the national level, an explicit entrepreneurship strategy document would contribute to a higher profile, as well as guiding the various actors involved in implementing policy in this field. At the regional level, the production of entrepreneurship strategies would complement the existing regional development strategies and RIS. There is an associated need for capacity building, particularly at the regional level where entrepreneurship development is not always seen as a high political priority and there is often a lack of experienced staff in what is still an emerging policy field. These issues could be addressed through a nationally coordinated capacity building program, which includes leadership workshops, as well as professional training programs in the economic development field.

f. There is a need to improve the effectiveness of the mechanisms for coordinating national and regional level economic development policies. At the same time, for co-ordination to be effective, there is a need to clarify the respective roles of national and regional level governments in economic development. Unfortunately, the current arrangements appear to involve an unclear division of responsibilities, a lack of co-ordination of policies, beyond an administrative level (e.g. budget ceilings for policy measures) and limited co-operation.

g. There is a need to integrate the publicly funded business services systems, including those funded from both national and regional sources. Fragmentation of business support contributes to entrepreneurs being uncertain about where to go to access specific types of business services. This process would be helped considerably if there were joint branding of nationally and regionally funded business support services, as part of a move towards increased integration. It is important that the system appears coherent to business users as well as service providers.

h. The need intelligently to use the current EU funding programming period to build policy design and delivery capacity for entrepreneurship and SMEs for the period 2021-2027 at both the national and regional levels. While they present particular operational and implementation challenges, the current levels of funding are unprecedented and provide a unique but relatively short time period in which to gear up the national and regional level administrations for longer term regional development challenges.

i.The central role of the new regional policy principles currently under development to address the issues of regional-national co-ordination and division of policy design and delivery responsibility, horizontal co-ordination at the regional level and regional differentiation to meet regional needs.

j. Romanian SMEs and clusters need digital solutions for supply chain development as well as of investment in production equipment and digital managemet tools.

k.SMEs and clusters need the exchange of best practices on green and digital transition, of inter-sector consultations and of access to new markets.

Clusters and SMEs are supported by CLUSTERO to increase their knowledge about various topics in fields such as digital and green transition, business models, eco-innovation, circular economy, internationalization, Corporate Social Responsibility (CSR) through exchange of best practices with Norwegian partners and training sessions carried out within the project.

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6.3 Role of CLUSTERO in supporting the twin transition of SMEs members of clusters

After analyzing the documents on clustering process in Romania, the results of the questionnaires and of the interviews with the cluster managers on twin transition of SMEs and clusters, the project team obtained the following main conclusions on the **SWOT analysis of clusters and SMEs members engaged in the twin transition process:**

Strengths	Weaknesses
Creation by the National Cluster Association-CLUSTERO of a national acreditation system based on specific criteria that helps to identify clusters of excellence and SMEs with innovation potential.	Lack of a document on green and digital transition of SMEs in Romania and of a related Action Plan. CLUSTERO elaborated in 2024 an analysis on clusters including twin transition aspects.
The annual organization of National Cluster Conferences with European participation where specific issues are discussed inclusively green and digital transition.	Lack of an integrated and unitary approach of clusters (industrial and non-industrial) at the central public administration level.
Support for integrating clusters and SMEs in the regional innovation ecosystems and digital innovation hubs.	A poor promotion of clusters and SMEs (i.e.of bioinnovators) in media, at national and international fairs and economic missions; lack of promotional materials.
A National Cluster Association - CLUSTERO with European and international recognition and with an active involvement in promotion and internationalization of clusters and SMEs .	Lack of experience of SME management on specific issues-green and digital transition (i.e. training and coaching and foreign languages sessions are required).

Stimulation of regional and national economic development; inter-cluster and inter-SMEs competition at regional level.	A reduced number of SME members of clusters and with a reduced innovation capacity.
Existence of regional consortia and sectoral networks.	Lack of knowledge and experience, of best practices on green and digital transition at SMEs
Involvement of clusters and SMEs members in European projects (Interreg, Horizon Europe, Digital Europe, COSME etc) and with public financing inclusively in green economy and digitalization.	Lack of a coherent approach of cooperation with other business infrastructures (incubators, industrial parks, smart cities, local action groups etc).
Promotion of clusters with an industrial brand with a long tradition and by developing a market image.	Size of SMEs, majority small
Existence of some clusters with experience in implementing circular economy in various sectors (textiles, furniture etc).	A poor collaboration research and industry in many cases lack of trust between partners
Making exchanges of good practices between Romanian clusters and European ones.	Existence of some clusters without business model, a development strategy with a separate chapter on green and digital transition, projects.
Existence of a cluster policy as component of industrial policy (in elaboration).	Lack of digitalization at many SMEs
CLUSTERO is founder member of European Cluster Alliance-ECA and other European networks.	A reduced protection of intelectual property rights in clusters and SMEs.

SMEs members of clusters are more flexible and reactive but still vulnerable (political, financial, and environmental shocks).	Difficult conditions of accessing European funds by SMEs.
Strategic orientation of SME members of clusters to exports with availability to new niche markets.	Lack of skilling to transition 4.0
A huge potential of development on horizontal in various fields (waste management, creative sectors, green economy etc)	Administrative burden and excessive requirements for SMEs
A huge visibility of clusters within European Commission and networks of clusters.	A reduced involvement of the local public administration in supporting cluster infrastructure.
SMEs members of clusters offer a large variety of green and digital products and services.	Limited capability to adapt (family owned, funding, human resources etc).
Opportunities	**Threats**
Encouraging the development of new economic sectors (creative sectors, touristic industry, renewable energies, platics, bioeconomy, healthcare etc).	Unprofitable management of funds by the cluster and SME management.
Exchange of best practices and experience with clusters from Asia, Africa, America.	Problems on collaboration with banks for co-financing projects.
Easier labor recruitment and specialization of cluster members.	Lack of collaboration and trust between members of clusters.
Information in CLUSTERO newsletter, EEN etc on financing schemes for clusters	Barriers or restrictions imposed to SMEs by the local public administration.

and SMEs at national and European levels.	
Strengthening the relationships with cluster managers from Diaspora (i.e Bianca Dragomir from Renewable Energies Cluster-Valencia Spain).	Lack of important documents for clusters and SMEs (strategies, partnership agreement etc).
Participation in the European Cluster Conferences and attracting SMEs into global value chains.	Lack of coherent national and regional strategies on green and digital transition.
Participation in consortia for European projects (Interreg, COSME, Horizon Europe, Digital Europe etc).	Few schemes to support innovation in SMEs; bureaucracy and corruption reported at accesing funds.
Participation at the joint activities within European Cluster Collaboration Platform such as Clusters meet regions, Cluster talks, Green Transition Support, C2 labs or matchmaking events.	Lack of transparency and excessive bureaucracy at accesing national funds (IMM Invest program; Start Up Nation etc).
High potential of some sub-sectors of green and digital transition.	Lack of trust in innovative solutions of SMEs in the fiels of green and digital transition.

Clusters members of CLUSTERO that are labelled by ESCA and have **good practices in twin transition** activate in five economic sectors: agriculture and food industry; constructions; renewable energy; textiles; wood &furniture, and the digital technologies support them to become more environmentally friendly.

Economic sector: Agriculture and food industry

The agriculture sector plays a crucial role in food production and power generation. Agriculture in Romania has a value of 5% of the Gross Domestic Product and employs 30% of the employed active population. Romania has an agricultural area of 14,8 million hectares of which only ten million are occupied by arable land. Land is a carbon sink, absorbing more carbon from the atmosphere than it releases. This is why sustainable agriculture and food systems are key to the objectives of the European Green Deal. The agriculture sector and the production, use, processing, and distribution of biological resources generates 4.7 % of the GDP in the European Union and employs approximately 8 % of its workforce.

The agriculture sector provides products for which there are no alternatives, such as food, feed and ecosystem services. Agriculture is also a source of biomass that is used for power generation. To contribute to the green transition, biomass resources (i.e. organic material that can be used as fuel for transport, or to produce heat or electricity) should be sourced sustainably.

Agriculture will have to adapt to become more resilient. Sustainable farming techniques could improve resilience and at the same time reduce chemical inputs and greenhouse gas emissions. Digital sensors and Internet of Things applications can help to monitor the condition and health of agricultural land or biodiversity in natural landscapes. Another option to improve resilience is to use gene editing and design to develop hardier and more productive crop varieties. Furthermore, modern agriculture technologies enable improved crop, water, and livestock management.

Trust in digital tools and the protection of private data are central factors. The main economic requirements include: value chain profitability; the uptake and expansion of collaborative business models; and the logistics of supply of goods and services. Digital skills and knowledge about the available and upcoming green-digital solutions are key requirements for farers to be successful. Many aspects of agricultural activity require an adequate digital infrastructure for rolling out green-digital solutions. Data ownership should be ensured, together with secure platforms that can help stakeholders to use data efficiently. Protocols and procedures for circularity are likely to be essential requirements.

Standards for data interoperability can help to increase data availability and reliability. Sensors and the Internet of Things will need to be energy efficient, durable, and non-hazardous.

Fisheries and aquaculture need to reduce their carbon emissions, avoid emitting pollutants and diseases, and reduce their impact on biodiversity. Water recirculation systems and growing multiple species at the same time (integrated multitrophic aquaculture) could achieve that by re-using byproducts and waste.

Forests are carbon sinks, but they also need to adapt to climate change to remain healthy. The diversification of forests and the introduction of climate resistant trees is important to ensure the long-term viability of forests. Furthermore, precision forestry and robotics allow for monitoring and managing the health of forests, even in remote areas.

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Bio-based industry enables the replacement of fossil resources with renewable ones, for example when producing plastics, essential oils, glues, or soaps. Second generation bioconversion processes use biomass that cannot be used for food and feed and are not in conflict with food security. Lastly, ‘pyrolysis’ from woody residues is a process that yields biochar, which stores carbon while improving soil fertility.

Food processing and supply chain management could make a substantial contribution to reducing greenhouse gas emissions in the sector by switching from animal to alternative proteins. Such a switch also requires a fundamental behavioral change in terms of eating habits. A potential solution for alternative protein production is precision fermentation. Furthermore, avoiding food waste.

The clusters Agro Transylvania and INDAGRO POL labelled with gold and silver by ESCA supported their SMEs members **to implement smart sustainable farming** that means the uptake of practices already known in the context of Industry 4.0 in farm management.

t is it about?

