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# D1.1 A review of green, digital and twin transition policies

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# List of Abbreviations

| | |
|---|---|
| **ADSEU** | Advanced Digital Skills Europe |
| **AI** | Artificial Intelligence |
| **AKIS** | Agricultural Knowledge Innovation Systems |
| **DigComp** | Digital Competence Framework for Citizens |
| **EC** | European Commission |
| **ECSF** | European Cybersecurity Skills Framework |
| **EDF** | European Disability Forum |
| **EESC** | European Economic and Social Committee |
| **EGD** | European Green Deal |
| **EIB** | European Investment Bank |
| **EPSR** | European Pillar Social Rights |
| **ERDF** | European Regional Development Fund |
| **ESCO** | European Classification of Occupations, Skills, and Competences |
| **ESF+** | European Social Fund Plus |
| **EU** | European Union |
| **GreenComp** | European Sustainability Competence Framework |
| **ICT** | Information and Communications Technology |
| **IT** | Information Technology |
| **JRC** | EC Joint Research Centre |
| **JTF** | Just Transition Fund |
| **JTM** | Just Transition Mechanism |
| **MSMEs** | Micro, Small and Medium-sized Enterprises |
| **RRF** | Recovery and Resilience Facility |
| **SEIP** | Sustainable Europe Investment Plan |
| **STEM** | Science, Technology, Engineering and Mathematics |
| **SWD** | Staff Working Document |

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|---|---|
| **TT** | Twin Transition |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **VET** | Vocational Education and Training |

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# 1. Introduction

Since 2019, the European Commission (EC) has set a new strategic vision for the future, making sustainable development, together with the digital agenda, core elements of its growth strategy. This policy direction is reflected in the release of the new European strategies for growth, such as the European Green Deal, the Digital Strategy and the New Industrial Strategy for Europe. The European Green Deal (EGD)[1] was introduced as a long-term growth plan and a roadmap aiming to make Europe the first climate-neutral continent in the world. To create 'A Europe fit for the digital age'[2], the Commission has developed a digital strategy that enhances digital sovereignty and sets standards on the use of new technologies that promote a competitive economy and benefit people and society. The new Digital strategy[3] for 2020-2030[4] addresses the changes brought about by digital technologies, ensuring that all citizens, regardless of their socio-economic background or geographic location, can benefit from the opportunities offered by the digital age. The green and the digital transitions have also a prominent position in the new political guidelines for 2024-2029. The main goals of the new plan for Europe's sustainable prosperity and competitiveness include actions on industrial decarbonisation (through a 'Clean Industrial Deal' and an 'Industrial Decarbonisation Accelerator Act'), the promotion of circular economy and the improvement of productivity through digital technological diffusion[5].

The transition to green forms of production and consumption, along with the digital transformation, is expected to yield long-term environmental benefits and create new opportunities for economic growth. Current policies emphasise a just transition, meaning that all Europeans should benefit from these changes while addressing potential inequalities such as extra pressure on vulnerable households, rising unemployment for low-skilled people, challenges faced by regions more reliant on fossil fuels. Europe's green and digital transition must be just and affordable, prioritising the development of new skilled jobs, extensive retraining, smooth labour market transformations and the development of accessible products and services.

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[1] European Commission (EC) (2019). *The European Green Deal*. (Communication). COM/2019/640 final. Brussels, 11.12.2019

[2] European Commission (EC) (n.d.). *Europe fit for the digital age.* Retrieved October 16, 2024, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en

[3] The first 'Digital Agenda for Europe: 2010-2020' established, among others, the digital single market, enhanced internet connectivity, strengthened consumer protection through privacy and data protection Directives and emphasized digital growth by promoting digital skills.

[4] European Commission (EC) (2021). *2030 Digital Compass: the European way for the Digital Decade*. (Communication). COM/2021/118 final. Brussels, 09.03.2021

[5] Von der Leyen, U. (2024*). Political Guidelines for the Next European Commission 2024-2029*. https://commission.europa.eu/document/download/e6cd4328-673c-4e7a-8683-f63ffb2cf648_en?filename=Political%20Guidelines%202024-2029_EN.pdf

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While these twin transformations present significant opportunities, they also pose challenges to the social fabric, with the risk of increasing (or creating new) inequalities, particularly for people of low socio-economic status and those limited access to infrastructure (European Parliament, 2024; OECD, 2021)[6]. The implementation of the two transitions will also vary across territories, as Member States, regions, and cities have different starting points and capacities to respond to both the green and the digital transition, depending on many contextual factors such as their industrial structure, their international connectivity/collaboration and the skills of their populations.

Ideally, the two policy streams and societal transitions would complement and reinforce each other. However, their dynamic interdependence makes the twin transition a more complex process with largely unknown (positive and negative) implications to economies and societies. A recent report published by the EC Joint Research Centre (JRC) highlights that these transitions can sometimes clash, creating unintended consequences (Muench et al., 2022)[7]. The twin transition is anticipated to generate **new layers of cumulative and intertwined inequalities, with conflicting dimensions appearing over different time horizons and geographical areas** (Galgóczi, 2023)[8]. A combined (green/digital) divide could slow down overall progress and widen the gap between individuals, regions, and social groups, ultimately leading to increased inequality in the long run. Given that **European policies are often planned within a silo-based approach**[9], i.e. conceptually isolated with limited interactions among them, **it is important to recognise the distinct and joint short- and long-term effects of these transitions**. These effects, which vary **according to the social and geographic contexts of different places and populations,** necessitate dedicated and coordinated policy measures at all levels to address challenges and emerging contradictions, also considering the varying timeframes associated with specific policy decisions.

**Deliverable 1.1*'A review of green, digital and twin transition policies'*** presents the main EC policies promoting the transitions and reveals their approach in dealing with inequalities. The purpose of the deliverable is not to conduct a policy analysis but to **provide a comprehensive overview of key European policies and instruments for**

[6]Mazzoni, L., Botta, M., Carlini, R., Filistrucchi, L., Menendez Gonzalez, N., & Parcu, P. L. (2024). *Implications of the digital transformation on different social groups* (Study No. PE 760.277). Policy Department for Citizens' Rights and Constitutional Affairs, Directorate-General for Internal Policies, European Parliament. https://www.europarl.europa.eu/RegData/etudes/STUD/2024/760277/IPOL_STU(2024)760277_EN.pdf; OECD. (2021). *The inequality-environment nexus: Towards a people-centred green transition* (OECD Green Growth Papers, 2021-01). OECD Publishing. https://doi.org/10.1787/ca9d8479-en

[7] Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M. and Scapolo, F., *Towards a green and digital future*, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/54, JRC129319.

[8] Galgóczi, B. (2023) Inequality in the green transition, In Arabadjieva, K. et al. (eds.) *Transformative ideas – ensuring a just share of progress for all*. European Trade Union Institute (ETUI), ISBN: 978-2-87452-674-9

[9] Chatzopoulou, S. (2023). Resilience of the silo organizational structure in the European Commission. *JCMS: Journal of Common Market Studies*, *61*(2), 545-562

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**delivering a just and socially equal green, digital and twin transition.** Specifically, it **reviews over 100 policy documents** and initiatives established since 2020, focusing on existing or emerging inequalities within domains important for the transitions[10], such as **(i) skills, occupations, education and the labour market, (ii) technologies, industries and innovation and (iii) consumer behaviour**. Additionally, it explores main funding mechanisms and interconnections between the two policy streams, laying the groundwork for policy recommendations towards a just and equitable twin transition. The purpose of this mapping exercise is to **link the project's identified inequalities to specific policy instruments** and be able to propose targeted mitigation measures. It will also **serve as a foundation for selecting and analysing specific twin transition policies** in the project's case studies.

Methodologically, the initial step involved a thorough search for key policy documents on official EU websites, including the EC's website, EUR-Lex, and other relevant EU agency publications. The selection criteria targeted documents (including strategies, action plans, communications, and regulations) published after 2020 that specifically discuss the implementation of the two transitions and their interaction with key areas of interest, as outlined above. Documents that do not discuss inequalities or those that are too narrowly focused on technical aspects without broader social implications were excluded from the review. The timeframe captures the most recent and relevant policy developments, reflecting the EU's latest strategic priorities and actions taken to manage these transitions. Each document was organised into thematic priorities (e.g. environmental and climate policies, digital policies, social policies etc.) and was analysed to extract relevant information regarding its goals, strategic directions, and mechanisms for addressing inequalities related to the transitions, while also identifying common themes and patterns. The collection of these texts allows for the **establishment of a theoretical framework**, and a comprehensive understanding **of the EU's policy landscape** and its approach to ensuring an equitable transition.

The deliverable is structured into four sections. Following the introductory section, the second section delves into relevant EU policies, strategies and initiatives that impact the green, digital and twin transition pathways in the context of skills, labour market and education. The third section examines the sectoral implications and the spatial vulnerabilities created by the transitions focusing on technologies and industrial structures, while the fourth section is dedicated to policies concerning consumer behaviour. Each of these three sections starts with a short review of the main impacts of the transitions – introducing the reasoning behind our research – and concludes with a visual graph illustrating the timeline of the publication of strategic documents (green,

[10] Inequalities might also be discussed with regards to other domains, yet we select these areas since they are most relevant to the scope of our project.

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digital, twin), showing the evolution and political adaptation towards emerging challenges and trends. The last section focuses on the main funding mechanisms for implementing these policies and summarises our conclusions from this mapping exercise. The report is accompanied by a list of significant policy documents, including their reference details.

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# 2. Twin transition and skills, occupations, education and employment

## 2.1 The impact of the green, digital and twin transitions on skills, employment and education

The twin transition poses significant challenges regarding skills, impacting not only employment, but also people's everyday lives and how they take part in society. The complex interlinkages of the green and digital transition have direct and indirect effects across sectors and occupations, exacerbating existing patterns of social disadvantages or generating new ones.

First, *the twin digital and green transition profoundly affect job markets* by influencing **future skills demand within and across sectors, altering the bundles of tasks characterising occupations, and determining the emergence of new occupations** (Consoli et al., 2016)[11]. Jobs requiring both green and digital skills, termed as '**twin jobs' are crucial for guiding the transition** from a traditional brown-economy model to a green-growth trajectory characterised by a lower environmental risk and higher efficiency. The availability of the right skill set among workers enhances their ability to master and operate key sustainable and digital technologies, reflecting the capacity to navigate workplace transformations. Since income inequality is inherently related to the occupation performed by individuals, a lack of skills and competences can increase earning disparities among workers (Autor, 2019)[12]. The shift requires continuous learning and upskilling for individuals to remain adaptable in a changing job market and keep pace with emerging technologies and practices, through changes **in education systems**, **curriculum adjustments, new teaching methods and updated infrastructure**, to address skill gaps[13] and education and industry mismatches.

Second, the two transitions disrupt the labour market, through **job creation and job displacement**, creating inequalities among people and places. While the green transition primarily impacts specific sectors and occupations concentrated in few regions, digitalisation has a profound effect on most sectors , commonly reducing the demand

[11] Consoli, D., Marin, G., Marzucchi, A., & Vona, F. (2016). Do green jobs differ from non-green jobs in terms of skills and human capital?. *Research Policy*, *45*(5), 1046-1060.

[12] Autor, D. H. (2019). Work of the past, work of the future. *AEA Papers and Proceedings*, 109, 1-32. https://doi.org/10.1257/pandp.20191110

[13] European Commission: Directorate-General for Employment, Social Affairs and Inclusion. (2023). *Employment and social developments in Europe 2023.* Publications Office of the European Union. https://data.europa.eu/doi/10.2767/089698.

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for low skilled workers (Acemoglou and Autor, 2011; Frey and Osborn, 2017)[14]. Also, the dematerialisation of production and consumption has significant impacts on the labour market as, for instance, a relevant fraction of green jobs will rely on the development and use of digital technologies. New job categories emerge, such as those in artificial intelligence, advanced automation, electric vehicle manufacturing etc., while many traditional jobs undergo significant changes, leading to unemployment or underemployment for those unable to transition to new roles.

Third, the digital transition also **affects employment patterns by promoting remote work** and providing **greater flexibility,** but it also creates **instability regarding job security and benefits**. COVID-19 has accelerated this transition, making telework and distance learning a reality but has also brough new career challenges and revealed limitations in digital preparedness. Evidence shows that jobs that can be done from home (such as managers, educators, people working in ICT, finance etc.) have typically a higher compensation (Dingel and Neiman, 2020)[15]. There are certain occupations however (e.g. in construction, healthcare, public safety, restaurants etc.) that cannot be practiced remotely. The growing polarisation in the job market towards home office workers in well-paid high-skill occupations and low-skill, low-paying jobs can widen income inequalities and lead to a kind of embedded inequality between occupations and regions (Akgüç et al., 2023)[16]. Empirical evidence from both the United States and Europe shows that regions with higher share of employment in information work (including management, professional and related occupations) tend to shift towards working from home at a higher percentage (Brynjolfsson et al. 2020[17]; Eurostat 2022[18]).

The rapid digitalisation of workplaces raises concerns about surveillance, data usage, and the implementation of algorithmic management tools[19]. Artificial intelligence (AI) systems are frequently employed to **streamline recruitment, monitor workloads, determine pay rates**, manage careers, and enhance process efficiency, particularly in

[14] Acemoglu, D. and D. H. Autor (2011), Skills, tasks and technologies: Implications for employment and earnings, in O. Ashenfelter and D. E. Card (eds.), Handbook of Labour Economics, 4B, 1043-1171, Elsevier; Frey, C.B., M.A. Osborne (2017): The Future of Employment: How Susceptible are Jobs to Computerization? Technological Forecasting and Social Change 114: 254–280

[15] Dingel, J. I., & Neiman, B. (2020). How many jobs can be done at home?. *Journal of public economics*, *189*, 104235.

[16] Akgüç, M., Galgóczi, B., & Meil, P. (2023). Remote work and the green transition. In Countouris, N. et al. *The future of remote work,* European Trade Union Institute (ETUI), pp. 45-59.

[17] Brynjolfsson E., Horton J.J., Ozimek A., Rock D., Sharma G. and TuYe H.Y. (2020) Covid-19 and remote work: an early look at US data, Paper 27344, *National Bureau of Economic Research*. http://www.nber.org/papers/w27344

[18] Eurostat (2022). *Rise in EU population working from home*, Eurostat Newsletter, 8 November 2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20221108-1 (retrieved 14.07.2024)

[19] European Commission (EC) (2021). *Better working conditions for a stronger social Europe: harnessing the full benefits of digitalisation for the future of work.* (Communication). COM/2021/761 final. Brussels, 9.12.2021

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high-stakes tasks (Köchling and Wehner, 2020[20]; Tilmes, 2022[21]). However, algorithms may be biased along social axes such as race, gender, and class (Mitchel et al., 2021)[22], therefore, tackling the challenges posed by algorithmic decision-making – such as biased outcomes, discrimination, and transparency issues – can bolster trust in AI systems, encourage their adoption, and safeguard fundamental rights. Ensuring that digitalisation does not undermine established labour rights and protections remains a critical issue.

Overall, the two transformations create unequal effects on many fronts, including skills, gender, age, and region. Men and women, older people, persons with disabilities, displaced persons or socially marginalised have different adaptive capacities. Among the categories that pay the largest cost are **low-skilled and older workers** (next to the retirement age), who face **job insecurity and mental well-being deterioration** (Charles et al., 2022; Lee and Clark, 2019)[23]; young people, raising concerns about **intergenerational inequality**; as well as women, who have lower access to, adoption of and representation in green and digital occupations and technology (Kaddour and Ghbara, 2023)[24]. There is already a large body of literature on inequalities related to gender and intersectionality in the green transition (Allwood, 2020; Johnson et al., 2020)[25], and the digital transition (Clancy and Feenstra, 2019)[26]. These studies discuss the negative impact of green policies on deeply entrenched social inequalities and the consequences of the digital gap on disadvantaged groups of people, including older adults, people with some disabilities, marginalised women, or indigenous peoples (Liptrott, 2016; Fang et al., 2019; Mariscal et al., 2019)[27]. The current state of the art

[20] Köchling, A., & Wehner, M. C. (2020). Discriminated by an algorithm: a systematic review of discrimination and fairness by algorithmic decision-making in the context of HR recruitment and HR development. *Business Research*, *13*(3), 795-848

[21] Tilmes, N. (2022). Disability, fairness, and algorithmic bias in AI recruitment. *Ethics and Information Technology*, *24*(2), 21

[22] Mitchell, S., Potash, E., Barocas, S., D'Amour, A., & Lum, K. (2021). Algorithmic fairness: Choices, assumptions, and definitions. Annual Review of Statistics and Its Application, 8:141– 163.

[23] Charles, L., Xia S., Coutts A. P. (2022). Digitalization and employment: a review. International Labour Organisation. https://www.ilo.org/publications/digitalization-and-employment-review; Lee, N., & Clarke, S. (2019). Do low-skilled workers gain from high-tech employment growth? High-technology multipliers, employment and wages in Britain. Research Policy, 48(9), 103803

[24] Kaddour, A., Ghbara, H. (2023). Gender Inequalities, Poverty, and Disparities: Impact and Links in the Era of Digital Transformations and Green Transition. In: Drucza, K., Kaddour, A., Ganguly, S., Sarea, A.M. (eds) Centering Gender in the Era of Digital and Green Transition. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-38211-6_3

[25] Allwood, G. (2020). Mainstreaming gender and climate change to achieve a just transition to a climate-neutral Europe. *J. Common Mkt. Stud.*, *58*, 173; Johnson, O. W., Han, J. Y. C., Knight, A. L., Mortensen, S., Aung, M. T., Boyland, M., & Resurrección, B. P. (2020). Intersectionality and energy transitions: A review of gender, social equity and low-carbon energy. *Energy Research & Social Science*, *70*, 101774.

[26] Clancy, J., & Feenstra, M. (2019). *Women, gender equality and the energy transition in the EU*. Publications Office of the European Union.

[27] Liptrott, M. (2020). Tackling the digital divide: The shift from access to capacity. In *Wealth Creation and Poverty Reduction: Breakthroughs in Research and Practice* (pp. 1-16); Fang, M. L., Canham, S. L., Battersby, L., Sixsmith, J.,

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suggests that the green, digital and twin transition have the potential to simultaneously exacerbate and address gendered and intersectional inequalities.

The EC has identified these challenges in various documents and implemented targeted measures to address them. However, progress in different areas varies due to the diverse backgrounds and specificities of individuals and regions. As the nature of these inequalities continues to be explored, new forms of – sometimes intersecting – inequalities are being identified, necessitating the evolution of these policies. To effectively tackle these disparities, the Commission must continuously adapt its strategies, ensuring they remain inclusive and responsive to emerging challenges.

## 2.2 Green, digital and twin skills and jobs

The green and digital transitions are expected to significantly reshape the labour market by creating new jobs and transforming existing ones. According to the EC, more than 2.5 million additional jobs will be created in the EU by 2030. This growing demand for green and digital jobs requires a common understanding among policy makers to effectively stimulate employment and develop the necessary skills (Auktor, 2020)[28]. Although accelerating upskilling and reskilling to succeed in increasing digital and eco-friendly jobs is a major challenge for the coming years, to date, there is **not a fixed definition of what exactly these skills are**, as technologies, requirements, regulatory standards continuously evolve. The following section provides a review of how the EC and other organisations define green and digital skills, which will be discussed in later sections of this document.

### 2.2.1 What are green skills and jobs

Green jobs, as defined by the European Commission (EC, 2013)[29], encompass all jobs that *'depend on the environment or are created, substituted, or redefined (in terms of skills sets, work methods, profiles generated, etc.) in the transition process towards a greener economy'*. A taxonomy of 'greenable' jobs is explored in a 2019 Staff Working Document (SWD) examining employment and social impacts of climate change policies (EC, 2019)[30].

Wada, M., & Sixsmith, A. (2019). Exploring privilege in the digital divide: implications for theory, policy, and practice. *The Gerontologist*, *59*(1), e1-e15.; Mariscal, J., Mayne, G., Aneja, U., & Sorgner, A. (2019). Bridging the gender digital gap. *Economics*, *13*(1), 20190009

[28] Auktor, G. V. (2020). Green industrial skills for a sustainable future. United Nations Industrial Development Organization, Vienna.

[29] European Commission (EC), Barton, M., Hawley, J., Scott, D., Manoudi, A., Marsden, J., Farrell, J., Medhurst, J., & Finlay, L. (2013). *European employment observatory review - Promoting green jobs throughout the crisis: A handbook of best practices in Europe.* Directorate-General for Employment, Social Affairs and Inclusion. Luxembourg: Publications Office of the European Union. https://data.europa.eu/doi/10.2767/43395

[30] European Commission (EC) (2019), Sustainable growth for all: choices for the future of Social Europe, Employment and Social Developments in Europe 2019, chapter 5, *Towards a greener future: employment and social impacts of climate change policies.* (Staff Working Document). SWD/2019/579, 4 July 2019.

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According to this document, the taxonomy is based on 'a broad definition of greenable jobs as all jobs/occupations that will be affected by greening'. Five categories were identified: (i) Green Increased Demand jobs, (ii) Green Enhanced Skills jobs, (iii) Green New and Emerging jobs, (iv) Green Rival jobs, (v) Other non-green jobs.

Green skills were originally defined by Cedefop (2012) [31] as *'the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society'*. This definition was extended by the OECD and Cedefop (2014)[32] to include the skills needed across all sectors and levels to adapt to climate change and comply with environmental regulations[33], a definition adopted in the Council Recommendation on Learning for the Green Transition and Sustainable Development.

In a recent publication (Bianchi et al., 2022)[34], the GreenComp, the European Sustainability Competence Framework, defines a broader term, namely sustainability competences, as the knowledge, skills, and attitudes necessary for sustainable living, working, and acting. In this context, green skills are defined as professional skills that are required across all sectors and levels for the green transition. These skills include the creation of new green jobs and the transversal skills that are essential for critical thinking, systems thinking, problem solving, and innovation.

Aiming to support a society that minimises environmental impact, the European Classification of Occupations, Skills, and Competences (ESCO) has recently (2022) created a new taxonomy of green skills (EC, 2022)[35]. ESCO classified (through machine learning processes) skills into *green*, *brown*, and *white* categories based on their environmental impact, with the green category representing skills and knowledge concepts with a low environmental impact. The ESCO taxonomy includes 571 green-labelled skills and knowledge concepts, including information and communication skills and expertise in engineering, manufacturing, and natural sciences (Figure 1)[36]. This

[31] Cedefop (2012). *Green skills and environmental awareness in vocational education and training*. Luxembourg: European Commission.

[32] OECD/Cedefop (2014). *Greener skills and jobs*. OECD green growth studies. OECD Publishing. Paris. https://doi.org/10.1787/9789264208704-en.

[33] OECD and Cedefop (2014) defined green skills as: *'the skills needed by the workforce, in all sectors and at all levels, in order to help the adaptation of products, services and processes to the transformations due to climate change and to environmental requirements and regulations'*

[34] Bianchi, G., Pisiotis, U., Cabrera Giraldez, M. (2022*) GreenComp – The European sustainability competence framework.* Bacigalupo, M., Punie, Y. (editors), EUR 30955 EN, Publications Office of the European Union, Luxembourg.

[35] European Commission (EC) (2022) *Green skills and knowledge concepts: labelling the ESCO classification technical Report*—January 2022.

[36] As for the skills hierarchy, about half of the skills are part of: (a) information skills (S2) and Communication, collabouration, and creativity skills (S1). Within the knowledge hierarchy, which is based on the International Standards Classification of Education (ISCED-F), most of the skills labelled as green are part of the following groups: (a) Engineering, manufacturing, and construction (e.g. types of wind turbines, sustainable installation materials, emission standards) and (b) Natural sciences, mathematics, and statistics (e.g. ecological principles, biomass conversion, oceanography).

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comprehensive list of green skills and knowledge is available on the ESCO portal[37], providing essential resources for aligning education and training programmes with the demands of the green economy, while also ensuring that the workforce is prepared for future challenges and opportunities.

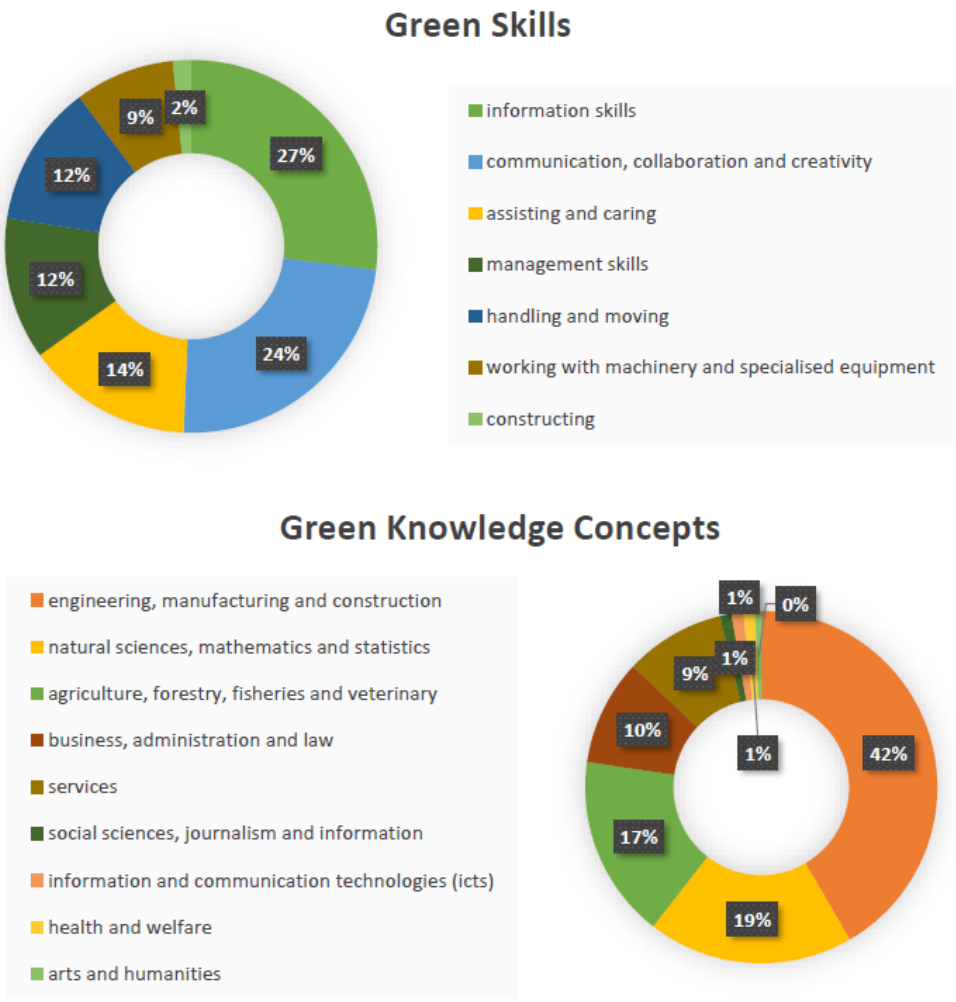


***Figure 1: Distribution of green concepts in the skills and knowledge (EC, 2022, p.6)***

Since 2020, Cedefop performs sectoral skills foresight exercises with a forward looking approach as well as country reports to understand the occupation/skills profiles that are necessary for a greener future.