It covers the potential of automation and digitalization of farming processes and their supply and value chain relations. The goal of smart sustainable farming is to achieve enhanced sustainable development, more resilience, and increased resource efficiency. Beyond agriculture farms, the principles also apply to forestry (**Pro Wood cluster** labelled with gold) and aquaculture (**Agrofood Covasna** cluster labelled with silver) practices.

- What is the role of digital technologies?

Digital technologies enable optimization in the agriculture sector. Digitalization has been a driver for the modernization of the agriculture sector for many years. There are different ways digitalization contributes to precision agriculture. These include monitoring the health of plants or livestock, data analysis to propose actions to improve farm processes, and managing autonomous devices (i.e. robotic arms, switches, valves, or sprayers). Drones can also spray pesticides, or be used to control land and livestock. Digitalization further contributes to communication and management of the agri-food supply chain and enables traceability and transparency of products.

- What is the advantage?

Digital agriculture has the potential to change farming practices, but also to transform the agri-food value chain. The Internet of Things can integrate data from farms with other sources and thereby enable a shift to smart farming. Situational data of plant, livestock, and soil status, combined with weather forecasts and further environmental monitoring data, can provide decision-making support to the farmer. Such guidance can be given through data visualization, recommendations, and user interaction. Digital technologies make it possible to deploy autonomous vehicles (e.g. tractors, robots, or drones) and other autonomous systems, such as irrigation systems. W

hat re the challenges?

The transformative potential of digital technologies comes with a variety of challenges. Digitalization in agriculture has been developed for standardized processes in highly mechanized large-scale farms. To support more diversified farming processes and farm businesses, digital systems must advance in order to enable automation and optimization in a rather diverse natural environment Connectivity in remote rural areas (i.e. fast mobile internet) might be challenging and requires new solutions to close digital infrastructure gaps. Digital components need to be biodegradable, or should at least not harm the environment if they get lost (i.e. sensors in soil, or on livestock). It is likely that not all farmers will be able to afford the investments in digital solutions. ‘Farming-as-a-Service’ could be a solution for this challenge, but it comes with issues of data ownership and reluctance to share data. Lastly, there is a need to upskill farmers, which could pose a challenge, in particular for small family farms.

Digital technologies can help farms to become green and sell sustainable products**.** A good practice example is **Agrofood Covasna cluster** (labelled with silver) **and the bio-innovators in the Covasna county.** Conventional farming is characterized by high specialization, high intensity, and simplification of operations. Smart farming and precision farming can nevertheless optimize the use of energy-intensive agrochemicals such as fertilizers. Implementing smart technologies in sustainable farming.

Economic sector: constructions[13]

Housing and office buildings make up most of the floor area in the European Union and are therefore key to the green transition. The focus of this section is therefore on housing and office buildings, which represent 75 % of total building floor area in Europe. Residential and commercial activities account for 12 % of greenhouse gas emissions in the European Union. Buildings have long life times and in Europe 85 to 95% of the existing buildings are expected to still be standing in 2050. Circularity in the buildings and construction sector is an important aspect that includes renovation, retrofitting, and demolition of buildings. A key area for the green transition is the volume and space needs for future buildings. Furthermore, the design, construction, and end-of-life phases are

[13] (European Construction Sector Observatory, 2021)

important. Lastly, the daily operation of buildings influences the environmental impacts via their heating, ventilation, and use of building-related appliances.

Digitalization provides several options to enable the green transition in the construction sector. The first and most obvious is through efficiency improvements in *systems management* such as more efficient building operations and construction processes. A second is through *monitoring and tracking* regarding the environmental impact of materials, including life cycle analysis and options for reducing environmental impacts through various actions (e.g. installing solar panels on roofs). A third is that *information and communication* technologies can support a more intense use of existing buildings (e.g. by supporting sharing of office space that would otherwise have remained empty), thus reducing the need for new constructions. A fourth is when digitalization replaces space needs entirely through *virtualization* (e.g. online banking and shopping make spaces for customers obsolete).

Low-carbon and resilient construction are important drivers for greening in new buildings. Green architecture, engineering, and construction require information on the embodied grey energy in buildings (i.e. the energy associated with production). They need to consider several characteristics of the materials and components used, such as their energy efficiency performance, potential for repair, and end-of-life treatment. Building design and construction methods need to integrate resilience to possible extreme events to avoid premature decay or loss of functionality. Digital tools can help to address this in the design phase. For example, building information modelling can analyse long-term consequences of design choices and can help to decrease environmental impact in both the construction and use phases.

Retrofitting will be key to making existing buildings greener. Keeping as many structural elements as possible means retaining the grey energy embodied in building material. Thermal and acoustic insulation and air tightness of the building envelope are crucial for deep renovations. Introducing new and efficient space heating and cooling systems with smart technologies for building automation and control systems is another key element. Digital tools like digital building logbooks can ease renovation, retrofitting, and recyclability of materials from old buildings.

Reduced energy use during operation can provide a stabilizing function to the overall energy system. Heating, cooling, ventilation, and lighting systems can be adaptively managed to reduce energy consumption while maintaining the same level of comfort for inhabitants. Building automation and control systems are based on sensors that recognize the building's users and their requirements, and help to actively manage energy-consuming appliances.

Low-carbon heating and cooling reduces emissions and pollution during the use phase of a building. Electrification (e.g. using heat pumps instead of oil or gas heating) is key for sustainable heating. In addition, building-added or -integrated solar PV is a renewable electricity source with high potential for the future.

Reduced demand for building space decreases environmental impacts from constructing and operating buildings. Options to cut building space include reducing the need for space use and increasing the usage intensity in existing buildings. Digital platforms can enable smoother sharing of space. Lastly, tiny houses and micro apartments also provide options for reduced need for space.

Cluster TEC- „Technology enabled construction" (labelled with bronze) **and PRO nZEB Cluster** (labelled with bronze**) from Bucharest Ilfov region** have the mission focused on increasing competitiveness and market share of the cluster's members through products, services and technologies quality growth, through strengthening the cooperation relationships within the members of the cluster, by training staff and adopting innovative techniques for design and execution by implementing research-development activities and by joint promotion of the offer.

Labeling with bronze appeared as a necessity because in the case of construction sector, that represent 4% of Romania's GDP, the idea of interconnecting the existing processes, materialized through the buiding information modelling technology (Building Information Modelling-BIM), a digital tool that optimizes the planning processes, design, construction and admi nistration of the construction and which appeared and developed following the needs identified in the interdisciplinary area.

The cluster TEC is the initiator of the Digital Innovation Hub -DIH Technology Enabled Construction Building Smartly Smart Communities where the targets are mainly SMEs in the construction industry but also the public authorities. The hub has as its main objective the digitalization of the construction industry along the entire value chain, from the production of materials, to the design, execution and exploitation of the objectives. The Hub also aims to increase the level of information and understanding regarding the concept of smart communities, so that the whole chain can generate innovation that will lead to the verification of this concept in Romanian communities. Increasing the level of digitization on the entire chain and an integrative approach on the chain would lead directly to increasing the efficiency of the industry in terms of all the resources involved (human, financial and time).

Good practice of TEC cluster: Reduced demand for space

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Reducing the need for indoor building space cuts down on the environmental impacts from constructing and operating buildings. There are two strategies to reduce the demand for space: either by increasing the intensity of building use, or by reducing the need for space for a particular activity. Existing examples of the first are co-working spaces, desk sharing in offices, or renting of private holiday homes. Examples of the latter are sharing of living and working space, tiny houses, or micro apartments. Another option is the virtualization of shop floors through online services like online banking or online retail. The predictability of the activities in a space determines how complex the organization of sharing the space will be.

What is the role of digital technologies?

Digital technology can help to reduce the demand for space. Sharing platforms and smart digital solutions such as integrated workspace management systems, place and desk booking, or digital concierge services are key enablers for the sharing of spaces. Internet of Things applications, like sensors in buildings, can provide a real-time understanding of the use of the building space. It also allows last minute flexible room or space booking alongside modelling, simulation, and forecasting of the occupancy of particular spaces. Digital technologies, like universal connectivity and wearable digital devices, also enable mobile working and make office and living space more flexible. Digitalization of retail and service provision is currently fundamentally changing the form and function of physical stores and reducing the demand for retail space.

What is the advantage?

Digital tools reduce the organizational burden of sharing spaces. They simplify booking processes, enable just-in-time booking, provide transparency of supply and demand, and offer a matchmaking service between parties to meet the mutual requirements. Artificial Intelligence and machine learning could improve predictive capacities and resource planning. If it is rolled out successfully, reducing the need for building space will also reduce the overall need for new constructions and significantly change the operation of all buildings and their related costs.

What are the challenges?

Reducing the amount of space we live and work in would be a radical change in many people's lifestyles and habits. The current trend in residential buildings shows a clear increase of per-capita floor area over in recent decades in Europe. Security and reliability are key concerns in both residential and office spaces when external users are sharing the building or parts of it. People's concerns about having private spaces and the security of the shared buildings need to be considered, such as the safety of valuables. The adaptability of buildings and their ability to meet different demands of users and changing demands of residents is also a special challenge. Rebound effects need to be carefully considered in this area, in order to avoid that space reduction in one place leads to expansion or increased use of other built spaces.

The reduction of building space demand has a positive environmental effect. A reduction in building space could contribute towards a large reduction of CO2-emissions in Europe via two levers. Reduced use of space avoids the need for new constructions and the related environmental costs and impacts on resources. On average, avoiding the construction of a new building can save about 2 MWh per square metre. The energy needed to operate buildings, such as heating, cooling, and lighting, would also be reduced at the annual amount of 250 kWh per square meter for non-residential buildings, and 180 kWh per square meter for residential buildings. Further environmental benefits include reduced mobility needs due to teleworking. Shared workplace equipment and shared household appliances, which are used more intensively and need central care to guarantee their functionality, supports circular economy principles.

The construction business is shifting from new constructions to the management of existing buildings spaces. Facility management needs are growing for building management and building security. Tenants might have higher, specific expectations towards extended services, while requiring adaptability of spaces. The construction sector will shift from new construction business to renovation and creating modular, multi-functional spaces and to care for early wear and tear from intensive use. The furniture industry will grow in the segments of equipment for multifunctional convertible use of rooms, lockers, mobile solutions, and digital walls. Property owners can increase their revenues by renting the space to different users around the clock. New business opportunities will emerge to manage matchmaking, sharing, contracting, or providing security.

The optimized use of building spaces could increase affordability and social contacts. Increasing the efficiency of space use will reduce the costs for the individual users, which could drive affordability of housing and workplaces. Shared spaces also reduce the individual investment needs for shared user equipment. Spaces will become more flexible and will be tailored to the specific needs of users, even if these needs change over time. Lastly, co-working spaces and the sharing of office and living spaces and common areas could bring people closer together.