[37] European Commission (EC) (n.d.). Use ESCO: Download. ESCO. https://esco.ec.europa.eu/en/use-esco/download

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### 2.2.2 What are digital skills and jobs

'Digital' jobs are categorised into three types based on their relationship with digital technologies (World Bank, 2018)[38]. First, ICT-intensive jobs, such as software developers and 3D animators, are entirely dependent on digital services and technologies. Second, ICT-dependent jobs, like stockbrokers and call centre analysts, utilise digital advancements but also require skills from other disciplines. Third, ICT-enhanced jobs, such as graphic designers and accountants, benefit from digital technologies but can function without them, though with reduced performance or quality. The Digital Skills and Jobs Platform (2023)[39] argues that digital jobs encompass all jobs *'where application of information and communications technologies (ICT) to a new or existing activity or process is essential, although other skills can also be crucial.'*

Key to facilitating this digital transformation is the cultivation and comprehension of 'digital skills'. As defined by the UNESCO Institute for Statistics (2009)[40], digital skills encompass *'a range of abilities to use digital devices, communication applications, and networks to access and manage information'.* These skills empower individuals to collaborate, solve problems, and explore innovative opportunities. Building on this, the Council Recommendation on Key Competences for Lifelong Learning (EC, 2019)[41] further defines digital competence as *'the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It is defined as a combination of knowledge, skills, and attitudes'.* It emphasises the integration of knowledge, skills, and attitudes necessary for effective digital engagement across various contexts.

Later developments in defining digital skills are articulated through the DigComp framework (Figure 2), which identifies key digital skills and competencies across five general areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Vuorikari, Kluzer, & Punie, 2022)[42]. This framework provides a structured approach to understanding and developing digital

[38] World Bank (2018). *Digital Jobs for Youth: Young Women in the Digital Economy.* https://documents1.worldbank.org/curated/en/503651536154914951/pdf/129757-S4YE-Digital-Jobs-Report.pdf

[39] Digital Skills and Jobs Platform (2023). Digital Jobs Deep Dive. https://digital-skills-jobs.europa.eu/en/latest/briefs/digital-jobs-deep-dive

[40] UNESCO Institute for Statistics (2009). *Guide to Measuring Information and Communication Technologies (ICT) in Education.* https://uis.unesco.org/sites/default/files/documents/guide-to-measuring-information-and-communication-technologies-ict-in-education-en_0.pdf

[41] European Commission, Directorate-General for Education, Youth, Sport and Culture, (2019). *Key competences for lifelong learning*, Publications Office. https://data.europa.eu/doi/10.2766/569540

[42] Vuorikari, R., Kluzer, S., & Punie, Y. (2022*). DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes* (EUR 31006 EN). Publications Office of the European Union. https://doi.org/10.2760/490274

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competencies essential for navigating the digital landscape and contributing to the digital economy.

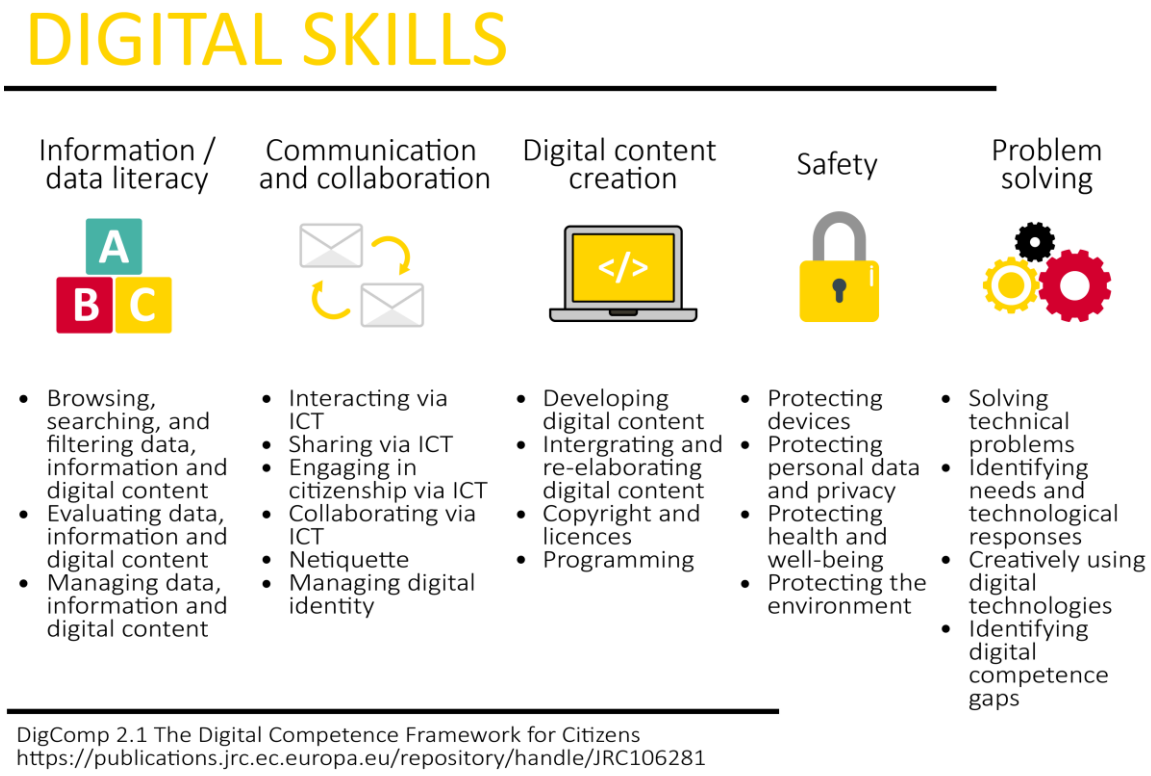


***Figure 2: The digital competence framework for citizens (Carretero, S.; Vuorikari, R. and Punie, Y., 2017)[43]***

Assessing the employment impacts of the digital transition is intricate, involving comprehensive evaluations of related policies and their economic and labour market repercussions. According to Cedefop (2021)[44], the demand for digital skills and knowledge has seen significant growth in online job advertisements, particularly in sectors requiring expertise in business ICT systems, software and web development tools, and data analysis. This trend reflects a broader shift towards workplace digitalisation, which is expected to endure beyond the pandemic, reshaping skills, tasks, and job roles across various industries. The integration of digital technologies into organisational business models and customer interactions suggests a lasting impact on skills development and job requirements in the digital economy (Cedefop, 2023)[45].

[43] Carretero, S.; Vuorikari, R. and Punie, Y. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use, EUR 28558 EN, doi:10.2760/38842

[44] Cedefop. (2021). *Digital skills: Challenges and opportunities*. https://www.cedefop.europa.eu/en/data-insights/digital-skills-challenges-and-opportunities

[45] Cedefop. (2023, March). *2023 skills forecast: Technical report*. https://www.cedefop.europa.eu/files/2023_skills_forecast_technical_report.pdf

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Cedefop's skills forecast report (2023) predicts that IT professionals and technicians will contribute 8.3% to employment growth in the EU-27 by 2030, reflecting the critical role of digital competencies in future workforce dynamics.

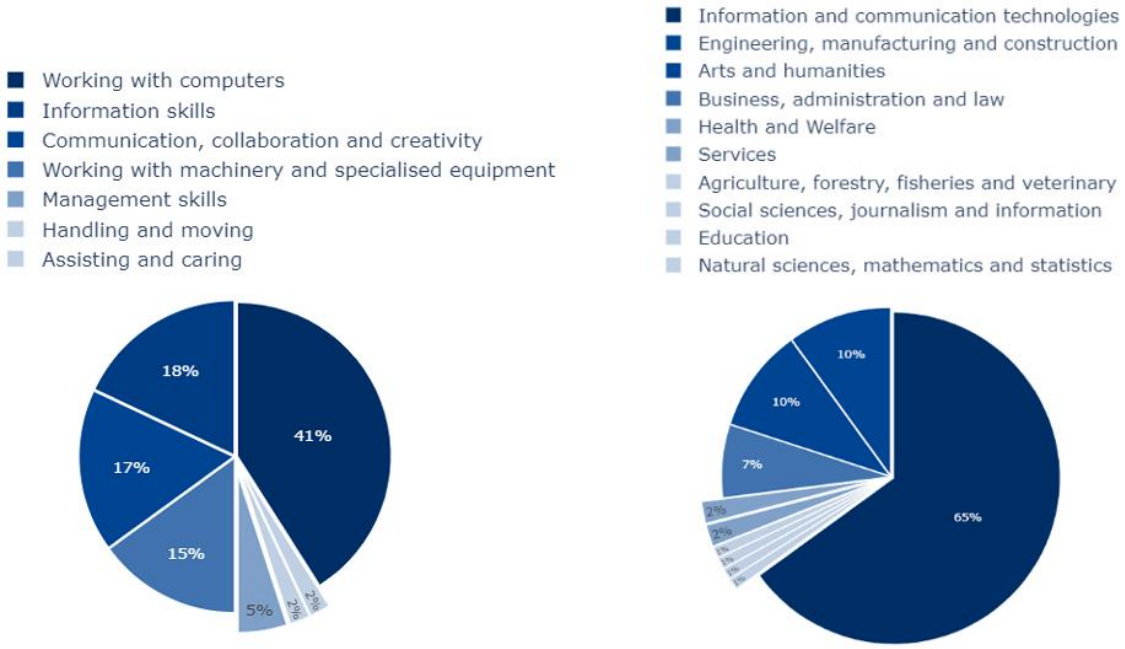


***Figure 3: Distribution of digital concepts in the respective hierarchies (EC, 2022, p.9)[46]***

In line with the European Skills Agenda and the Commission's efforts to tackle the digital skills gap, ESCO has also distinguished digital skills and knowledge competences as part of its classification, introducing Digital Skills and Knowledge Concepts labelling (EC, 2022)[47]. This labelling is based on the Digital Competence Framework for Citizens (DigComp)[48], which provides a common language to identify and describe key areas of digital competence, as mentioned above. As with the green skills, the labelling process combined machine learning algorithms with human validation, resulting in the classification of 1,201 ESCO skills and knowledge concepts as digital, including 718 skills, 475 knowledge concepts, and 7 transversal skills. Figure 3 shows the distribution of the digital concepts in the skills and knowledge[49]. The comprehensive list of digital

[46] European Commission (EC) (2022). *Digital Skills and Knowledge Concepts: Labelling the ESCO classification technical Report*—October 2022.

[47] European Commission (EC) (2022). *Digital Skills and Knowledge Concepts: Labelling the ESCO classification technical Report*—October 2022.

[48] European Commission (EC), Joint Research Centre (JRC), Vuorikari, R., Kluzer, S., Punie, Y. (2022). *DigComp 2.2, The Digital Competence framework for citizens: with new examples of knowledge, skills and attitudes*, Publications Office of the European Union.

[49] As for the skills hierarchy, groups on information skills, communication, collaboration and creativity, and working with machinery have about the same share. Examples of digital skills mapped in these groups are: collection of data using GPS, edit digital moving images, maintain automated lighting equipment. Looking at the knowledge hierarchy,

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skills and knowledge is available on the ESCO portal, providing essential resources for aligning education and training programs with the demands of the digital economy while also ensuring that the workforce is prepared for future challenges and opportunities.

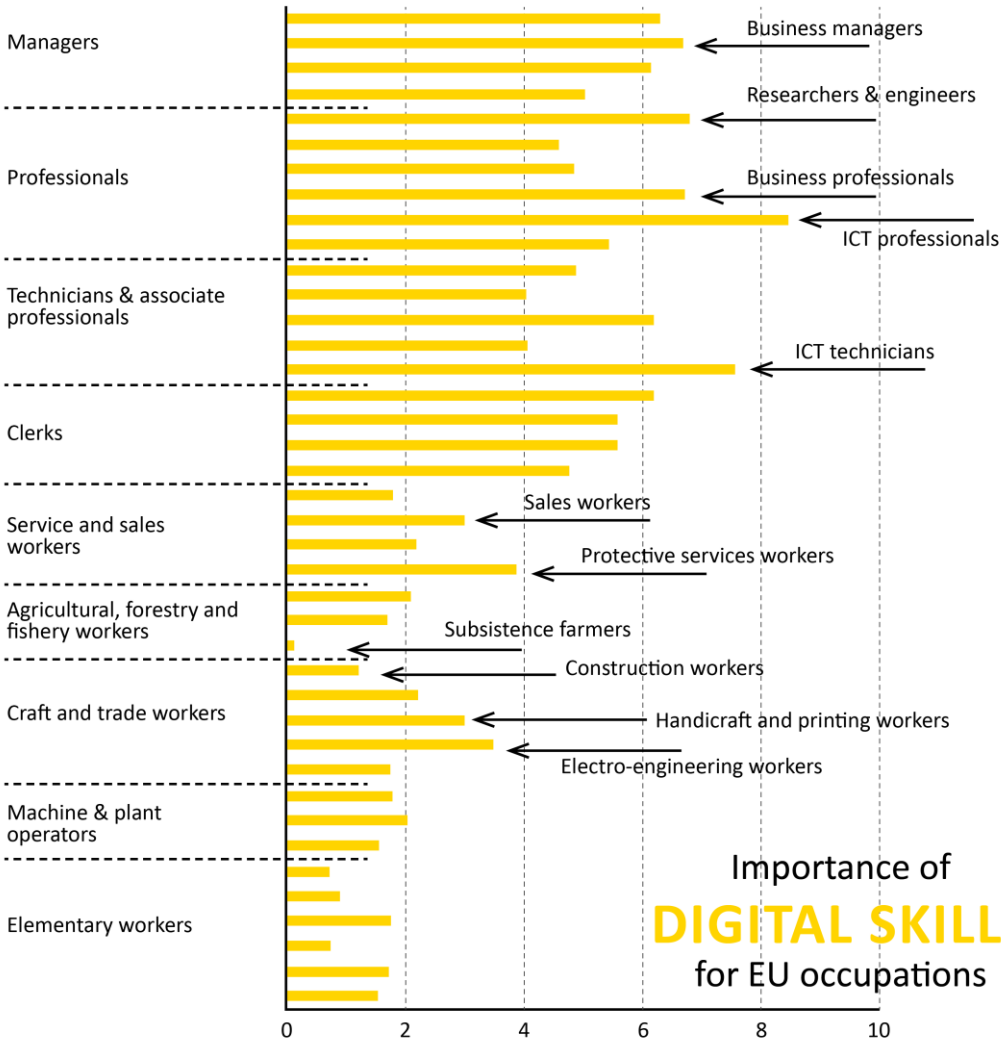


***Figure 4: Use of ICT in occupations (ISCO 1 and 2), (Cedefop Skills Panorama, 2020)[50]***

Even before the COVID-19 pandemic, demand for digital skills was high across various sectors, including finance, business administration, science & engineering, education, health care, trade, and manufacturing. While most managerial, professional, and

which is based on the International Standard Classification of Education (ISCED), following ICT concepts, knowledge concerning engineering, manufacturing and construction, and arts and humanities have the same share of digital concepts. Examples are: building systems monitoring technology, 3D printing process.