Enabling factors highlight important aspects to facilitate successful transition in constructions

A key social requirement is that energy poverty and affordable housing need to be addressed to ensure fairness and public support. Social acceptance of technologies, for example of Internet of Things-based smart solutions and data sharing, is critical for the uptake of solutions for efficiency and space optimization. Avoiding rebound effects from optimized space use, or energy efficiency gains in households, is needed to ensure these do not lead to increased consumption in other areas. Digital services and digital signing of contracts related to the supply of goods and services need to be mainstreamed. To enable these services, data sharing needs to be secured and trusted by all stakeholders.

Coherent standards are needed to boost the implementation of digital building logbooks. Regulatory frameworks and a common set of rules for the sector could play an important role, for example for circularity, or for combining building regulations with urban planning and district level solutions. Adequate financing could push the sector towards green-digital solutions, and could also ensure that there are affordable solutions available, including in rural or less-developed areas. Digital skills need to be strengthened in the construction sector to enable digital solutions. Skills and training are needed to realize renovation and retrofitting.

Economic sector: Textiles

The European Commission is proposing rules to make producers responsible for the full lifecycle of textile products and to support the sustainable management of textile waste across the EU. This initiative will accelerate the development of the separate collection, sorting, reuse and recycling sector for textiles in the EU, in line with the EU Strategy for Sustainable and Circular Textiles. Increasing the availability of used textiles is expected to create local jobs and save money for consumers in the EU and beyond, while alleviating the impacts of textile production on natural resources.

The Commission is proposing to introduce mandatory and harmonised Extended Producer Responsibility (EPR) schemes for textiles in all EU Member States. EPR schemes have been successful in improving the management of waste from several products, such as packaging, batteries and electric and electronic equipment. Producers will cover the costs of management of textile waste, which will also give them incentives to reduce waste and increase the circularity of textile products – designing better products from the start. How much producers will pay to the EPR scheme will be adjusted based on the environmental performance of textiles, a principle known as 'eco-modulation'.

Common EU extended producer responsibility rules will also make it easier for Member States to implement the requirement to collect textiles separately from 2025, in line with current legislation. The producers' contributions will finance investments into separate collection, sorting, re-use and recycling capacities. The proposed rules on waste management aim to ensure that used textiles are sorted for reuse, and what cannot be reused is directed to recycling as a priority. Social enterprises active in the collection and treatment of textiles will benefit from increased business opportunities and a bigger market for second-hand textiles.

Today's proposal will also promote research and development into innovative technologies for the circularity of the textiles sector, such as fibre-to-fibre recycling.The proposal also addresses the issue of illegal exports of textile waste to countries illequipped to manage it. The new law would clarify what constitutes waste and what is considered reusable textiles, to stop the practice of exports of waste disguised as being done for reuse. This will complement measures under the proposal for a new Regulation on waste shipments that will ensure that shipments of textile waste only take place when there are guarantees that the waste is managed in an environmentally sound manner.

The EU generates 12.6 million tonnes of textile waste per year. Clothing and footwear alone accounts for 5.2 million tonnes of waste, equivalent to 12 kg of waste per person every year. Currently, only 22% of post-consumer textile waste is collected separately for re-use or recycling, while the remainder is often incinerated or landfilled. The Waste Framework Directive is the EU's legal framework for waste management in the EU. It sets the definitions related to waste management, including definitions of waste, recycling and recovery, the waste hierarchy and basic concepts. Today's initiative delivers on the Commission's commitment made in the EU Strategy for Sustainable and Circular Textiles to propose measures to harmonise Extended Producer Responsibility rules for textiles, and to develop economic incentives to make textile products more sustainable and circular.

In Romania, the textile and clothing industry has a long tradition with enterprises operating for over 100 years. In 2020, the number of enterprises in the textile manaufacturing industry in Romania reached a peak with 1738 enterprises and 148.000 employees. The turnover of the textile manufacturing industry was at around 1506,9 million euros in 2020. The four clusters labelled with silver and bronze operating in Romania formed the NOATEX national network of clusters (ASTRICO Nord Est; Romanian Textile Concept; Transylvania Textile and Fashion and Traditions, Manufacturing, Future).

The cluster Transylvania Textile and Fashion (labelled with silver) Covasna county from the Central region of Romania is focusing on respecting the fundamentals of the circular economy as well as of the Sustainable Development Goals Agenda 2030. SMEs members of cluster are involved in developing innovative and creative solutions in order to provide possibility for introducing the textile waste in the value chain thereby extending the time interval that a textile product is used. Clusters of NOATEX network have three key focus as follows:

Key focus 1-awareness raising circular economy (consumption patterns and the way we are thinking about clothing-Re-fashion starts in schools);
Key focus 2-smart textiles for the HORECA industry (new products from industrial textile waste) (redesign and reuse of existing items-clothing, carpets);
Key focus 3-new products made from recycled materials (new yarn-infinity made from the recycled fibre REGEL);
Key focus 4- cross sectoral collaboration.

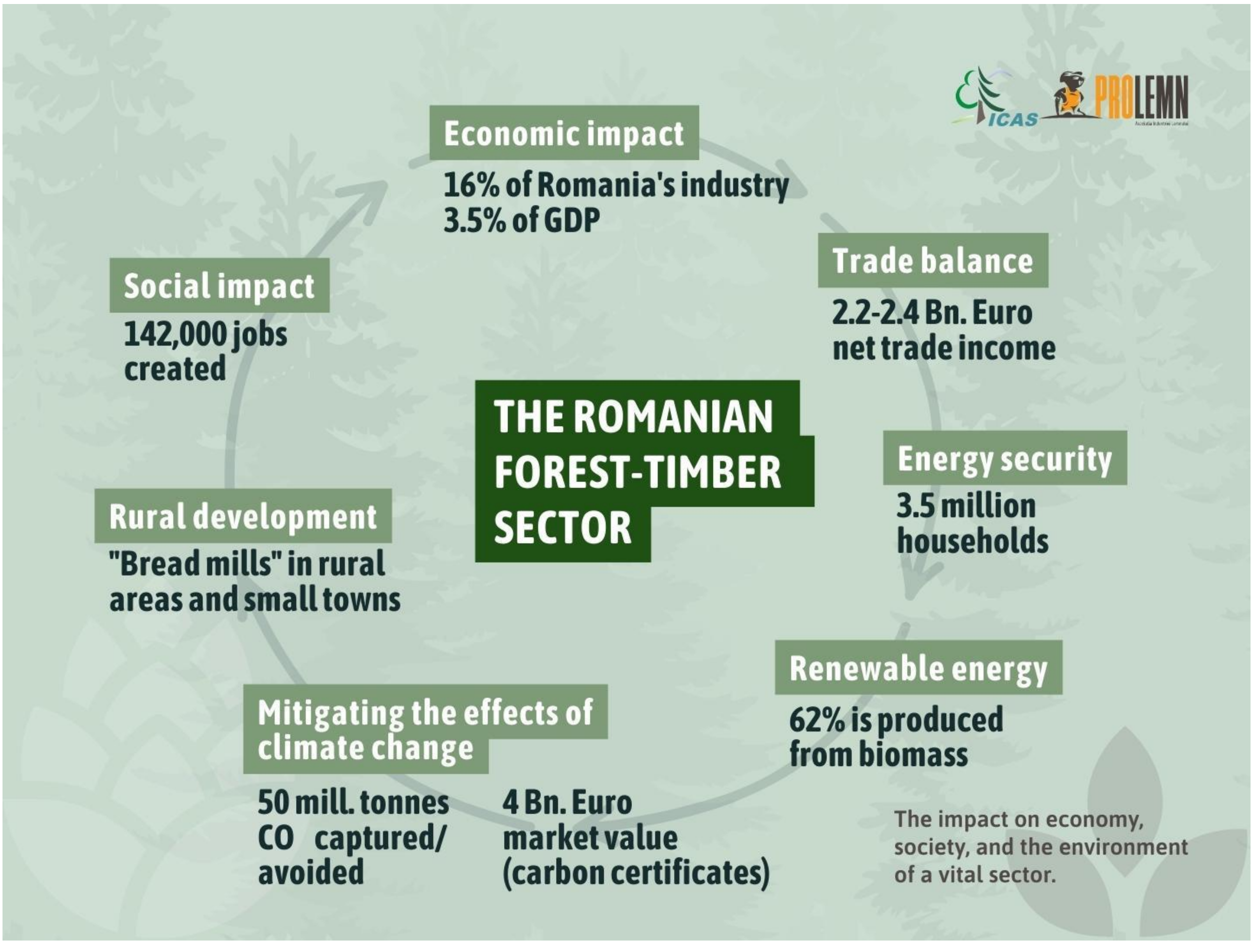
Economic sectors: Wood; Renewable energy

According to the National Institute of Statistics (INS) the area covered with forests in 2020 is 6.9 million ha (29%), which also includes areas of forest vegetation located outside the forestry fund, included in the category “forest”, according to the definition of forest (FAO). It was also shown that Romania has an unanimously appreciated forestry fund at European level in terms of biodiversity, health, stability, and functionality of forests, as well as the existence of natural structures, virgin, and quasi-virgin forests.
The evolution of the import-export balance, from log exports of over 1.5 million cubic meters annually before 2013 to current imports of 4.1 million cubic meters of raw wood in 2021 in the conditions of quasi-disappearance of raw wood exports from Romania, shows a progressive increase of the measures’ effectiveness of to combat illegal logging and to balance the demand for timber products for the internal market and the timber industry by increasing imports.

The wood resource from sustainably managed forests is one of the pillars of the green, circular, clean economy, bioeconomy that represents the future of development.The turnover of wood-based industries, resulting from the processing of data from 13,790 companies in the wood and furniture industry, is 6.1 billion Euro**,** and if we include the pulp and paper industry, also based on wood resources plus recycling, we reach 7.36 billion Euro.These turnovers represent 16% of the turnover of the Romanian industry and 3.5% of the Romanian GDP.

At the same time, wood-based industries are creating 142,000 attractive jobs, many in rural areas. In counties such as Maramureș and Satu Mare in the North of Romania, the furniture industry is the main industrial branch of the county. In counties such as Suceava and Neamt, the wood processing industry is the main industry.

By being in rural areas, the factories in the wood industry are also called “bread factories” by contributing to maintaining the economic viability of the communities in which they operate. There are a lot of rural localities and small towns where wood-based industries are the main employer.Through the horizontal impact in related industries and services, transport, the direct and indirect impact reaches 300,000 jobs created.



The contribution to Romania's import-export trade balance is also remarkable, through the annual net foreign exchange contribution of 2.2-2.4 billion Euro of wood-based industries**.**Thus, Romania gradually became after 2013 a large importer of raw wood, with annual imports in 2021 of 4.1 million cubic meters, and an exporter of high value-added products. Practically, out of the 4.5 billion Euro exports, over 80% is represented by exports of furniture, doors and windows, chipboard, OSB, MDF, and other finished products with high added value.

In the context of the war in Ukraine and the strategy of accelerating the abandonment of fossil fuels, the role of forest biomass in ensuring energy security has increased in importance. Forest biomass, in its various forms, from the classic firewood to waste from primary wood processing, becoming pellets and briquettes, supports the heating of 3.5 million households in Romania, with an estimated consumption in Romania's energy strategy at 14 million tons.The thermal energy generated is 40,000,000 MWh per year. To replace the wood heating with gas heating, at the current cost of over 100 Euro/MWh, it would require annual imports of 4 billion Euro and investments in the expansion of the gas network of 17 billion Euro**.**

Given the assumed targets for the transition to renewable energy, it should be noted that biomass energy contributes no less than 62% of the renewable energy produced by Romania, according to Romania's international reports. Hydropower supplies 24% of Romania's renewable energy, the wind energy – 10% and the solar energy – 2.9%.

The historical structure of thermal energy consumption in the residential sector (wood heating of almost half of Romania's residential sector) has led to the achievement of renewable energy production targets in Romania for 2020. However, the targets for 2030 are a very well-integrated strategy for energy and climate change, and biomass is practically the only renewable energy resource available for the heating / cooling component in the residential sector, with huge opportunities to increase the energy efficiency of biomass use, promote the use of cogeneration and huge substitution effect by replacing coal in SACET systems (Centralized Thermal Power Supply Systems) in large coal-using cities that are in a dire need of renewable energy solutions. Also, the forest – wood products sector is the only economic activity with a positive balance in combating climate change by fixing carbon. Thus, the forest-timber sector annually fixes 30% of the emissions of all the other economic activities, in the balance of greenhouse gases, according to Romania's international reports.

Thus, we have a direct contribution of 24 million tons of CO_2 net carbon storage balance in forests and wooden products. In addition, 14 million tons of CO_2 saved from emissions can be quantified by using wood, by replacing wooden products, by avoiding the use of other materials with a higher carbon footprint, such as plastic, non-biodegradable packaging, concrete, or steel. An additional substitution effect, of at least 13 million tons of CO_2, is registered by using wood biomass, by avoiding the use of fossil fuels, to heat the 3.5 million Romanian households that are using wood for heating. Therefore, the impact of the forest-timber sector in combating the climate change, through the balance sheet of the sector in the balance of greenhouse gas emissions, is the equivalent of 50 million tons of CO_2 stored or avoided, with a market value in carbon certificates of 4 billion of Euro. So far, the forest-timber industry is not among the funding priorities in the National Strategic Plan and in the National Recovery and Resilience Plan, although it offers an immense potential for decarbonizing the economy, energy efficiency and cost reduction. The multiplier effect in the economy of investments in the forest-timber sector is unique. Thus, with 1 billion Euro invested, which could be allocated from the Environmental Fund, for a single bonus for the inclusion of meadows in the forestry fund of 2,500 Euro/ha, the surface of the national forestry fund could be extended by 400,000 ha.

With 1 billion Euro from National Plan for Recovery and Resilience (PNRR) invested in forest accessibility, storage, and sorting infrastructure, in the execution of forestry care works, the environmental impact of harvesting activities could be reduced, sustainable harvesting at the level of the possibility established by the management plans, respectively 22 million cubic meters per year.

With 1 billion Euro from the renewable energy component of PNRR, invested in increasing by only 25% the energy efficiency for heating the 3.5 million households that heat with wood, the equivalent of 10,000,000 MWh would be released for use in cogeneration MWH biomass, enough to save and pass all SACETs on coal in large cities on biomass, while making available an additional 2 million cubic meters of this resource for use in wooden products, according to the principle of cascading use of wood resource.

The vision for 2030 – 10 targets for the forest-timber sector**,** targets based on sustainably managed forests, regardless of the type of ownership in Romania, and on the responsible use of wood on a large scale, in construction, energy and other industrial applications.

Sustainably managed forests are the foundation of the bioeconomy

Romania has an unanimously appreciated European forestry fund for biodiversity, forest stability, identical natural structures. The surface of Romania's forests, the stock of standing timber, the health of the forests registers a positive trend. Supporting sustainable forest management through financing programs is low, and Romania allocates less than 1% of the National Strategic Plan for forests compared to a European average of 5%. The forest cover rate of 29% is far from optimal.

Immediate opportunity: increasing the surface of the forestry fund through programs for the inclusion of the 500,000 ha of forested meadows, in the process of natural regeneration. Within 20 years, they could reach the degree of biodiversity of natural forests if they were protected by inclusion in the forestry fund.

Increased, sustainable mobilization of the timber resource

The growth of forests and standing timber in Romania's forests is on an upward slope, due to the structure by age classes with surplus of trees in the 3rd and 4th age classes leading to an increase in the fixed CO_2 stock. The evolution of the forest structure by age classes, the accessibility of the forest fund, the conducting forest care works, an improved forestry technique, research and innovation can lead to an upward trend in the sustainable harvest of the wood mass, to a value of at least 22 million cubic meters annually by 2030.

Supporting sustainable growth. Wooden products for a clean and healthy environment

Currently, the forestry and timber-based industries generate an annual turnover of 7.1 billion Euro, with a share in Romania's GDP of 3.5% and exports worth 3.5 billion Euro annually. By increasing the added value and diversification of wooden products, by promoting the use of wood in construction and increasing the degree of wood recycling, the volume and value of wooden products could be doubled**,** as it happened during 2005-2020.

Supporting the local communities, the rural economy, safe and attractive jobs, the connection between rural and urban areas.

The economy based on forests and timber resources is an attractive employer, offering interesting jobs related to research, innovation, and development, both in rural and urban areas. These jobs develop the skills of workers and of the managers in these fields. The forest – timber sector provides 150,000 direct jobs, or 300,000 jobs with the inclusion of the horizontal training effect. From a social point of view, it is important to ensure energy security for the 3.5 million households in Romania heated by biomass (firewood).

Healthy environment, vital impact in combating climate change – the balance of greenhouse gases.

The environmental impact of the forest-wood sector can be quantified in two directions:

The contribution of the forest through the provision of ecosystem services**:** *support* (biodiversity conservation, water and soil protection), *supply* (food, materials, energy), *regulation* (mitigation of the toxic effect of waste and pollutants, prevention of erosion and extreme events, regulation water flows, carbon status, control of atmospheric composition, etc.) and *cultural* (social, spiritual and symbolic interactions with the environment, physical and intellectual interactions with the environment, etc.)

The contribution of the forest to combating climate change**:** greenhouse gas balance.

- 24 million tons of CO_2 net carbon storage in forests and wooden products.
- 14 million tons CO_2 saved from emissions by using wood, by substituting wooden products, by avoiding the use of other materials with a higher carbon footprint.

- minimum 13 million tons CO_2 emissions replaced by thermal energy used to heat the 3.5 million households that heat with wood, by avoiding the use of fossil fuels.

The impact of the forest sector – wooden products on the line of combating climate change through storage of CO_2 in forests and wooden products, substitution effect of wooden products and wood biomass in energy totals 50 million tons of CO_2, which at a market price of 80 Euro / carbon certificate means a market value of Euro 4 billion annually.

This impact can be increased by at least 30% by increasing the energy efficiency of wood resource use, with the immediate opportunity to replace biomass in coal-fired plants, cascading wood resource use and increasing the volume used in wooden products.

Renewable building materials for a healthier life.

Wood, the widest used renewable building material globally, has a bright future. By 2040, the market share in construction in Europe is going to triple compared to 2015. Its advantages: it is reusable, biodegradable, healthy, with a low carbon footprint for finished products, with innovative uses – from construction modular to multifunctional furniture.

Each cubic meter of wood stores a ton of CO_2 in its structure for at least 35 years. At the end of the construction life, the wood can be easily recycled, in energy uses or technical panels (chipboard). But, at the same time, by using wood we avoid the use of a cubic meter of concrete – the studies have estimated that there will be emissions of almost a ton of CO_2 for its production and transport. For this reason, wood in construction is considered to have a substitution factor of 2 tons CO_2 / m^3 used. If wood is also used for structural elements and thus the iron is replaced, the substitution factor reaches 2.8 tons of CO_2 / m^3 used.

An average volume of 30 cubic meters of timber is required for a wooden house. In average, 40,000 houses are built annually in Romania. Therefore, with a volume of 1.2 million cubic meters of timber annually, all the houses in Romania could be built out of wood. This timber is currently exported and supported for timber construction in countries that have policies to support the use of timber in construction.

Tangible objective:promoting the use of wood in public constructions, sustainability criteria of wooden constructions, resulting in the wooden construction of at least 50% of new houses in Romania.

Renewable energy for society

The use of agricultural and forestry biomass is a huge opportunity to decarbonize and reduce costs in this segment of activity, an even more important opportunity in the context of the gas and oil supply crisis.Currently, biomass supplies 60% of the renewable energy produced in Romania – double that of Hidroelectrica does.

In Europe, but also in Romania, 35% of the total energy (thermal, electric, transport) is used in the residential sector, for heating and cooling, mainly in households. In Romania, almost half of the households are heated with wood. Regardless of the energy resource used – coal, gas, biomass, nuclear – if it is used exclusively for electricity production, the efficiency is only 30%. The resulting thermal energy, the remaining 70%, is wasted. It is simply blown into the air – through large cooling tanks or in the case of nuclear energy, through the water-cooling system.

For this reason, all European directives encourage cogeneration plants, with the simultaneous production of thermal and electrical energy, which have total thermal + electrical efficiencies of over 80%. The destruction, in Romania, of the central heating systems, based on CETs in high efficiency cogeneration, is a great loss, with economic and environmental costs, a trend that must be reversed.

The great opportunity for green renewable energy is the forest and agricultural biomass, estimated in national studies at a potential of 28 million tons per year, with a high share of agricultural biomass. Biomass energy, at current gas costs on the market, is 3-4 times cheaper than gas energy, with huge benefits adjacent to the substitution effect and avoiding carbon emissions from fossil fuels.