[50] Tasks within occupation indicator, Cedefop Skills Panorama (2020) https://skillspanorama.cedefop.europa.eu/en/indicators/tasks-within-occupation

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clerical jobs require digital skills, certain medium to low skilled occupations, such as protective services and electro-engineering workers, also demand higher digital skills (Figure 4).

Addressing the skills needed for a greener economy is crucial to closing the skills gap in the labour market and mitigating the potential negative employment effects of environmental regulation (Vona et al., 2015)[51]. On the other hand, digital skills create new opportunities and can mitigate potential negative impacts of technological advancements (EC, 2017)[52]. The demand for both green and digital skills will permeate all sectors of the economy, requiring accelerated upskilling and reskilling efforts to meet evolving labour market demands (Knudsen et al., 2023; OECD, 2024)[53],[54].

## 2.3 EU policies on green, digital and twin skills and labour market transformation

### 2.3.1 The European Green Deal and green skills and occupations

The **European Green Deal** (EC, 2019)[55], launched in December 2019, is the main strategy for promoting a clean and circular European economy. It serves as a roadmap and a collection of policies affecting various sectors, setting ambitious targets for achieving carbon neutrality by 2050. The Green Deal emphasises the importance of a just transition, ensuring that the move towards a greener economy is fair and inclusive, providing support for regions, industries, and workers who may be adversely affected by the changes. Among the key policy measures complementing other actions under the next multiannual financial framework for the period 2021-2027 is the **Just Transition Mechanism** (JTM)[56], part of the Sustainable Europe Investment Plan (EC, 2020)[57]. Besides these flagship documents, the importance of skills is also evident in many policies developed since 2020 to implement the European Green Deal across various aspects such

[51] Vona, F., G. Marin, D. Consolin, and D. Poll (2015). Green skills. NBER Working Paper No. 21116. Cambridge US: National Bureau of Economic Research.

[52] European Commission (EC) (2017). Digital Single Market: Making the Most of Digital Opportunities in Europe. https://digital-strategy.ec.europa.eu/en/library/digital-single-market-making-most-digital-opportunities-europe

[53] Knudsen, M., Caniëls, M., Dickinson, P., Hery, M., Könnölä, T., & Lotz-Sisitka, H. (2023). Futures of green skills and jobs in Europe in 2050: scenario and policy implications.

[54] OECD (2024), OECD Digital Economy Outlook 2024 (Volume 1): Embracing the Technology Frontier, OECD Publishing, Paris, https://doi.org/10.1787/a1689dc5-en.

[55] European Commission (EC) (2019). *The European Green Deal*. (Communication). COM/2019/640 final. Brussels, 11.12.2019

[56] European Parliament, Council of the European Union (2021). T*he public sector loan facility under the Just Transition Mechanism*. (Regulation (EU) 2021/1229). PE/33/2021/REV/1. Brussels, 14.07.2021

[57] European Commission (EC) (2020) *Sustainable Europe Investment Plan, European Green Deal Investment Plan.* (Communication). COM/2020/ 21 final. Brussels, 14.01.2020

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as climate, energy, agriculture and industry. Below, we outline the main policies where skills are more explicitly mentioned and include the way these are addressed.

Among the first EDG strategic documents where skills are being mentioned, is EU's strategy for a sustainable future '**Circular Economy Action Plan for a Cleaner and More Competitive Europe**' (EC, 2020)[58] launched in March 2020. This Plan underlines the essential role of green skills and education in the green transition. It highlights that the shift to a circular economy will have a net positive effect on job creation, contingent upon equipping workers with the necessary skills.

The **Farm to Fork Strategy** (EC, 2020)[59], a key component of the European Green Deal, creates pathways for education and skills development to prepare a workforce capable of supporting and promoting sustainable food systems. It highlights the need of primary producers for **tailored advisory services, for data and knowledge sharing and the acquisition of skills**. Although its primary focus is on environmental and health outcomes, the strategy promotes investment in the research, innovation and technology needed for sustainable food systems. Among the proposed actions are **human and financial investments to accelerate the uptake of digital technologies** in the agro-food sector and initiatives to promote innovation and skills development, such as Agricultural Knowledge and Innovation Systems (AKIS).

The **European Climate Pact** (EC, 2020)[60,61], launched in December 2020, aims to engage the public in climate action and pull-down potential barriers resulting from personal characteristics such as gender, age and disabilities. It **focuses on the development of green skills,** which are essential for employment in the green economy and for changes in people's behaviours, ensuring that these programmes are accessible to everyone, **including people with disabilities**. Additionally, it supports educational institutions in **developing programmes in flexible learning formats** for people of all ages, backgrounds and languages. These efforts aim to ensure an inclusive green transition, address social inequalities and promote a resilient green economy across Europe.

The '**Fit for 55 Package**' (EC, 2021)[62] is a set of interconnected proposals aiming towards a fair, competitive green transition. It argues that the green transition can only succeed if

[58] European Commission (EC) (2020). *A new Circular Economy Action Plan: for a cleaner and more competitive Europe.* (Communication). COM/2020/98 final. Brussels, 11.03.2020

[59] European Commission (EC) (2020). *A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system.* (Communication). COM/2020/381 final. Brussels, 20.05.2020

[60] European Commission (EC) (2020) *European Climate Pact.* (Communication). COM/2020/788 final. Brussels, 09.12.2020

[61] European Parliament and Council of the European Union (2021). Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'). Office Journal, L 243, p. 1. Brussels, 30.06.2021

[62] European Commission (EC) (2021) 'Fit for 55': *delivering the EU's 2030 Climate Target on the way to climate neutrality*. (Communication). COM/2021/550 final. Brussels, 14.7.2021

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the EU has the skilled workforce it needs in order to remain competitive. In this context, it recognises the crucial role of education and training and the need for a skilled workforce to maintain the EU's competitiveness during this transformative period. The package also highlights the importance of linking demand and supply in the labour market.

Following this, the **European Economic and Social Committee (EESC)** has published two opinion documents. The first relates to **an EU strategy for enhancing green skills and competences for all**[63], which underscores the necessity of integrating green skills into all levels and forms of education and training across Europe. The EESC emphasises that environmental responsibility is a collective obligation requiring a fundamental shift in societal attitudes, behaviours, and organisational structures. To achieve sustainable development and meet the UN Sustainable Development Goals (SDGs), particularly SDG 4 on quality education and SDG 13 on climate action, **Member States are urged to develop effective national strategies**. These strategies should involve social partners and stakeholders to promote inclusive, equitable education and to enhance awareness and skills related to climate change mitigation and sustainable development. The integration of green skills into the curriculum should not only focus on environmental topics but also **foster a culture of sustainability in schools, workplaces, and communities**. Furthermore, the EESC calls for **comprehensive policies, sustainable funding, and professional support for teachers and trainers to facilitate this integration**, ensuring that all citizens, regardless of age or socio-economic background, acquire the necessary competences to contribute to a green economy and society.

According to the second document[64], a successful green transition requires that micro, small and medium-sized enterprises (MSMEs) should also be ready for this transition. For this reason, **EESC** recommends: (i) appropriate curriculum development (of vocational and university studies and of continuous professional development) that take into account the skills needed in the green transition, (ii) close cooperation between MSMEs and education providers, (iii) social dialogue to identify needs and develop skill at workplaces, and (iv) creation of appropriate indicators and tools to monitor the impact of MSMEs in relation to green transition.

Following the 'Fit for 55' package and the accompanying proposal for establishing a social climate fund[65], the EC published a **Proposal for a Counsil Recommendation on Ensuring**

[63] European Economic and Social Committee (2021). *Opinion of the European Economic and Social Committee on towards an EU strategy for enhancing green skills and competences for all* (own-initiative opinion). Office Journal, C 56, p. 1-9. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020IE1255

[64] European Economic and Social Committee (2022). *Opinion of the European Economic and Social Committee on SMEs, social economy enterprises, crafts and liberal professions / Fit for 55* (own-initiative opinion). Office Journal, C 486, p. 1-8. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022IE1049

[65] European Parliament and Council of the European Union (2023). Establishing a Social Climate Fund and amending regulation (EU) 2021/1060. (Regulation). PE/11/2023/REV/1. Strasbourg, 10.05.2023

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**a Fair Transition Towards Climate Neutrality**[66], providing guidance to Member States on **how best to address the social and labour aspects of the climate transition**. It aims to achieve several key objectives, including a fair and inclusive transition, particularly for workers and households most affected by the green transition and for vulnerable groups. In terms of skills development, the proposal is closely aligned with the associated European policy, as it emphasises on the importance of up-skilling and re-skilling to support the green transition. In this context, it **calls for national skills strategies** to integrate just transition aspects, in line with the European Skills Agenda, and advocates the use of **labour market intelligence to identify relevant skills needs**. It also stresses the importance of lifelong learning opportunities and support for labour market transitions as key prerequisites for a just and inclusive green transition. Overall, it aims to promote fairness and inclusivity throughout the green transition pathway while addressing equity and inequalities issues.

A Commission **Staff Working Document accompanying** the above-mentioned proposal[67] argues that **priority should be given to stimulating job creation in the regions most affected by the green transition** and supports facilitating access to finance and markets for small and medium-sized enterprises (SMEs) that contribute to climate and environmental goals. In addition, this SWD explores some **emerging business models**, such as 'carbon farming', which are consistent with climate objectives and offer new opportunities regarding: (i) tailor-made strategies and plans (to specific policy areas and tools), (ii) **skills intelligence and foresight** (in addressing skill needs for the green transition), (iii) **vocational education and training** (VET) and (iv) holistic approaches (to address the skills needs associated with the green transition). More recent policy documents give greater emphasis to skills and link the importance of both types of skills (green and digital) for the green transition. Skills is one of the four pillars outlined in the Commission's **Green Deal Industrial Plan for the Net-Zero Age** (EC, 2023)[68], to achieve a people centred and inclusive transition. It **promotes both green and digital skills to all people, including women and the youth**. The Commission will consider how to combine a **'Skills-first' approach,** recognising actual skills, with existing approaches based on qualifications, and works on measures to **foster and align public and private funding** for skills development. Addressing labour shortages in key professions critical to net-zero

[66] European Commission (EC) (2021). *Ensuring a fair transition towards climate neutrality.* (Proposal for a Council Recommendation). COM/2021/801 final. Strasbourg, 14.12.2021

[67] European Commission (EC) (2021). Accompanying the Proposal for a Council Recommendation on: *Ensuring a fair transition towards climate neutrality*. (Commission Staff Working Document). SWD/2021/452 final. Strasbourg, 14.12.2021

[68] European Commission (EC) (2023). *A Green Deal Industrial Plan for the Net-Zero Age.* (Communication). COM/2023/62 final. Brussels, 01.02.2023

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industries (as indicated by a report from the European Labour Authority)[69] would cost between €1.7 billion and €4.1 billion by 2030[70]. To meet these needs, the EU and Member States need to **invest in STEM education and training, promoting gender inclusivity and practical experience**. Indirect support for skills development may come from programmes such as Erasmus+, which promotes sectoral cooperation on skills, and the European Social Fund Plus (ESF+), which provides €5.8 billion for green skills and jobs. The European Regional Development Fund (ERDF) adds €8.9 billion for skills, education, and training infrastructure, while the Just Transition Fund provides €3 billion for worker training. The role of several initiatives (e.g. European Skills Agenda, European Pact of Skills, European Year of Skills, etc.) and significant EU funding resources towards this direction are also mentioned in the Green Deal Industrial Plan for the Net-Zero Age.

More specific proposals regarding skill shortages and mismatches that pose a threat to the growth of European net-zero technology industries are made in the **Net Zero Act** (EC, 2023)[71]. Chapter V of this document details some relevant policies that could enhance skills for the clean energy transition. Among them, a distinct objective is to create synergies between Member States by encouraging cooperation among educational institutions, promoting best practice exchanges, and developing joint programmes. This chapter also underscores the need for a skilled, adaptable workforce through comprehensive training programmes on net-zero technologies, lifelong learning, and incentives for business investment in training. Aiming to address the most important labour market challenges, the Proposal includes a set of **targeted recruitment strategies and promotes both diversity and programmes to transition workers from traditional to clean energy labour sectors**. It also supports innovation and entrepreneurship by funding R&D, by establishing innovation hubs, and by fostering industry-academia-government partnerships.