The conclusion is simple: it is necessary to use biomass to heat the population. The residential sector is the neglected segment in Romania’s energy strategy, focused almost exclusively on electricity, and in the PNRR, with the huge opportunity to use agricultural and forestry biomass in cogeneration plants to decarbonize the energy sector and reduce costs, instead of subsidizing billion Euro annually to fossil fuel energy industry, with the permanent aggravation of problems and rising costs by increasing the price of carbon certificates, so penalties, the huge opportunity is agricultural and forest biomass.

Immediate opportunity:with 1 million cubic meters of wood biomass, coal can be replaced in the CETs of the big cities in Romania, with huge social, economic and environmental benefits.

By 2030, through a national program to increase energy efficiency in the residential sector, by promoting thermal and pellet fireplaces and directing the resource released to cogeneration plants, the amount of energy obtained from the same current volume of biomass can be doubled, with the elimination of coal and gas. In fact, doubling the amount of energy in biomass is also the goal assumed at European level by 2050.

More value added through ecosystem services, other than wood.

New economic models, cross-sectorial integration of forest ecosystem services, can be implemented, concrete examples being the water, food and tourism sectors, combating climate change, other forest products – mushrooms and berries.

To ZERO waste: circular economy

By 2040, the collection rate for wooden-based products could reach 90% compared to 50% today, contributing with 70% of the reuse of all recyclable materials, in line with European targets. This circular economy fixes carbon and replaces other more energy-intensive materials. By using innovative, biodegradable, wood-based cellulose materials, we can get rid of pollution from plastic materials.

Diversification of production technologies and logistics

A multitude of uses, new wood-based products, available as finished products or integrated in other industrial chains, lead to new wood recovery chains.In addition to the classic uses of wood – in construction, bioenergy, furniture, interior and exterior decoration, chipboard, MDF, OSB, pallets, doors and windows – there have been many new uses in the industry of biodegradable packaging that replaces plastic, wood cellulose viscose that replaces synthetic textiles, many new generation biofuels. The technology of synthesis gas (syngas, green gas obtained by pyrolysis of wood biomass) at the same time as the production of biochar (organic fertilizer) is already mature in Europe. Also, the production of bioenergy with carbon storage will play the key role in the green energy sector. Of all the branches of the wood industry in Romania, the bioenergy, pulp and paper industry are less developed where we have a strong negative trade balance, biofuels and almost all innovative industries in the use of wood, with high added value.

The PRO WOOD Regional Wood cluster (labelled with gold) was established in 2010, a result of an FP7 project, with the same name "PRO WOOD", carried out between 2008-2010, in the sub-program "Regions of knowledge", having as its main objectives: joint marketing at the association level and strategic approach to foreign markets; strengthening the links between Industry and School to increase the qualification level of tradesmen (secondary studies) in the field; increasing the degree of innovation of enterprises by strengthening the links between them and CDI service providers (especially the Faculty of Wood Industry within the "Transylvania" University in Brașov. It is the first cluster in the modern sense of the term in Romania and the first cluster in the field of the wood industry and of furniture. The PRO WOOD generation methodology has become a national model, elements such as the "partnership agreement" that identifies the cluster from a geographical and economic point of view, as well as the "four-leaf clover" model referring to the type of members (industry - CDI organizations - public authorities – catalyst organizations) being taken over at the national level by relevant actors such as the Ministry of Economy or the Romanian Cluster Association - CLUSTERO, becoming quasi-normative criteria for recognizing cluster status. The cluster is labelled with gold and has currently 69 members, out of which 48 are SMEs acting in wood harvesting & processing; wooden constructions (houses, etc.); production of wooden doors, windows, stairs, balusters; solid wood furniture manufacturing; production of wooden decorations, accessories, sculptures; design.

The management of the PRO WOOD Regional Wood cluster is ensured by the KO-FA Association (Hungarian acronym for Kovászna (Covasna) and FA: wood) established in 2009 and currently having 48 members. The KO-FA Association is the management entity of the PRO WOOD Cluster according to the organizational statute of the KO-FA Association.

Among the most relevant projects **of PRO WOOD cluster** with a twin transition component are the followings:

-POS CCE O 1.3.3: Increasing the competitiveness of SMEs from the PRO WOOD cluster by integrating them into national and international supplier chains, with the aim of integrating SMEs into the cluster, respectively creating the cluster's value chain; was carried out during 2014-2015 with the involvement of 12 member SMEs;

-The Danube Strategy: Smart Furniture Remanufacturing, a project aimed at identifying a new business model based on eco-innovation through the revalorization of hotel furniture; it took place in the period 2015-2016 with the involvement of 25 member SMEs and Transylvania University in Brașov;

-**Danube Transnational Program: FORESDA, Forest-Based Cross-Sectoral Value Chains Fostering Innovation and Competitiveness in The Danube Region**, aiming to increase the competitiveness of the wood processing industry and other traditional related sectors; took place in the period 2017-2019 with the involvement of 37 SMEs, 11 public authorities and the Transylvania University of Brașov, members of the cluster;

-**Horizon 2020: ROSEWOOD, European Network of Regions On Sustainable Wood Mobilization**, aiming to create a regional network by integrating innovative ideas and solutions regarding the mobilization of the wood industry; the creation of new business opportunities and sustainable mobilization in the wood industry took place in the period

2018-2020 with the involvement of 37 member SMEs, 11 public authorities (decentralized institutions and local public authorities) and Transylvania University in Brașov.

-Horizon 2020 – Rosewood 4.0 - Digital Solutions and Knowledge Transfer for Sustainable Wood Mobilization In Europe, focuses on digitization and the implementation of various digital tools, promoting IT-based solutions for forestry, thus allowing industry representatives to exchange knowledge and experiences with a much greater impact large.

-Competitiveness Operational Program **- The distributed industrial research-innovation network in partnership for the sustainable development of the forest sector in the cluster PRO WOOD - BIO WOOD NET** - Increasing the degree of competitiveness of PRO WOOD cluster members based on innovation and internationalization thus Increasing the RDI capacity at cluster level in the field of bioeconomy for the sustainable development of the forestry sector. Total amount of the project 4 mil. EUR, in which over 60 new, innovative equipment and machinery will be purchased in order to increase the innovation and production capacity of the cluster member companies.

Green Energy -Romanian Innovative Biomass Cluster (labelled with silver) has been founded with the aim to raise the interest toward the production and utilization of the biomass, the most important renewable energy source in Romania. Green Energy Cluster labelled with silver is a social economy cluster that ensures the frame to develop solutions in the field of the biomass by putting emphasis on the ecological and social innovations.

The Cluster ensures the frame for cooperation between business, research organizations, universities and public administration. Businesses are represented by the solid biofuel prodicers, the biomass- based heating system manufacturers, ESCO-s and consultants. The cluster has 84 members of which 49 are SMEs and the cluster'services are:

bioenergy value-chain development; awareness-raising, education; stimulate research and innovation; internationalisation; advocacy, lobbying; cluster management.
The Cluster is involved in several EU-funded projects, of which in green and digital transition are: BioRural (Horizon 2020); P2GreenEST (COSME programme); SPIRE - Smart Post-Industrial Regenerative Ecosystem (European Fund for Sustainable Development -Urban Innovative Actions program); COSMENERG-4i 'Global Clusters for Renewable Energy and Environmental Technologies' (COSME programme, ESCP4i); Bioenergy Villages (BioVill) (Horizon 2020);Energy Efficiency in Rural Areas (EEA grants and Norway grants);Biomass4energy (Norway grants).

A best practice example of Green Energy cluster is the project „One village-1 MW" developed with Norway grants.

The general objective of the project is to strengthen the internal capacity of the Green Energy Association to formulate and implement collaborative mechanisms between the business environment, civil society representatives and local public authorities for the promotion and development of sustainable and energy-independent communities in the area of Targu Secuiesc (Estelnic and Ghelinta communes) from Covasna country-Central Region of Romania.

Sustainable and energy independent communities propose the transition to a sustainable and energy independent system based on local bio resources; from a linear economy to a circular one; from fossil fuels to renewable resources, especially biomass-based and especially in rural areas. The sustainable community can contribute to the sustainable development of less developed regions such as rural and mountainous regions such as the Targu Secuiesc area.

Energy problems are so acute that it is no longer possible to satisfy the world's constantly growing needs. This growth of energy demand must be increasingly satisfied by diversified energy sources, including sustainable and renewable resources. Biomass is a renewable energy option that can be practical and safe, can strengthen the economy, and can help ease the urgent strain on our planet's ecosystem.Currently there is a poor organization of the biomass market. It is necessary to find a viable solution for the biomass sector by ensuring a balance between production and use of biomass.

Green Energy Biomass Cluster has received a grant from Norway Grants to implement a project whose aim is to develop an integrated model of a community-scale energy system. Small-scale bioenergy systems are plants of up to 1 MW of energy generating capacity. They have the advantage of being able to be distributed throughout a community.Using locally-sourced waste wood in small-scale community-based bioenergy systems has great potential to develop local jobs and economies and to ensure the energy of rural settlements. The investment in the small 'pilot plant' is taking place at Estelnic village, Covasna County and it has the following components:

- Establishing a willow crop of 3 hectares on a land owned by the village for producing woodchips;
- Harvesting green wood waste from public areas; and using a wood-chipper to obtain woodchips;
- Installation of a 135 kW biomass heating system for a local public institution, fueled with locally obtained woodenchips.

7 Recommendations for a successful twin transition of SMEs

These recommendations are practical and tailored to suit the varying needs and obstacles encountered by SMEs across different industries and regions of Romania.

These recommendations are crucial in steering SMEs towards a more technologically advanced and competitive future. The recommendations have been structured in non-financial support, financial support, capacity development, innovation ecosystems and policies and mechanisms[14].

[14] (Digital Innovation Hubs, 2023)

Non-financial support

Integrated guide mechanisms to support technology adoption of SMEs

Industry 5.0 offers a great opportunity to strengthen European resilience. However, to realise this potential requires a deep transformation of the approach and existing business models. SMEs can be supported by integrated guidance mechanisms adapted to the SMEs needs for adopting new technologies. This support can be provided for instance by specialized technology consultants and experts, hands-on guides and access to best practices shared by EU-wide knowledge sharing platforms. It is essential to provide integrated and comprehensive support throughout the entire transformation process, from the generation of an idea until the final market implementation (TRL 1-9). This holistic support aims to address all phases of the digital and green transition, utilizing different instruments to bridge the gap between innovative technologies and their practical application across diverse business settings.