The majority of the abovementioned documents mention and promote European social policies that deal with issues of skills, education, gender equality and so on, among which are the European Skills Agenda for Sustainable Competitiveness, Social Equity and Resilience, the Pact for Skills[72], the European Education Area by 2025 (and its flagship

[69] John McGrath (2021), Report on Labour Shortages and Surpluses, European Labour Authority, https://www.ela.europa.eu/sites/default/files/2023-12/2021_Labour_shortages_surpluses_report.pdf, November 2021, ISBN 978-92-9464-189-2.

[70] European Commission (EC) (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity*. (Staff Working Document). SWD/2023/ 68 final. Brussels, 23.03.2023

[71] European Commission (EC) (2023). Proposal for a Regulation of the European Parliament and of the Council on: *Establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act).* (Communication). COM/2023/161 final. Brussels, 16.03.2023

[72] European Commission (EC) (n.d.). Social Europe: European Pillar of Social Rights Action Plan. (Pact for Skills). https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

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initiative Education for Climate Coalition[73]) as well as other programmes, practices and initiatives such as the European Vocational Skills Week[74], Skills for Life, the European Alliance for Apprenticeships[75] and Erasmus+[76] funded projects. They also promote the Youth Guarantee to offer opportunities in the green sector to unemployed youth. The Commission has also published a number of documents on learning for sustainability[77] and vocational education and training for sustainable development[78]. These policies are described in more detail in section 1.3.3 of the present document.

### 2.3.2 Europe fit for the digital age and green, digital and twin skills and occupations

Between February 2020 and March 2021, the EC published two policy documents forming the core of the Commission's priority to a Europe fit for the digital age. First, the Commission's digital strategy '**Shaping Europe's Digital Future**' (EC, 2020)[79], presents the vision and goals behind the Commission's digital priority, while the second, **'2030 Digital Compass: The European Way for the Digital Decade'** (EC, 2021)[80] translates the Commission's ambitions into concrete actions. Shaping Europe's Digital Future expresses the importance of **education and skills** for the digital transformation highlighting that digital skills and competences are not only increasingly necessary for the labour market but also for participating in society. The Digital Compass places skills as one of the four cardinal points for mapping the EU's digital transformation trajectory. It mentions the need not only for **essential digital skills** to bolster societal resilience (such as basic computing enabling for example individuals to trust digital products and identify disinformation) but also of **advanced digital skills** for quality jobs (e.g. in areas like cybersecurity and data analysis). In fact, basic digital skills are considered as a precondition for delivering on the twin transition and for inclusion and participation in

[73] European Commission (EC) (n.d.). *Education for Climate community*. https://education-for-climate.ec.europa.eu/community/

[74] European Commission (EC) (n.d.). *European Vocational Skills Week*. https://vocational-skills.ec.europa.eu/index_en

[75] European Commission (EC) (n.d.). *Employment and social affairs: Overview.* https://ec.europa.eu/social/main.jsp?catId=114

[76] European Commission (EC) (n.d.). *Erasmus+ projects*. https://ec.europa.eu/programmes/erasmus-plus/projects/

[77] European Commission: Directorate-General for Education, Youth, Sport and Culture (2022). *Learning for the green transition and sustainable development : staff working document accompanying the proposal for a Council recommendation on learning for environmental sustainability*. Publications Office of the European Union. https://data.europa.eu/doi/10.2766/02392.

[78] Council of the European Union (2020). *Recommendation on vocational education and training (VET) for sustainable competitiveness, social fairness and resilience.* 2020/C 417/01. Brussels, 24.11.2020.

[79] European Commission (EC) (2020). *Shaping Europe's digital future.* (Communication). COM/2020/67 final. Brussels, 19.02.2020

[80] European Commission (EC) (2021). *2030 Digital Compass: the European way for the Digital Decade.* (Communication). COM/2021/118 final. Brussels, 09.03.2021

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the labour market and society. The **'Path to the Digital Decade'** (EC, 2021)[81], the implementation roadmap for Europe's digital strategy, provides measurable targets for digital skills, infrastructure and digital penetration in businesses and the public sector. It also notices **gender disparity in digital penetration** and aims to adopt the recommendations provided by the European Disability Forum (EDF) on the **accessibility and digital inclusion of people with disabilities**, preventing their marginalisation due to digital transformation.

Besides these flagship documents, the significance of digital skills is emphasized in several policies developed since 2020 to support the 'Shaping Europe's Digital Future' strategy. Below, we highlight the main policies that explicitly reference digital skills and describe how they are addressed. These policies can be categorised into three main clusters: i) the **Digital Skills and Education** cluster focuses on enhancing digital literacy and adapting education systems to the digital age, including basic and advanced skills for various technologies and lifelong learning initiatives, ii) the **Innovation and Technology** cluster addresses the need for advanced skills in emerging fields like deep tech and virtual worlds, supporting innovation and startup ecosystems, and iii) the **Digital Infrastructure and Policy** cluster includes strategies to improve digital infrastructure, ensure digital inclusion, and build resilience in the digital economy. Each cluster reflects a comprehensive approach to integrating digital skills into Europe's broader digital transformation efforts.

In the Digital Skills and Education cluster, alongside the flagship documents, the key policies include the Digital Education Action Plan, the Digital Skills and Jobs Platform, the Digital Skills and Jobs Coalition, and the European Declaration on Digital Rights and Principles for the Digital Decade.

The **Digital Education Action Plan** (EC, 2020)[82] focuses on the adaptation of the education and training systems of Member States to the digital age. The report identifies that lack of digital skills and lack of accessibility (not only with regards to infrastructures but also to access of disadvantaged groups and people with disabilities) not only increases the risk of poverty and disadvantage but also widens inequality in education and training. Therefore, building on the first Digital Education Plan (2018-2020) (EC, 2018)[83], it sets out two strategic priorities: **developing a high-performing digital education ecosystem** and **enhancing digital skills** for the digital transformation. Key actions include, among others, (i) fostering digital literacy and advanced digital skills to support the twin digital and green

[81] European Commission (EC) (2021). *Proposal for a Decision of the European Parliament and of the Council establishing the 2030 Policy Programme 'Path to the Digital Decade'*. (Staff Working Document). SWD/2021/574 final. Brussels, 15.9.2021

[82] European Commission (EC) (2020). *Digital Education Action Plan 2021-2027. Resetting education and training for the digital age*. (Communication). COM/2020/624 final. Brussels, 30.09.2020

[83] European Commission (EC) (2018). *Digital Education Action Plan*. (Communication). COM/2018/22 final. Brussels, 17.01.2018

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transition of society, (ii) updating the **European Digital Competence Framework for citizens (DigiComp 2.1)**[84] to include AI and data skills and promoting a stronger representation and participation of young people, women and underrepresented groups in AI research and the AI industry, (iii) establishing a **European Digital Skills Certificate**[85], (iv) promoting women's participation in Science, Technology, Engineering and Mathematics (STEM) and representation in ICT jobs through initiatives such as 'Women in Digital'[86] and 'WeGate'[87], and (v) creating a **European Digital Education Hub**[88].

Additionally, the latest update to the **European Digital Competence Framework for citizens (DigiComp 2.2)**[89] builds on its predecessor by further emphasising the importance of advanced digital competences. DigiComp 2.2 introduces new areas such as **digital citizenship, digital rights, fairness and ethical considerations** related to AI and data usage. This comprehensive framework aims to ensure that all citizens are not only equipped with basic digital skills but also with the advanced competences necessary for navigating and contributing to a rapidly evolving digital society. The inclusion of these elements aims to foster a holistic understanding of digital transformation, encouraging a more inclusive and ethically aware digital ecosystem across Europe.

The **European Declaration on Digital Rights and Principles for the Digital Decade** (EC, 2022)[90] emphasises putting people at the centre of digital transformation, aiming to empower individuals and foster innovative businesses. It sets concrete digital targets in areas such as digital skills, infrastructures, and the digitalisation of businesses and public services. The declaration promotes digital sovereignty, inclusion, equality, sustainability, resilience, security, trust, and improving quality of life. It commits to ensuring everyone has **access to education, training, and lifelong learning to acquire necessary digital skills**. Special attention is given to **protecting and empowering children and young people online**, ensuring they can navigate the digital environment safely and creatively. The

[84] European Commission (EC), Joint Research Centre (JRC), Carretero, S., Vuorikari, R., Punie, Y. (2017). DigComp 2.1 : the digital competence framework for citizens with eight proficiency levels and examples of use, Publications Office. https://data.europa.eu/doi/10.2760/38842

[85] European Commission, Joint Research Centre. (n.d.). *European digital skills certificate* (EDSC). https://joint-research-centre.ec.europa.eu/scientific-activities-z/education-and-training/digital-transformation-education/digital-competence-framework-citizens-digcomp/european-digital-competence-certificate-edsc_en

[86] European Commission (EC) (2023). *Women in the Digital*. https://digital-strategy.ec.europa.eu/en/library/women-digital

[87] WEgate (2023). WEgate: Supporting women in building their businesses with a clear vision and agility. A non-profit association established as a COSME-funded initiative. https://www.wegate.eu/

[88] European Commission (EC) (n.d.). *European Digital Education Hub.* https://education.ec.europa.eu/focus-topics/digital-education/action-plan/european-digital-education-hub

[89] European Commission, Joint Research Centre, Vuorikari, R., Kluzer, S., Punie, Y. (2022). *DigComp 2.2, The Digital Competence framework for citizens : with new examples of knowledge, skills and attitudes*, Publications Office of the European Union. https://data.europa.eu/doi/10.2760/115376

[90] European Commission (EC) (2022). *European Declaration on Digital Rights and Principles for the Digital Decade*, (Communication). COM/2022/28 final. Brussels, 26.1.2022

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declaration supports up-skilling and re-skilling to help individuals adapt to changes brought by digitalisation, striving for a fair, resource-efficient, and inclusive digital economy and society. Complementary on this, the European Commission (EC, 2022)[91] issued the communication staff working document on **establishing Digital Rights and Principles for the Digital Decade**, which aims to ensure the EU's digital transformation respects fundamental rights, including data protection and equal treatment, while enhancing digital skills and education. The COVID-19 pandemic highlighted the digital divide, exacerbating inequalities between urban and rural areas and among different population groups. The declaration emphasises the need for all citizens, regardless of age, gender, abilities, or location, to have equal access to digital tools, services, infrastructures, and skills. It aims to empower individuals and businesses, ensuring they enjoy the same rights online as offline, and to **support vulnerable populations** in fully benefiting from digital advancements. The strategy includes extending high-performance broadband, building digital skills, and digitalising businesses and public services, thereby fostering an inclusive, secure, and prosperous digital society that aligns with European values and the goals of the green transition.

The **Digital Skills and Jobs Platform**[92], part of the Connecting Europe Facility Programme, offers resources such as training opportunities, career support, and funding information to help bridge this gap. The Coalition's efforts are monitored through the Digital Economy and Society Index (DESI)[93], which assesses progress in connectivity, human capital, internet usage, business integration of digital technology, and digital public services. It aims to boost digital competencies among all Europeans by providing high-quality information, resources, and opportunities, from basic to advanced levels. The Platform supports the DIGITAL Europe Programme's objectives of enhancing Europe's competitiveness in the global digital economy through digital capacity-building. It offers insights into EU and national initiatives, training opportunities, career development support, funding options, and access to a vibrant community space. By collaborating with National Digital Skills and Jobs Coalitions, the Platform helps share best practices, training resources, and digital skills policies. It also plays a crucial role in achieving the EU's Digital Decade targets, including ensuring that 80% of Europeans have basic digital skills and that 20 million digital technology experts are employed in the EU by 2030. Additionally, the Platform encourages life-long learning and aims to modernise education and training systems to better prepare individuals for the digital economy and society.

[91] European Commission (EC) (2022). *Establishing a European Declaration on Digital rights and principles for the Digital Decade*. (Staff Working Document). SWD/2022/14 final. Brussels, 26.1.2022

[92] European Commission (EC) (n.d.). *Digital skills and jobs.* https://digital-strategy.ec.europa.eu/en/policies/digital-skills-and-jobs

[93] European Commission (EC) (2022). Digital economy and society index (DESI) 2022 (Thematic Chapters). (Staff working document). SWD/2022/205 final. Brussels, 02.08.2022

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The **Digital Skills and Jobs Coalition**[94] is an initiative by the EC aimed at addressing the digital skills gap across Europe by uniting Member States, companies, and organisations. It encourages all entities involved in boosting digital skills to join by pledging actions such as training the unemployed, offering **coding classes for children**, and providing advanced training for ICT specialists. The Coalition shares successful initiatives through the **European Digital Skills Awards** to promote replication and scaling across Europe. It targets four main groups: citizens, the labour force, ICT professionals, and education systems, with the aim of training 1 million young unemployed people for digital jobs, supporting SMEs in digital upskilling, modernising education, and raising awareness of the importance of digital skills. Despite the critical need for a digitally skilled workforce for competitiveness and an inclusive society, 42% of Europeans lack basic digital skills, and 37% of the labour force is insufficiently skilled.

In the **Innovation and Technology** cluster, the primary policies are the New Industrial Strategy, the New European Innovation Agenda, the EU's initiative on Web 4.0 and virtual worlds, and the White Paper on Artificial Intelligence - A European Approach to Excellence and Trust.

The **New Industrial Strategy for Europe** (EC, 2020)[95] underlines the importance of skills for the twin transitions and the opportunities they can create for people. The strategy argues on the importance of retraining and reskilling as well as on attracting skills and talent from abroad.

The White Paper on **Artificial Intelligence - A European Approach to Excellence and Trust** (EC,2020)[96] addresses the critical issues of skills and inequalities in the context of AI. Recognising the increasing importance of AI in economic growth and societal well-being, the European approach prioritises the development of skills to address competence shortages. The upcoming reinforcement of the Skills Agenda aims to ensure that all Europeans can benefit from the green and digital transformations of the EU economy. This includes initiatives to support sectoral regulators in enhancing their AI skills and an updated Digital Education Action Plan to better utilise AI-based technologies for improving education and training systems. The revised Coordinated Plan on AI will prioritize increasing **women's participation in AI** and support the establishment of leading AI research centres to **attract global talent**. Recognising the risks of bias and discrimination in AI, the EU legislative framework will be adapted to protect fundamental rights and ensure that AI developments are inclusive and equitable, fostering trust and

[94] European Commission (EC) (n.d.). *Digital skills coalition*. https://digital-strategy.ec.europa.eu/en/policies/digital-skills-coalition

[95] European Commission (EC) (2020). *A New Industrial Strategy for Europe*. (Communication). COM/2020/ 102 final. Brussels, 10.03.2020. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0102

[96] European Commission (EC) (2020). *White Paper on Artificial Intelligence - A European approach to excellence and trust.* COM/2020/65 final. Brussels, 19.02.2020

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social fairness. This commitment extends to ensuring that **AI systems are designed and implemented to avoid algorithmic biases**, thereby promoting digital fairness. The focus on algorithmic fairness seeks to prevent discriminatory outcomes and ensure that AI applications serve all segments of society equitably, thereby reinforcing the EU's dedication to social justice and equal opportunities in the digital age.

The **New European Innovation Agenda**[97] is closely aligned with the Digital Compass 2030 and the Digital Education Action Plan, particularly in addressing skills development and reducing inequalities. This agenda underscores the need for advanced digital skills to drive Europe's competitiveness in deep tech fields, such as AI, quantum computing, and biotech. It also emphasises the importance of green skills and the twin transition to a digital and sustainable economy. Key initiatives like **Innospace**[98], an AI-driven platform for innovation, and the **EIC ScaleUp 100**[99] action, which supports deep tech start-ups, complements the Digital Compass 2030's emphasis on advanced skills for quality jobs. Additionally, the agenda's commitment to nurturing deep tech talent aligns with the Digital Education Action Plan's goals of enhancing digital education and inclusivity, while also fostering skills crucial for the green transition. Efforts to attract and retain diverse talent through programs like the **EIT Deep Tech Talent Initiative**[100] and the **EU Talent Pool**[101] further support the overarching objective of addressing skills gaps and promoting equal opportunities across the digital economy. By prioritising the development of green skills, the agenda ensures that Europe's workforce is prepared for the **twin transition**, thereby reinforcing the EU's commitment to both digital advancement and environmental sustainability.

The **EU's initiative on Web 4.0 and virtual worlds: a head start in the next technological transition** (EC, 2023)[102] outlines a strategic approach to position Europe at the forefront of the next technological transition. Focusing on skills, business, and government, this strategy addresses the **need for advanced digital skills**, technological literacy, and user acceptance. It highlights the critical shortage of specialists in virtual world technologies and the **gender imbalance within the ICT sector**. Actions include building a talent pool through the European Year of Skills, investing in future ICT specialists, and partnering with

[97] European Commission (EC) (2022). *New European Innovation Agenda.* (Communication). COM/2022/332 final, Brussels, 05.07.2022

[98] European Commission (EC) (n.d.). *Innospace platform. EISMEA.* https://eismea.ec.europa.eu/funding-opportunities/calls-tenders/innospace-platform_en

[99] European Innovation Council (EIC) (2022). *European Innovation Council launches the Scale up 100 call*. https://eic.ec.europa.eu/news/european-innovation-council-launches-scale-100-call-2022-05-16_en

[100] EIT Tech Talent. (n.d.). *EIT Deep Tech Talent Initiative*. https://www.eitdeeptechtalent.eu/

[101] EURopean Employment Services (EURES) (n.d.). *EU Talent Pool pilot*. https://eures.europa.eu/eu-talent-pool-pilot_en

[102] European Commission (EC) (2023). *An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition*. (Communication). COM/2023/442 final. Strasbourg, 11.07.2023

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leading education and research institutions. The EU will also promote the guiding principles for virtual worlds, support research on their impact on health and well-being, and develop resources for the public and young people. Additionally, efforts will be made to attract highly skilled specialists from non-EU countries to expand the talent pool necessary for achieving the EU's Web 4.0 ambitions.

Finally, in the **Digital Infrastructure and Policy** cluster, key policies include the European Strategy for Data, the EU's Cybersecurity Strategy for the Digital Decade and the EU Policy on Cyber Defence.

The **European Strategy for data** (EC, 2020)[103] addresses critical skills shortages and promotes data literacy to strengthen the EU's digital economy. It aims to fill approximately 496,000 big data and analytics positions and enhance general data literacy across the population. The strategy empowers individuals with better control over their data and invests in expanding the digital talent pool by 250,000 people, targeting a reduction in the digital skills gap by 2025. Additionally, it includes the development of a **European data space for skills (DS4S)**[104] to align education with labour market needs, supported by digital credentialing frameworks and governance models, ensuring high standards of data protection and cybersecurity.

The **EU's Cybersecurity Strategy for the Digital Decade** (EC, 2020)[105] addresses the critical shortage of cybersecurity skills and low cyber readiness among businesses and individuals by proposing the establishment and enhancement of Security Operations Centres across the EU, with a commitment of over EUR 300 million. It aims to upskill the workforce, attract and retain diverse cybersecurity talent, and invest in world-class research and innovation. The strategy includes raising cybersecurity awareness, particularly among children, young people, and SMEs, encouraging women's participation in STEM, and developing tools to increase business resilience against cyber threats. Enhanced education, vocational training, and coordinated efforts by key EU actors will further bolster cybersecurity and cyber defence skills across the EU.

The **EU Policy on Cyber Defence** (EC, 2022)[106] addresses the critical shortage of cybersecurity professionals in Europe, with an estimated gap of 500,000 experts needed as of 2022. This deficit undermines the EU's ability to innovate and safeguard vital infrastructure, with government sectors struggling to compete with the private sector's attractive salaries. To mitigate this, the EC will launch a Cyber Skills Academy in 2023 as

[103] European Commission (EC) (2020). *A European strategy for data*. (Communication). COM/2020/66 final. Brussels, 19.02.2020

[104] European Data Space for Skills (n.d.). *DS4S - Data Space for Skills*. https://www.skillsdataspace.eu/

[105] European Commission (EC) (2020). *The EU's Cybersecurity Strategy for the Digital Decade*. (Joint Communication). JOIN/2020/18 final. Brussels, 16.12.2020

[106] European Commission (EC) (2022). *EU Policy on Cyber Defence*. (Joint Communication). JOIN/2022/49 final. Brussels, 10.11.2022

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part of the European Year of Skills. This initiative will consolidate various cyber skills programs, enhancing training, certification, and stakeholder engagement. Additionally, the European Security and Defence College (ESDC) will facilitate best practice exchanges between military and civilian sectors and expand cyber defence training and exercises. Member States are encouraged to develop specialised education programs, foster collaboration between higher education institutions, and engage with private sector and academic training providers. A cyber defence skills certification framework will be developed, aligning with existing civilian initiatives like the European Cybersecurity Skills Framework (ECSF). These efforts aim to establish standardised training across different domains and enhance the EU's technological sovereignty and ability to act through strategic investment and technological development.

The European Commission's policy documents reviewed above emphasise the need to develop a spectrum of digital skills essential for Europe's digital transformation. These range from **basic digital skills**, such as basic computing and internet literacy, to **advanced competencies** in fields like cybersecurity and AI. **Specialised skills** are also in high demand, particularly in emerging technologies and deep tech sectors. Despite these priorities, significant disparities persist, particularly affecting women, children, and people with disabilities. These groups often face barriers to accessing and acquiring the necessary skills, perpetuating existing inequalities.

### 2.3.3 Addressing skill-related inequalities due to the two transitions

Skill related inequalities due to the two transitions are mainly tackled through policy programmes and initiatives from EU's social policy 'An economy that works for people'.

First, the shift towards dealing with skill-related vulnerabilities due to the two transitions was led by a Communication Document on a **strong social Europe for Just Transitions** (EC, 2020)[107] which highlights the importance of ensuring a fair and equitable transition. The Communication describes actions for updating, among others, the European Pillar of Social Rights (EPSR)[108], the Skills Agenda for Europe, the Digital Europe Programme and the Digital Education Action Plan, considering the needs that emerge from the digital and green transitions.

Based on this, and building upon the 2016 Skills Agenda, the Commission released in 2020 the **European Skills Agenda for Sustainable Competitiveness, Social Fairness, and Resilience** (EC, 2020)[109]. This is a five-year plan with quantitative objectives to help

[107] European Commission (EC) (2020). *A strong social Europe for Just Transitions.* (Communication). COM/2020/14 final. Brussels, 14.01.2020

[108] European Commission (EC) (2017). *The European Pillar of Social Rights*. (Staff Working Document). SWD/2017/201 final. Brussels, 26.04.2017

[109] European Commission (EC) (2020). *European Skills Agenda for sustainable competitiveness, social fairness and resilience*. (Communication). COM/2020/274 final. Brussels, 01.07.2020

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individuals and businesses develop more and better skills and to put them to use, linked with the objectives of the Green Deal and the digital transition. It emphasises the development of skills essential for transitioning to a more environmentally sustainable and digital economy through various strategic initiatives. Among its 12 actions, two are of particular interest.

First is Action 1, the **Pact for Skills** initiative (launched in November 2020)[110], which is one of the flagship actions of the European Skills Agenda, focusing on upskilling and reskilling strategies in priority areas identified in the European Green Deal. The agenda also supports initiatives **that help workers in declining industries transition to new, green jobs**, thereby reducing the risk of job displacement and economic inequality, **seeks to break gender and other discriminatory stereotypes**, while supporting the acquisition of skills for the green transition.

Second, is Action 6, which focuses on developing essential skills for the **twin transition**, although the relevant actions proposed are running in parallel for the two transitions separately, with no apparent interconnection. Specifically, **for the green transition**, the Commission defines a **taxonomy of green skills**, and aims to establish monitoring indicators with Member States, develop **a European competence framework for climate and environmental education**, promote a core set of green skills for the labour market, and integrate environmental considerations into various education levels. For **the digital skills**, the Commission will update the Digital Education Action Plan, implement the Digital Europe programme to **enhance digital capacities**, support **Digital Crash Courses for SMEs**, and facilitate **EU ICT-Jump-Start trainings to address ICT skill shortages with a focus on gender balance**. This initiative aims to prepare the workforce for sustainable and technologically advanced economic development.

Apart from the Skills Agenda, the Commission also updated the EPSR[111] with the **European Pillar of Social Rights Action Plan** (EC, 2021)[112] (launched in March 2021) including concrete initiatives and measurable targets for implementing the European Pillar of Social Rights. The plan places a particular focus on supporting the twin transition while ensuring that the necessary societal changes are accompanied by robust social considerations (i.e. by prioritising social equity and inclusion, and by ensuring that the

[110] European Commission (EC) (2020). *Pact for skills: A shared engagement and approach to skills development.* https://ec.europa.eu/social/BlobServlet?docId=23158&langId=en

[111] The European Pillar of Social Rights (EPSR) (EC, 2017) is a set of documents intended to build a fairer and more well-functioning labour markets and welfare systems that benefit all Europeans. It is based on 20 principles built around three main sections: i) equal opportunities and access to the labour market, ii) fair working conditions and iii) social protection and inclusion. The EPSR is accompanied by the Social Scoreboard with 35 indicators to monitor 12 areas of principles associated with the EPSR and provides an interactive tool to compare countries and time periods.

[112] European Commission (EC) (2021). *The European Pillar of Social Rights Action Plan*. (Communication). COM/2021/102 final, Brussels, 04.03.2021

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benefits of the two transitions will be accessible to everyone). The Plan, prepared after a large-scale consultation with EU institutions, national and local authorities and the civil society, is fundamentally designed to ensure a socially fair and just transition towards climate-neutrality, digitalisation, and demographic change, aligning with the goals of the European Green Deal and the 2030 Digital Decade. Therefore, it places emphasis on (i) achieving more and better jobs, creating **job opportunities in the twin transition**, facilitating **job-to-job transitions towards green and digital sectors** with special attention to the **youth and low-skilled** and ensuring **equal treatment, occupational safety and health standards for all people regardless of sex, age, ethnic or racial origin, disability, religion or belief**, (ii) skills and equality, investing in education and training systems, reducing discrimination in employment rates and pay levels among men and women and other underrepresented groups, and adopting work-life balance policies and (iii) social protection and inclusion, with measures and investments that target poverty and intergenerational cycles of disadvantage. The updated social scoreboard accompanying this plan includes **headline and secondary indicators related to digital equal opportunities and inclusion** such as 'Individuals' level of digital skills' and 'Connectivity dimension of the Digital Economy and Society Index'.