Targeted resource provision

It is essential to understand the different levels of digital and innovation maturity. Leveraging this data can help to address the varied needs of SMEs based on their maturity and their business strategy. By segmenting and categorizing resources, SMEs can gain access to tools and assistance that are directly aligned with their current stage of development, ensuring more efficient and targeted support. Moreover, clusters play a significant role in providing specialized support to help find new and tailored resources to aid SMEs in their journey.

Local peer support to address regional differences and impact on adopting advanced technologies

The literature[15] has underlined several factors that determine the regional impact of new technology including inherent regional and socio-cultural characteristics such as (i)

[15] (Impact of technological transformation on regional development, 2021)

existing research portfolio, (ii) Industrial structure, (iii) technology infrastructure, (iv) proximity to global knowledge networks, (v) proximity to markets and resources and (vi) physical geography. However, awareness, ability and willingness also play a key role. For that matter, the different levels of technological development and emerging value chains have to be taken into account, and the regional dimension needs a special focus on policy design and implementation.

It has been proved that counting with peer support at a local level to address the different resources in the same language and context can be very effective to facilitate the adoption of new technologies by SMEs. Also, establishing local support centres that can assist SMEs in their native languages and address their unique needs.

Also, it is essential to prioritize targeted communication strategies tailored to suit the specific needs and preferences of manufacturing SMEs. By ensuring that messages about available resources, grants, and support programs are both pertinent and easily accessible, SME engagement can be amplified and the effective utilization of these opportunities promoted.

Financial support

Funding and financial incentives targeted to SMEs needs

One of the primary barriers to SME engagement is the lack of direct funding to implement solutions. To bridge this gap, it's essential for EU policymakers, along with national and regional managing authorities, to devise specialized financial packages or grants tailored explicitly for technology adoption by SMEs. These measures could include options such as low-interest loans, tax breaks for tech-related investments, or direct grants.

Enhancing SME access to combined financing in EU Policies

While the flexibility of combining financing with grants offers advantages, policymakers must consider streamlining and simplifying the application and reporting procedures to ensure that SMEs can effectively harness these opportunities without being overwhelmed by excessive bureaucracy.

Policymakers from European, national and regional levels should work together to coordinate different funding schemes. This coordination is essential to avoid overlapping and potential redundance of funding activities at the same level of maturity. In other words, it is crucial to avoid duplicating efforts (and thus resources) by targeting projects with different Technology Readiness Levels (TRLs) simultaneously. Instead, fostering more complementary funding schemes that build upon the results from one grant to the next can provide continuity and help propel more companies towards the market.

Capacity development

Comprehensive digital skills development

The transition to Industry 5.0 transformation presents substantial demands and novel challenges. Therefore, it is imperative to develop targeted training programs to enhance digital skills within the manufacturing workforce. These programs should ensure that employees have sufficient resources and are equipped to effectively utilize new technologies.

The development of these training programs should take into account the specific regional or sectoral needs, ensuring no SME is left behind in this transformation process. It is vital to constantly consider the different levels of digital maturity, market strategies and innovation levels of SMEs.

This consideration enables the provision of tailor-made resources to along with the different maturity levels and specific goals of each SME, thus fostering a more inclusive and effective approach to Industry 5.0 adoption.

Upskilling of clusters to provide effective guidance to SMEs

Clusters and technological centres play a crucial role in supporting manufacturing SMEs in their digital transition. This is achieved by facilitating collaboration, knowledge sharing, and providing valuable resources. A significant part of their role is to keep SMEs updated on the latest trends, technologies, and funding opportunities related to digital transformation.

However, given the observed differences in resources, levels of maturity and expertise among different clusters, it may be necessary to allocate resources not only to SMEs, but also to industrial clusters. That way, clusters act as intermediaries, facilitating the flow of information to SMEs. This intermediary role is crucial, as clusters are well-equipped to navigate the diverse landscapes, both institutional and SME-related, and effectively navigate the different realities while addressing the challenges posed by the EU digital transformation goals.

Innovation ecosystems

Involvement of regional stakeholders to achieve more effective results

Understanding the unique context and factors that each region can help to address the tools and mechanisms and ensure the engagement of SMEs to access to both regional and EU level instruments. For that, it is essential to engage and mobilize the adequate regional stakeholders considering the contextual, cultural and linguistic differences as well as the relevance of these stakeholders. This approach is guided by the well-established principle, as supported by previous literature and in interviews with experts that: "t*he more local, the better"* when it comes to fostering collaboration among EU regions. The digital maturity assessments during the digitalization process can play a key role as an initial benchmark to get a better understanding of the state-of-the-art. These data and assessment tools are instrumental in measuring the impact of policies and mechanisms, providing a means to gauge their effectiveness and make informed adjustments as needed.

Integration of SMEs into regional innovation ecosystems

Promoting the active participation of SMEs in established ecosystems like Clusters, Digital Innovation Hubs (DIH), Open Innovation Testbeds (OITB) and other industry networks and associations is highly beneficial. By becoming integral members of these networks, SMEs can benefit from the wealth of shared knowledge, collaborative opportunities, and a unified push towards technological adoption. It is crucial that SMEs understand and identity the incentives and advantages of being part of these networks. Therefore, the messages sent should be tailored to address the specific needs and concerns that SMEs may have, ensuring that they see the value and relevance of their participation.

Policies and mechanisms

Identification and improvement of synergies between policies and mechanisms

To improve the synchronization and coordination of strategies for digitalization and technology adoption across SMEs, establishing a connection between funding opportunities and evaluation calls among agencies can be highly effective. SMEs often face time constraints when applying for different (funding or support) mechanisms and the overlap between different funding instruments can be overwhelming.

Therefore, to address this challenge, aligning the efforts of different agencies is essential. The alignment can take the form of creating platforms, fostering communities of practice or providing other complementary resources that explain the difference between the mechanisms and how they tailor to the different needs of SMEs. Such initiatives can be incredibly beneficial, helping SMEs navigate the landscape more efficiently and make informed decisions about which funding opportunities are most suitable for their specific circumstances.

Continuity and engagement of policies and mechanisms

Creating linkages and establishing pathways between funding opportunities and network possibilities is crucial for leveraging developed sustainability plans and avoiding the emergence of short-term projects with low impact. It is essential to establish mechanisms, roadmaps and incentives to ensure the sustainability and successful exploitation of project results beyond the scope of the project.

Without such measures, there is a risk that valuable projects may not be sustained or integrated into longer-term strategies, potentially leading to missed opportunities for long-term growth and development. Therefore, fostering these pathways and ensuring the continuity of project results is extremely important for maximizing the long-term benefits of these initiatives, which is also a matter of sustainability.

8 Conclusions

In summary, a number of key needs for a successful twin transition were identified as follows:

a. The portfolio of service provision for twin transition to various types of firms differs in the region depending on the characteristics of the economic structure of the region and the potential for innovation and technology-based growth. Designing a package of SME policies should be based on a rigorous analysis of the strengths and weaknesses of the region and fine-tuned to the specific economic and sector structure.

b. On the longer run, the present business support network, which is formed by a mix of national and regional organizations, would need a more serious streamlining. There should be a clearly branded and limited number of publicly funded support organizations which can provide a set of support schemes to all targets groups (e.g. established businesses, high-tech, micro-firms, start-ups) which cannot be provided by private sector organizations. While there is a need for nationally set quality standards and performance criteria, on the regional level there should be sufficient room for man -oeuvre to adapt the package of support and information services to the local needs.

c. There is an urgent need for joint capability building in the design, implementation and evaluation of SMEs and entrepreneurship policies. The national and regional authorities could play a vital role in supporting the regional development organizations with training, coaching and exchange of experience. The regional authorities should be open to exchange their experiences with the other regions and national agencies on reskilling and upskilling of the labour force to fully exploit the potential of digital and green technologies.

d. The dialogue between clusters and national and regional authorities on financing the twin transition should be organized more systematically.

e. There is a need to make entrepreneurship development more explicitly central to the economic development policy agenda at the regional level. The production of entrepreneurship strategies would complement the existing regional development strategies and RIS.

f. Access to training is a pre-requisite for addressing skills shortages. Skills creation programs in collaboration with industry are needed.

The project team identified in the answers to the questionnaire and the interviews with the cluster managers a need for a follow up of Romanian-Norwegian collaboration in areas of interest for clusters such as green and digital strategy, exchange of best practices on support services for internationalization and twin transition, role of clusters within Digital Innovation Hubs.

9 Annexes

9.1 Annex 1 Members of Romanian Cluster Association

No	Field/ Network	Romanian Clusters members of CLUSTERO	Romanian Location	No of members	No. of members from which SMEs
1.	Textiles and Fashion	ROMANIAN TEXTILE CONCEPT Silver label expired at 2021/01/01	Bucharest	44	34
2.		TEXTILE CLUSTER ASTRICO NORD-EST Silver label expired at 2021/11/15	Piatra Neamt	33	27
3.		TRANSYLVANIA TEXTILE & FASHION Silver label expired at 2022/08/31	Sfantu Gheorghe	45	25
4.		TRADITION MANUFACTURE FUTURE	Focsani	12	10
5.		SORINTEX	Republic of Moldova	33	22

6.		CANEPARO Cluster	Bucharest	26	17
7.	**Wood and Furniture**	PRO WOOD Gold label expired at 2022/08/31	Sfantu Gheorghe	69	44
8.		TRANSYLVANIAN FURNITURE CLUSTER Gold label valid until 2025/11/30	Cluj Napoca	86	62
9.		DANUBE FURNITURE CLUSTER	Bucharest	24	20
10	**ICT services**	TRANSILVANIA IT Gold label expired at 2023/08/31	Cluj Napoca	180	126
11		CLUJ IT Silver label expired at 2018/10/19	Cluj Napoca	98	66
12		BANAT SOFTWARE Bronze label expired at 2021/08/01	Timisoara	29	22
13		CONTROL&IT Bronze label expired at 2019/07/31	Bucharest	12	10

14		DANUBE ENGINEERING HUB Bronze label expired at 2019/09/13	Bucharest	23	18
15		Euronest ITC Bronze label expired at 2019/01/11	Iasi	100	90
16		ICT OLTENIA CLUSTER Bronze label expired at 2018/01/12	Craiova	30	24
17		ALT Brasov -CLUSTER FOR INNOVATION AND TECHNOLOGY Bronze label expired at 2019/08/03	Brasov	45	35
18		ITC LOWER DANUBE	Galati	45	40
19		IT PLUS Bronze label expired at 2017/04/08	Miercurea Ciuc	40	28
20		ICONIC CLUSTER	Iasi	49	40
21	**Healthcare**	IMAGO MOL Gold label valid until 2025/07/31	Iasi	54	29
22		ROHEALTH Gold label valid until 2023/12/31	Bucharest	76	43