In line with the European Skills Agenda, the Commission has published (December 2021) a **proposal for Council Recommendation on individual learning accounts**[113], which advocates a skills transformation to exploit the environmental and digital transitions as opportunities for rapid and equitable recovery. This document proposes to explore individual learning accounts as a mechanism to support the up-skilling and reskilling of working-age adults (complementing thus other initiatives targeted at employers and education and training providers). It also recommends tailoring additional training entitlements to those most affected by the green transition, taking into account factors such as employment status, sectors undergoing significant change, specific skill needs, age groups and vulnerable groups. The **Council recommendation on individual learning accounts** adopted in June 2022 take into account the above-mentioned proposal, and recommends, among other things, the Member states to make maximum and most efficient use of Union funds and instruments (e.g. the European Social Fund Plus (ESF+), the European Regional Development Fund, the Just Transition Fund, the Recovery and Resilience Facility and the Technical Support Instrument) in order to provide additional individual training entitlements to the accounts of individuals most in need of upskilling and reskilling, reflecting national circumstances and Union priorities including for the green and digital transitions.

[113] European Commission (EC) (2021). *Individual learning accounts.* (Proposal for a Council Recommendation). COM/2021/773 final. Brussels, 10.12.2021

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The **proposal for a European Year of Skills in 2023**[114] aims to boost competitiveness of European companies and ensure a fair and inclusive green and digital transition by promoting a mindset of reskilling and upskilling. The objective was to ensure that nobody is left behind in this twin transition, as well as in the economic recovery, and to address labour shortages for a better skilled workforce in the Union. By taking into account the centrality of skills across all sectors, EU initiatives, including those outlined in the European Green Deal, are prioritising the measures expressly aimed at skill development. Thus, the **Decision on a European Year of Skills**[115]**,** adopted on 10 May 2023, further emphasises that **the biggest constraint to the successful green and digital transitions is the lack of workers with the right skills**. In this framework, the European Year of Skills aims to enhance the competitiveness of businesses, particularly SMEs, and foster the creation of high-quality employment opportunities, by promoting a culture of reskilling and upskilling. It seeks to facilitate the full realisation of the benefits of the green and digital transitions in a socially equitable, inclusive, and just manner, thereby promoting equal access to skills development and reducing disparities and segregation in education and training. This effort also contributes to **ongoing learning and career advancement, empowering individuals to access quality jobs** and fully engage in economic and social life. Additionally, there will be a focus on enhancing skills relevance and provision through collaboration among various stakeholders, facilitating the recognition of skills and qualifications. Moreover, initiatives will aim to align individuals' aspirations, needs, and skillsets with labour market demands, particularly in sectors related to the green and digital transitions. Special attention will be given to integrating underrepresented groups into the labour market, such as women, young people, low-skilled individuals, older workers, persons with disabilities, and those from disadvantaged backgrounds or remote regions.

As a key deliverable of the European Year of Skills, a recent plan on dealing with **'Labour and skills shortages in the EU'**[116] focuses on the increasing skills shortages across Member States driven by demographic shifts, new technological developments and the twin transitions, the development of industrial sectors, and challenges related to working conditions in some sectors and locations. The action plan aims to address these shortages, which have economic and social implications, through six policy areas: (i) **the support of underrepresented people in the labour market** (including women, low-skilled workers, older workers, young people, people with a migrant or minority racial or ethnic

[114] European Commission (EC) (2022). *A European Year of Skills 2023.* (Proposal for a Decision). COM/2022/526 final. Brussels, 12.10.2022

[115] European Parliament and Council of the European Union (2023). *A European Year of Skills,* (Decision (EU) 2023/936 of the PE/12/2023/REV/1). Office Journal, L 125. p. 1–11. Strasbourg, 10 May 2023. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023D0936

[116] European Commission (EC) (2024). *Labour and skills shortages in the EU: an action plan*. (Communication). COM/2024/131 final. Brussels, 20.03.2024

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background, and persons with disabilities), (ii) the **provision of skills, training and education**, (iii) improving working conditions, (iv) improving fair intra-EU mobility for workers and learners and (v) attract talent outside EU. The report mentions the different barriers that exist for each under-represented group (women, older workers, low-skilled workers, young people, migrants, persons with disabilities) and therefore, gives emphasis on tailored made policies addressing the specific root causes for each group.

Further conclusions and recommendation about the EU policy regarding the skill and competences for the green transition can be found in a recent **Notice of the Council** of the EU[117], while the Commission SWD**: Co-creation of a transition pathway for a more resilient, digital and green retail ecosystem**[118] highlights some key points regarding the reskilling and upskilling of the retail sector and small and medium-sized enterprises (SMEs) to ensure a fair, green and digital transition.

Finally, the Impact Assessment Report of the **EU Talent Pool** (the proposal for a Regulation of the European Parliament and the Council establishing an EU Talent Pool)[119] aims to address labour and skills shortages in the EU, contributing to the achievement of the green and digital transition. In particular, it underscores the pressing need to develop skills for the green transition, focusing on vocational and technical profiles, which are increasingly in demand under the EU Green Deal Industrial Plan. It also emphasises on ensuring that all workers, especially those in sectors and regions more impacted by the green transition, will benefit from the employment opportunities of a net-zero economy. Furthermore, other important policies are considered the following: training public sector workers to meet labour market needs, upskilling and reskilling the domestic workforce, activating vulnerable EU citizens, and encouraging intra-EU mobility.

The **skills and skill-related labour gaps are high in the political agenda for 2024-2029**. The political guidelines just published mention the establishment of a **Union of Skills**, embedding lifelong learning into education and careers and of a European Strategy for Vocational Education and Training, investing on skills that are better linked to the labour market and more focused on sectors crucial for the twin transitions.

Schools, training institutions, and universities are considered critical in fostering the knowledge, skills, and attitudes needed for sustainable development and digital transformation. The Commission has adopted a strategy on education (**European**

[117] Council of The European Union (2023). *Skills and competences for the green transition.* (Council conclusions). 2023/C 95/03, ST/7089/2023/INIT, Office Journal, C 95, 14.3.2023, p. 3–7. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023XG0314(01)

[118] European Commission (EC) (2023). *Co-creation of a transition pathway for a more resilient, digital and green retail ecosystem*. (Staff Working Document). SWD/2023/283 final. Brussels, 18.07.2023

[119] European Commission (EC) (2023). *Impact Assessment Report: Accompanying the document Proposal for a Regulation of the European Parliament and the Council: Establishing an EU Talent Pool.* (Staff Working Document). SWD/2023/717 final. Brussels, 15.11.2023

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**Education Area**) with actions that shift education and training of people towards acquiring knowledge, abilities, values and attitudes that are needed in an increasingly digitalised, sustainable and resource efficient economy and society[120]. The Communication on a **European Strategy for Universities**[121] in particular, aims to unlock the potential of individuals and support the development of new skills and job opportunities related to the transitions. By focusing on higher education, the strategy seeks to foster innovation and equip students with the skills necessary to thrive in a green and digital economy. The Commission has also proposed a **Council Recommendation on education for environmental sustainability** and a **European Competence Framework for Climate Change and Sustainable Development**.

The **Recommendation on Learning for Green Transition and Sustainable Development**, adopted by the Council of the European Union on 16 June 2022[122], highlights the strategic framework of the European Education Area (2021-2030) to promote cooperation and peer learning between Member States and stakeholders. It urges Member States to prioritise education for a green transition and sustainable development in their policies and programmes. This includes using EU funding programmes such as Erasmus+, LIFE and Horizon Europe to support both formal and non-formal education and sharing best practices through Erasmus+ projects and networks. The Recommendation also highlights the importance of providing learning opportunities in different settings, enhancing teaching with infrastructure and digital tools, and disseminating fact-based information on the climate and biodiversity crises. It supports the professional development of educators in sustainability and green transition issues, using platforms such as the European School Education Platform, EPALE and the European Youth Portal. It also promotes the involvement of young people through the European Year of Youth 2022 and the EU Youth Dialogue, ensuring that their perspectives are integrated. Creating synergies with the Education for Climate Coalition and the New European Bauhaus[123], developing and sharing resources such as GreenComp (see next paragraph) and monitoring the development of green skills or attitudes towards environmental sustainability by higher education, are also key components.

A dedicated group of policies and programmes aim to support **young people** with regards to education and employment in the twin era. The EU is committed to the

[120] European Commission (EC) (2020). *Achieving the European Education Area by 2025*. (Communication). COM/2020/625 final. Brussels, 30.09.2020

[121] European Commission (EC) (2022). A European strategy for universities. (Communication). COM/2022/16 final. Strasbourg, 18.01.2022

[122] Council of the European Union (2022). *Learning for the green transition and sustainable development.* (Recommendation). 2022/C 243/01, ST/9795/2022/INIT, OJ C 243, 27.6.2022, p. 1–9. 2020/C 372/01. Luxembourg, 16.06.2022

[123] European Commission (EC) (2021). New European Bauhaus - Beautiful, sustainable together. (Communication). COM/2021/573 final. Brussels, 15.09.2021

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implementation of the reinforced **Youth Guarantee**[124], safeguarding the offering of good quality employment, education, apprenticeship and traineeship to all young people under the age of 30. The Youth Guarantee is based on the **Youth unemployment support package**[125] guided by the EPSR and includes programmes such as the Youth Employment Initiative and ALMA[126]. The importance of youth was highlighted by the Commission's decision to establish 2022 as the **European Year of Youth**[127]**.** Also, the Commission has adopted dedicated actions on skills acquisition for people with disabilities in the **Disability Employment Package**[128] which is based on the Strategy for the Rights of Persons with Disabilities. Other policies that focus on under-represented groups are the EU Action plan on integration and inclusion and the Council Recommendation on Roma equality and participation.

## 2.4 Concluding remarks

As mentioned at the beginning of this report, the green and digital transitions are top priorities at the political agenda in Europe, each promoted by a distinct set of policies. Although both **recognise the upcoming changes in the labour market and the importance of acquiring a new set of skills**, reference on what such changes mean for people and places of different characteristics is quite fragmented. They also approach potential inequalities that emerge from the transitions with regards to skills and job market transformation from a different perspective.

More specifically, these two sets of policy documents (on green transition and digital transformation) seem to run in parallel with limited interaction. **The main documents on the green transition** note that digitalisation is a key enabler for delivering the European Green Deal due to the smart and innovative solutions that technologies offer to tackle climate change. However, they lack references to digital skills, while the exact skills and competencies that are needed for sustainability (green skills) are only discussed in technical documents (developed in parallel with the strategic programmes). The main focus of the documents that promote the green transition (especially at the beginning of the programming period) tend to have a **territorial perspective, aiming to address job**

[124] Council of the European Union (2020). A Bridge to Jobs – Reinforcing the Youth Guarantee and replacing the Council Recommendation of 22 April 2013 on establishing a Youth Guarantee. (Recommendation). 2020/C 372/01. Brussels, 30.10.2020

[125] European Commission (EC) (2020). *Youth Employment Support: a Bridge to Jobs for the Next Generation*. (Communication). COM/2020/276 final. Brussels 01.07.2020

[126] ALMA: an active inclusion initiative for young people, - Employment, Social Affairs & Inclusion - European Commission (europa.eu). (https://ec.europa.eu/social/main.jsp?catId=1549&langId=en)

[127] European Commission (EC) (2024). *European Year of Youth 2022*. (Communication). COM/2024/1 final. Brussels, 10.01.2024

[128] European Commission: Directorate-General for Employment, Social Affairs and Inclusion (2021). *Union of equality : strategy for the rights of persons with disabilities 2021-2030*. Publications Office. https://data.europa.eu/doi/10.2767/31633

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**substitution due to the greening of industries and the impact on employment in specific sectors**.

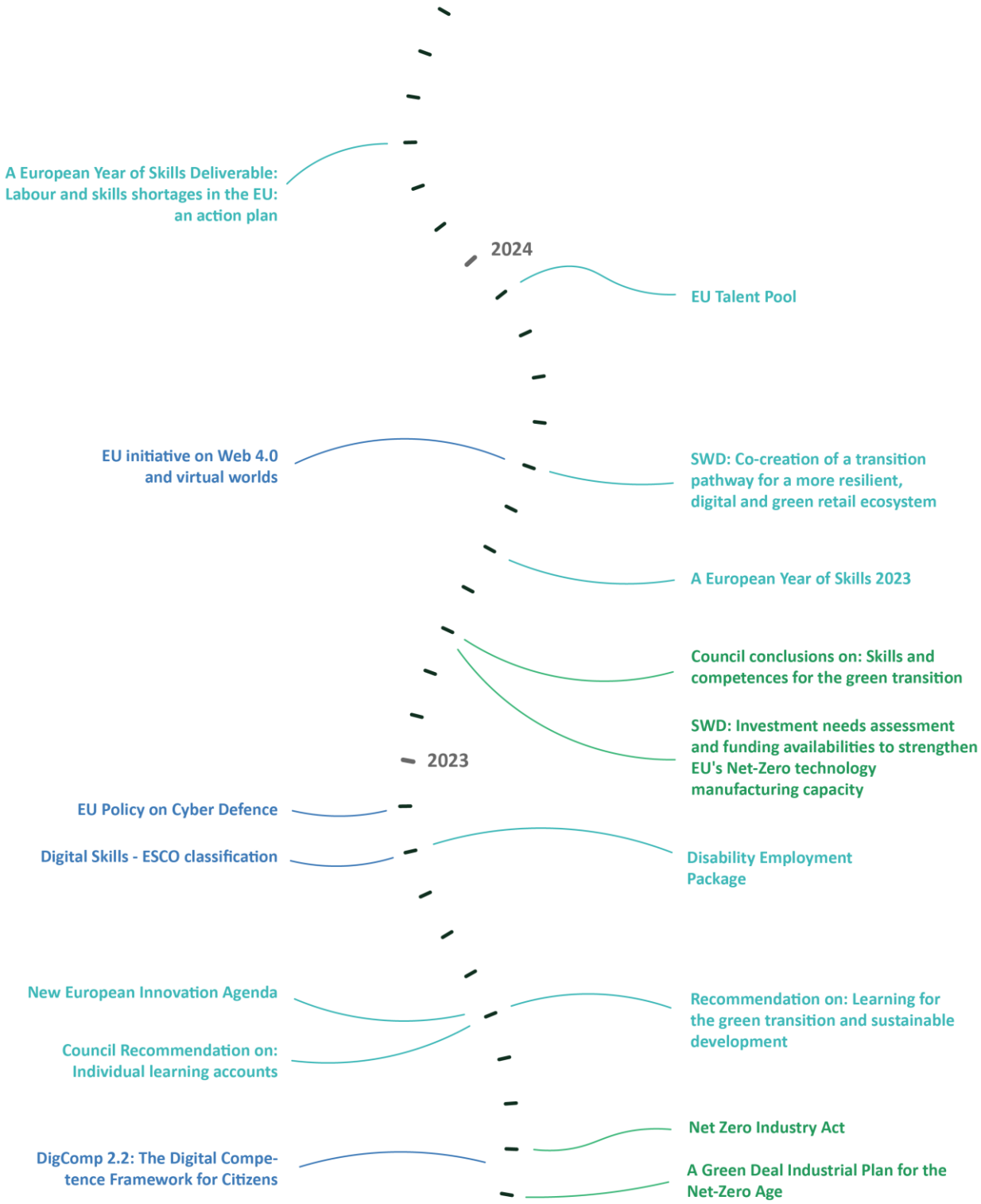
On the other hand, **documents on digital transformation** seem to have a better understanding on the opportunities but also on the different types of inequalities created by the digital transformation. They **aim to tackle the digital divide and address vulnerabilities** (e.g. access to training and digital services, safety in navigating the internet, reducing bias of technologies and promoting social fairness) **placing emphasis on disadvantaged groups**, such as women, children and people with disabilities.