23		LIFETECH CITY	Targu Mures	29	15
24		INNOVATIVE CLUSTER FOR HEALTH "DUNAREA DE JOS" Galati Bronze label expired at 2019/01/11	Galati	21	18
25	**Intelligent Energy**	Green ENERGY Silver label expired at 2018/01/12	Sfantu Gheorghe	84	49
26		TRANSYLVANIA ENERGY CLUSTER TREC Gold Label expired at 2023/07/31	Cluj Napoca	41	27
27		GREEN SOLUTIONS LOWER DANUBE	Galati	28	11
28		ROSENC- Romanian Sustainable Energy Cluster Silver label expired at 2018/01/14	Timisoara	63	49
29		3R Green Cluster	Cluj Napoca	17	14
30	**Transportation and logistics**	ROMANIAN RIVER TRANSPORT Bronze label	Galati	33	23

		expired at 2020/01/18			
31	**Creative industries**	OPEN HUB CREATIVE CLUSTER Bronze label expired at 2020/09/19	Galati	24	18
32		ICONIC CLUSTER	Iasi	49	40
33		CREATIVE TRANSILVANIA CLUSTER Bronze label expired at 2019/07/18	Cluj Napoca	48	34
34		ADVERTISING PRINTING AND PACKAGING CLUSTER Bronze label expired at 2019/07/01	Timisoara	25	23
35	**Sustainable constructions for smart cities**	TEC CLUSTER Bronze label expired at 2023/08/31	Bucharest	20	14
36		PRO nZEB CLUSTER Bronze label expired at 2022/11/30	Bucharest	26	6
37		CONSTRUCT CLUSTER Oltenia Bronze label expired at 2019/10/04	Craiova	37	34

38		Romanian New Materials Cluster Bronze label expired at 2020/09/26	Cluj Napoca	21	13
39	**Agrofood**	AGROTRANSILVANIA Gold label valid until 2024/03/31	Cluj Napoca	80	70
40		BIONEST CLUSTER	Iasi	35	23
41		AGROFOOD COVASNA Silver label expired at 2021/03/31	Sfantu Gheorghe	79	55
42		IND AGRO POL Silver label expired at 2020/12/30	Bucharest	137	83
43	**Nano micro technology**	MECHATREC Silver label expired at 2021/03/31	Bucharest	144	94
44		ELINCLUS Silver label expired at 2021/01/11	Bucharest	93	79
45		Cluster for Distributed Research Infrastructure for Future Materials, Applications And Technology (DRIFMAT) Bronze label	Bucharest	20	9

		expired at 2020/12/06			
46	**Electrical engineering**	ELECTRO TECHNICAL REGIONAL CLUSTER Silver label expired at 2021/01/11	Sacele, Brasov,	24	3
47	**Production Engineering**	TRANSYLVANIAN MECHANICAL ENGINEERING	Sfantu Gheorghe	34	18
48		PRELMET Transylvania Bronze label expired at 2016/12/24	Alba Iulia	28	17
49	**Smart Technologies**	START INOVARE Bronze label expired at 2019/12/12	Bucharest	26	12
50	**Automotive**	SPRINT ACAROM	Pitesti	160	110
51	**Tourism**	INOMAR	Constanta	40	21
52		VIA CAHUL	Rep. Moldova	50	21
53	**Aerospace**	SPACE TEH Cluster	Cluj	19	12

9.2 ANNEX 2 List of Romanian eHUBS

Nr crt	Digital Innovation Hubs	Regional Development Agency
1	ANAMOB	București-Ilfov
2	CiTyInnoHUB	South-East
3	CyberSecurityHub CSH	București-Ilfov
4	Danube DIH	South-East
5	Digital Innovation Hub South East Romania	South-East
6	Digital Innovation Zone	North-East
7	DIGIVEST	West
8	DIH LAB4COM	Central Region
9	FIT – DIGITAL INNOVATION HUB	Central Region
10	Green DIH	București-Ilfov
11	DIH4Society	North-West
12	HUB Digital Innovativ OLTENIA	South-West Oltenia
13	RENEW DIGITAL INOVATION HUB	North-East
14	Ro Tech Nation DIH	București-Ilfov
15	SMART eHUB (Digital Innovation SMART eHUB)	București-Ilfov

16	Technology Enabled Construction	București-Ilfov
17	Transilvania Digital Innovation HUB	North-West
18	Wallachia HUB	South Muntenia

The eDIHs are the following: DIH4Society; Transilvania Digital innovation Hub; FIT EDIH; Wallachia Hub; CiTyInnoHub; eDIH-DIZ and DIGIVEST.

9.3 Annex 3 Norwegian Innovation Clusters[16]

The cluster program Norwegian Innovation Clusters consists of Norwegian clusters at three levels: Arena, Arena Pro and GCE. NCE is no longer a program, but a brand name that clusters can qualify for.

Type of cluster	
Arena PRO	ACT Arctic Cluster Team
	Cod Cluster
	Energy Transition Norway
	Nordic Edge
	Norwegian Fashion & Textile Agenda
	Norwegian Offshore Wind
	Norwegian Smart Care Cluster
	Ocean Hyway Cluster
	Solenergiklyngen
	Stiim Aqua Cluster
	Vital Infrastructure Cluster
	The WoodWorks! Cluster
Arena	Circular Packaging Cluster
	Cluster for Applied AI
	Energi i Nord
	H2Cluster - The Norwegian
	Norwegian Wood Cluster
	Proptech Innovation
	Hydrogen Cluster

16 (https://nic.innovasjonnorge.no/artikkel/english)

GCE	GCE Blue Maritime
	GCE NODE
	GCE Ocean Technology
NCE	NCE Aquatech Cluster
	NCE Blue Legasea
	NCE Energy Technology
	NCE Finance Innovation
	NCE Heidner Biocluster
	NCE Maritime CleanTech
	NCE Seafood Innovation Cluster
Mature clusters	NCE Eyde
	NCE Norway Health Tech
	NCE Media
	NCE Smart Energy Markets
	Oslo Cancer Cluster

9.4 Annex 4 List of economic sectors with similar Romanian- Norwegian clusters

Field/ Network	Romanian Clusters members of CLUSTERO	Romanian Location	Norwegian Clusters	Norway: Main location
Textiles and Fashion	ROMANIAN TEXTILE CONCEPT Silver label expired at 2021/01/01	Bucharest	Norwegian Fashion and Textile Agenda (Arena Pro program/ Silver label exp 2020)	Oslo
	TEXTILE CLUSTER ASTRICO NORD-EST Silver label expired at 2021/11/15	Piatra Neamt		
	TRANSYLVANIA TEXTILE & FASHION Silver label expired at 2022/08/31	Sfantu Gheorghe		
Wood and Furniture	PRO WOOD Gold label expired at 2022/08/31	Sfantu Gheorghe	The woodworks cluster (Arena Pro program- preparing for gold label in 24)	Steinkjer
	TRANSYLVANIAN FURNITURE CLUSTER	Cluj Napoca	Norwegian Wood cluster	Hamar/ (Brummundal)

	Gold label valid until 2025/11/30		(Arena Program, no label)	
	DANUBE FURNITURE CLUSTER	Bucharest		
ICT services	TRANSILVANIA IT Gold label expired at 2023/08/31	Cluj Napoca	Cluster for applied AI Arena program/no label)	Halden
	CLUJ IT Silver label expired at 2018/10/19	Cluj Napoca	Norwegian Cyber Security Cluster No program, bronze label	Gjøvik
	BANAT SOFTWARE Bronze label expired at 2021/08/01	Timisoara	Digin Cluster No program, bronze label -23)	Kristian-sand
	CONTROL&IT Bronze label expired at 2019/07/31	Bucharest	VRINN cluster (Immersive Learning- No program, bronze label)	Hamar
	DANUBE ENGINEERING HUB Bronze label expired at 2019/09/13	Bucharest		

	Euronest ITC Bronze label expired at 2019/01/11	Iasi		
Healthcare	IMAGO MOL Gold label valid until 2025/07/31	Iasi	Oslo Cancer Cluster, (Mature Clusters, Gold label)	Oslo
	ROHEALTH Gold label valid until 2023/12/31	Bucharest	NCE Norway Health Tech (Mature Clusters, Gold label)	Oslo
	INNOVATIVE CLUSTER FOR HEALTH “DUNAREA DE JOS” Galati Bronze label expired at 2019/01/11	Galati	Norwegian Smart Care cluster (Arena Pro, Gold Label)	Stavanger
Intelligent Energy	GREEN ENERGY Silver label expired at 2018/01/12	Sfantu Gheorghe	Energy Transition Norway, (Arena Pro, no label)	Stavanger
	TRANSYLVANIA ENERGY CLUSTER TREC	Cluj Napoca	The solar energy cluster (Arena Pro, gold label planned early -24)	Oslo

	Gold Label expired at 2023/07/31			
	GREEN SOLUTIONS LOWER DANUBE	Galati	Energy in the North (Arena program, no label)	Hammer-fest
	ROSENC- Romanian Sustainable Energy Cluster Silver label expired at 2018/01/14	Timisoara	Energy Valley (NCE Program, gold label)	Oslo
			NCE Smart Energy Markets (Mature Clusters, Gold label)	Halden
			Norwegian Offshore wind (Arena Pro prog, Exp bronze label)	Haugesund
			Ocean Hyway Cluster (Arena Pro, no label)	Bergen
			Arena H2 Cluster (Arena program, no label	Oslo/Keller
Transportation and logistics	ROMANIAN RIVER TRANSPORT Bronze label	Galati	NCE Maritime Clean Tech (Electrification of boat transport)	Haugesund(Stavanger/Bergen)

	expired at 2020/01/18		NCE program, gold label)	
			GCE Blue Maritime (GCE program, gold label)	Ålesund
Creative industries	OPEN HUB CREATIVE CLUSTER Bronze label expired at 2020/09/19	Galati	Media City Bergen (Mature Clusters, Gold Label)	Bergen
	ICONIC CLUSTER	Iasi	NCE Finance Innovation Cluster (NCE program, no label)	Bergen
	CREATIVE TRANSILVANIA CLUSTER Bronze label expired at 2019/07/18	Cluj Napoca	VRINN cluster (Immersive Learning-No program, bronze label)	Hamar
Sustainable constructions for smart cities	TEC CLUSTER Bronze label expired at 2023/08/31	Bucharest	Nordic Edge Smart City Cluster (Arena Pro program, preparing gold label spring 2024)	Stavanger

	PRO nZEB CLUSTER Bronze label expired at 2022/11/30	Bucharest	Proptech Innovation Cluster (Arena program, no label)	Bergen
	Romanian New Materials Cluster Bronze label expired at 2020/09/26	Cluj Napoca	Construction City cluster (No program, bronze label)	Oslo
			Concrete Innovation Cluster. (No program, Exp. bronze label)	Narvik
Agrofood	AGROTRANSILVANIA Gold label valid until 2024/03/31	Cluj Napoca	NCE Heidner Biocluster NCE program, gold label)	Hamar
	BIONEST CLUSTER	Iasi	Stiim Aqua Cluster (Arena Pro, exp bronze label)	Stavanger
	AGROFOOD COVASNA Silver label expired at 2021/03/31	Sfantu Gheorghe		
	IND AGRO POL Silver label expired at 2020/12/30	Bucharest		

9.5 Annex 5- Questionnaire for SMEs and clusters on twin transition

Dear member of CLUSTERO,

The strategic objective of the “Innovative services for twin transition in SMEs and clusters” prroject is to increase the competitiveness of Romanian companies based on green industry eco-innovation, digitalization approaches and internationalization with a particular focus on strengthening the Romanian-Norwegian business & innovation relationships. The project is financed by the Norway Grants 2014-2021 in the frame of the SME Growth Program Romania.

For further information about the project go to www.clustero.eu/projects/

To get an idea about which services for twin transition we could offer to SMEs and cluster members we developed this short questionnaire.

We will kindly ask you to fill in the questionnaire in order to help us develop innovative services for twin transition tailored to your actual needs!

Thank you very much for your participation in this project!

General information

1. *Profile/General Data*

1.1. From which Romanian region are you?

1.2. Are you a company or a cluster management organization? Please specify the name.

1.3. What is your position? (General Director, Cluster Manager, other)

1.4. In which areas is your SME/cluster focused?

2. *Twin transition of your company/cluster*

2.1. What is the digitization level in your SME/cluster?

2.2. What do you consider to be the key barriers to digitalization?

2.3. Are you a member of a Digital Innovation Hub?

2.4. What areas of the green economy do you address? (ecological agriculture, bioeconomy, waste management, renewable energy, other)

2.5. Have you already implemented green and/or digital solutions in your firm/cluster?

2.6. What are your needs for a successful green and digital transition?

2.7. How could CLUSTERO help you with innovative services in ensuring sustainability? (training, exchange of best practices, internationalization, other)

3. Cooperation with Norwegian clusters

3.1. Have you collaborated with clusters/firms from Norway before?

3.2. Would you be interested in participating in our project's activities?

3.3. What are the areas of your interest of the Romanian-Norwegian collaboration?

9.6 Annex no 5 Romania fiche-Digital and Green Transition indicators

Romania

Rank: **27** Overall Score: **29.54**[17]

Romania is No. 27. Most of its performance is low: **Digital Transition** (No. 26), **Green Transition** (No. 15) and **SME Competitiveness** (No. 27). The country does best on **Green Transition** (No. 15), mainly thanks to a very good performance on **Emission Reduction** (No. 4), where it is the best performer on change in greenhouse gas emissions (with almost 66% reduction compared to 1990). It also performs well on **Natural Resource Conservation** (No. 9), but **Green Output** (No. 26) lags significantly. When it comes to digital indicators, the country has still a lot of work to do, as it is often the last or third-last performer: **SME Digitalisation** (No. 27), **E-Commerce** (No. 25) and **Digital Skills** (No. 25). Also low are **Exports** (No. 24), **Productivity** (No. 23) and **Growth** (No. 27). Romania occupies the last position on both share of high-growth enterprises (2.4% of active enterprises) and the workforce employed by them (5.4% of workforce).

		Rank	Score
I.	**Digital Transition**	**26**	**19.89**
I.1.	**SME Digitalisation**	**27**	**11.38**
I.1.1.	Share of SMEs using big data analytics	26	10.00
I.1.2.	Share of SMEs using cloud computing services	25	16.92
I.1.3.	Share of SMEs using two or more social media channels	27	10.00
I.1.4.	Share of SMEs with high and very high digital intensity	27	10.00
I.1.5.	Share of SMEs using any type of ICT security	27	10.00
I.2.	**E-Commerce**	**25**	**20.71**
I.2.1.	Share of SMEs with e-commerce sales in total SMEs	25	16.43
I.2.2.	Share of SME total turnover from e-commerce sales in total turnover	21	25.00
I.3.	**Digital Skills**	**25**	**27.57**

[17] (An SME Agenda for the 21st Century, 2022)

I.3.1.	Share of SMEs that employ ICT specialists in total SMEs	21	25.88
I.3.2.	Share of SMEs for which ICT functions are performed by own employees in total SMEs	14	46.82
I.3.3.	Share of SMEs providing training to develop or upgrade ICT skills of personnel	27	10.00

II.	**Green Transition**	**15**	**51.95**
II.1.	**Natural Resource Conservation**	**9**	**59.68**
II.1.1.	Share of SMEs reducing consumption of natural resources (e.g. saving water, energy, materials or switching to sustainable resources)	5	72.48
II.1.2.	Share of SMEs recycling by reusing material or waste within the company	17	46.89
II.2.	**Emission Reduction**	4	**74.76**
II.2.1.	Share of greenhouse gas emissions produced by SMEs in total greenhouse gas emissions	13	49.52
II.2.2.	Overall change in greenhouse gas emissions (Index 1990 = 100)	1	100.00
II.3.	**Green Output**	**26**	**21.42**
II.3.1.	Share of SMEs offering green products or services	23	27.31
II.3.2.	Share of SMEs in low intensive greenhouse gas emission sectors in total SMEs	26	15.54
III.	**SME Competitiveness**	**27**	**16.78**
III.1.	**Exports**	24	**27.71**
III.1.1.	Share of exporting SMEs in total SMEs	21	26.97
III.1.2.	SME trade to GDP ratio	22	28.45
III.2.	**Productivity**	23	**12.64**
III.2.1.	SME labour productivity	23	12.64
III.3	**Growth**	27	**10.00**
III.3.1.	Share of high-growth enterprises in total active enterprises (10+	27	10.00

employees)			
III.3.2.	Share of people employed in high-growth enterprises in total employment (enterprises with 10+ employees)	27	10.00

10 Bibliography

An SME Agenda for the 21st Century. (2022). *Green, Digital and Competitive-An SME Agenda for the 21st Century.* Retrieved from https://futurium.ec.europa.eu/system/files/2023-04/LISBON_COUNCIL_Green_Digital_Competitive%20%284%29.pdf

CNIMPR. (2023). *White Charter of SMEs in Romania editia 21.* Retrieved from https://cnipmmr.ro/wp-content/uploads/2023/07/Prezentare-FJ-Ca.pdf

Cosnita, D., Iorgulescu, F., Leucuta, C., & Pirvu, G. (2024). *Situatia clusterelor din Romania.* Bucharest: CLUSTERO. Retrieved from https://clustero.eu/wp-content/uploads/2024/01/situatia-clusterelor-din-romania.pdf

Digital Innovation Hubs, E. C. (2023). *Digital Innovation Hubs: helping companies across the economy make the most of digital opportunities.* Retrieved from https://digital-strategy.ec.europa.eu/en/library/digital-innovation-hubs-helping-companies-across-economy-make-most-digital-opportunities-brochure

European Commission. (2019). *The European Green Deal.* Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691

European Commission. (2020). *Communication COM/2020/103 final -An SME Strategy for a sustainable and digital Europe.* Retrieved from https://eur-lex.europa.eu/legal-content/RO/TXT/HTML/?uri=CELEX:52020DC0103

European Commission. (2022). *Digital Economy and Society Index 2022.* Retrieved from https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2022

European Commission. (2023). *Strategic Foresight Report.* Retrieved from https://commission.europa.eu/strategy-and-policy/strategic-planning/strategic-foresight/2023-strategic-foresight-report_en#documents

European Construction Sector Observatory. (2021). *Digitalisation in the construction sector.* Retrieved from https://ec.europa.eu/docsroom/documents/45547

https://nic.innovasjonnorge.no/artikkel/english. (n.d.).

Impact of technological transformation on regional development. (2021). *Impact of technological transformation on regional development.* Retrieved from https://monitor-industrial-ecosystems.ec.europa.eu/sites/default/files/2021-09/Impact%20of%20technological%20transformation%20on%20regional%20development.pdf

Innovation Norway. (2017). *Evaluation of Norwegian Innovation Clusters.* Retrieved from https://www.regjeringen.no/contentassets/377067362c2d4f5e87cd87063bce7a62/evaluation-of-norwegian-innovation-clusters_.pdf

Institutul Național de Statistică. (2023). *Romanian Statistical Yearbook 2023.* Retrieved from https://insse.ro/cms/ro/tags/anuarul-statistic-al-Romaniei

Joint Research Centre. (2022). *Towards a green a digital future.* Retrieved from https://op.europa.eu/en/publication-detail/-/publication/58c3af16-f692-11ec-b976-01aa75ed71a1/language-en

Ministerul Economiei. (2018). *Document de Policita Industriala a României.* Retrieved from https://oldeconomie.gov.ro/images/politici-industriale/SIPOCA7/Document%20de%20Politica%20Industriala%20a%20Romaniei.pdf

Porter M. (1990). *The Competitive Advantages of Nations.* Retrieved from https://economie.ens.psl.eu/IMG/pdf/porter_1990_-_the_competitive_advantage_of_nations.pdf

Romanian Government. (2022). *National Strategy for Circular Economy.* Retrieved from https://circulareconomy.europa.eu/platform/sites/default/files/national_strategy_for_the_circular_economy_in_romania.pdf

Romanian Government. (2023). *Romania's Sustainable Development Strategy 2030.* Retrieved from https://sdgtoolkit.org/wp-content/uploads/2019/10/Romanias-Sustainable-Development-Strategy-2030.pdf

Strategia Industriala a României 2023-2027. (2023). *Ministerul Economiei Antreprenoriatului si Turismului-Strategia Industriala a României 2023-2027.* Retrieved from https://economie.gov.ro/wp-content/uploads/2023/12/Proiect-de-Strategie-Industriala-a-Romaniei-2023-2027.pdf