Europe's policies on skills development (both green and digital), on education and for addressing changes in the labour market dynamics are mostly promoted through its social policy priority 'An economy that works for people'. Skills are identified as a major driver behind the two transitions, yet, as it will be illustrated later, there is **limited reference to twin skills** and what is needed for the future is limited to mentions on the **importance of incorporating digital skills into green jobs**. Finally, it should be mentioned that within this set of policies (e.g. European Pillar for Social Rights), the Commission has developed targeted strategies and initiatives focusing on specific groups of vulnerable individuals such as the youth, women, migrants and people with disabilities.

Overall, out of all the EU green, digital and twin transition policies examined that discuss skills (Figure 5), there is a noticeable **lack of conceptual coherence regarding the impact of the twin transition on skills**. Although the two transitions—green and digital—are often **portrayed as mutually beneficial**, policy documents primarily focus on the potential synergies without adequately addressing the possible contradictions arising from their simultaneous effects across various policy domains. In alignment with similar studies (Gao, 2024)[129], we find that most **policy documents display a limited understanding of the complex interdependencies, synergies, and trade-offs between the transitions across different sectors and timeframes.** This disconnect is further evident in the fragmented implementation tools and strategies, which tend to develop in parallel rather than in alignment, failing to manage these intertwined dynamics effectively.

[129] Xinchuchu Gao (28 Jun 2024): The EU's twin transitions towards sustainability and digital leadership: a coherent or fragmented policy field?, Regional Studies, DOI: 10.1080/00343404.2024.2360053

*This project has received funding from the European Union's Horizon Europe under Grant Agreement No 101132559.*




*This project has received funding from the European Union's Horizon Europe under Grant Agreement No 101132559.*

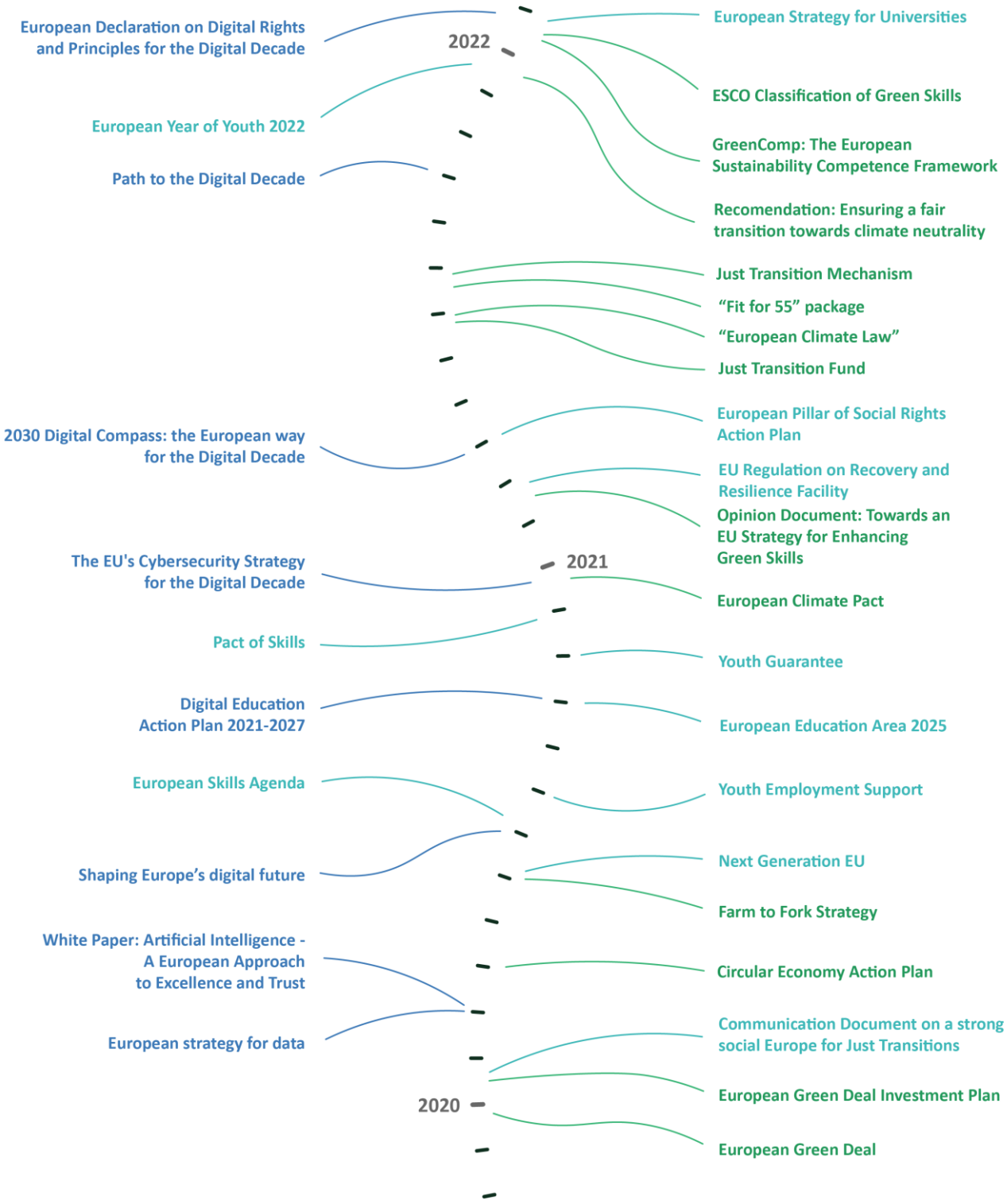



***Figure 5: Green, digital and twin EU policies discussing skills timeline (own elaboration)***

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# 3 Twin transition and technologies, industrial sectors and spatial development

## 3.1 The impact of new green, digital and twin transition on industry sectors and territorial development

The twin transition is a transformative but complex process, relying on regions' abilities to modernise industries and manage associated costs for communities and workers. New green and digital technologies constitute the catalyst for industrial transition with the creation of new opportunities but also the emergence of significant social and regional disparities. Success requires active transition management, a place-based approach, and tailored policies to raise productivity and well-being while leveraging each region's unique assets.

The green, digital and twin transition is expected to create a range of possible outcomes, with **divergent effects on different sectors**. Both literature and EU policy documents, focus so far separately on the impact of each one of the two transitions separately on different sectors.

**From the green transition perspective**, employment effects of environmental policy at the aggregate level are expected to be small by 2030, since most jobs in the EU are in sectors with low $CO_2$ emissions, known as 'white' sectors. Activities like electricity production, transport, manufacturing, agriculture, and mining generate about 90% of the EU's $CO_2$ emissions but employ less than 25% of the workforce (Vandeplas et al., 2022)[130]. While the overall employment effects are expected to be small, the green transition is anticipated to have more significant and varied impacts at the sectoral level.

A recent report of CEDEFOP (2023)[131], highlights that sectors like **electricity, manufacturing, construction, transport, and waste management** will see pronounced changes, driven by increased demand for renewable technologies and efficient appliances. Employment in electricity supply will rise due to renewable energy needs, while construction will face a slight decline but still offer millions of job openings. Supporting sectors such as **architectural services and R&D** will also grow, emphasising higher qualifications. The EGD will significantly reduce employment in primary industries (coal,

[130] Vandeplas, A., Vanyolos, I., Vigani, M., & Vogel, L. (2022). *The possible implications of the green transition for the EU labour market*. (Discussion Paper No. 176). Directorate-General for Economic and Financial Affairs, European Commission. https://doi.org/10.2765/583043

[131] Cedefop (2023). *Skills in transition: the way to 2035*. Luxembourg: Publications Office. http://data.europa.eu/doi/10.2801/438491

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oil, gas) by 2030,although the Ukraine war-induced energy crisis has temporarily reversed this trend.

Overall, employment in the **coal sector** is projected to decrease by an additional 46-49% by 2030 compared to the baseline. Similarly, other **energy-intensive sectors** may see declines in employment due to reduced output. However, these sectors will also benefit from restructuring and adapting to new, carbon-neutral production technologies and business models. An illustrative case of the transformation of entire value chains is seen in the **automotive sector**, shifting structurally from traditional petrol and diesel engines to battery-powered ones. Europe is increasingly embracing electro mobility, potentially leading to significant workforce reductions, particularly in the traditional automotive sector, both locally and across the EU. Suppliers of intermediate goods and upstream service providers throughout the EU will also need to adapt to remain competitive, impacting their workforces as well. Nevertheless, the overall job impact of this transition to electro mobility could be slightly positive, with new employment opportunities arising in electricity generation, the operation of charging infrastructure, and the development and production of battery technology, which is critical for electrifying mobility. The 'European Battery Alliance' underscores the employment potential of this shift[132].

Parts of the **construction sector** are also expected to benefit from the renovation wave[133], while there is an ongoing expansion in renewable energy, electricity supply and distribution, water supply, sewerage, waste management and other circular activities. Existing roles may also expand, benefiting from the emphasis on sustainability (e.g. increased demand for sustainable finance specialists, waste managers, urban planners and urban architects who incorporate evolving green and sustainability issues into their work).

**From the digital transition perspective**, the effect of transition is expected to be broad since it does not only refer to technologies but leads to a wider systems' change affecting past sociotechnical configurations such as infrastructures, training and skills, institutions, markets and business models (Fouquet and Hippe, 2022; Geels et al., 2021[134]). Besides, digitalisation is the dominant driver of industrial transformation since it creates new networked environments linking objects, infrastructures and people that control

[132] European Commission. (n.d.). *European Battery Alliance*. Single Market Economy. https://single-market-economy.ec.europa.eu/industry/industrial-alliances/european-battery-alliance_en

[133] European commission (EC) 2020. A renovation wave for Europe - greening our buildings, creating jobs, improving lives. (Staff working document). SWD/2020/550 final. Brussels, 14.10.2020

[134] Fouquet, Roger & Hippe, Ralph. (2022). Twin transitions of decarbonisation and digitalisation: A historical perspective on energy and information in European economies. Energy Research & Social Science. 91. 102736. 10.1016/j.erss.2022.102736; Geels, F.W., Pereira, G.I., & Pinkse, J. (2022). Moving beyond opportunity narratives in COVID-19 green recoveries: A comparative analysis of public investment plans in France, Germany, and the United Kingdom. *Energy Research & Social Science.*

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processes, services and devices disrupting all industry sectors, from agriculture, to manufacturing, transport, energy, health and financial services (Komninos, 2019, 2022[135]; Komninos et al., 2021[136]). The new generation of digital technologies can transform production processes, value chains and business models, leading to higher efficiency and flexibility and minimise the negative environmental impacts. A report by Eurofound[137] suggests that job losses due to digitalisation could affect up to 15% of certain roles, particularly in routine-based manufacturing, but the growth of digital technologies is expected to create demand for specialized roles. Although digital penetration is not the same for all sectors and industries, new technological advances have significant structural effects in all existing industries (Kolade and Owoseni, 2022)[138].

Also, smart use of digital technologies can improve energy and resource efficiency, facilitate circular economy, reduce environmental degradation, and mobilise collective action that can lead to systemic transformation and the removal of barriers that undermine the adoption of sustainable production practices. Green transitions typically involve a decentralized process of production and consumption, engaging multiple actors, knowledge sources, and technologies. This decentralized nature leads to high intermediation costs, where digital technologies can play a crucial role in optimizing and improving efficiency. These intermediation processes have significant implications for governance and the integration of digital technologies into green transitions, often resulting in unexpected trajectories and uncertainties (Mouthaan et al., 2023; Meijer, 2024) [139].

Technologies constitute the main driver of the two transitions (Diodato et al., 2023)[140]. Due to the differences in regional industrial structure, employment impacts vary considerably between countries and regions (Figures 6, 7). Employment in coal and lignite mining is concentrated in a few Member States, notably Poland, where it represents about 0.8% of total employment (136,000 jobs), and Bulgaria, Romania, and the Czech Republic,

[135] Komninos, N. (2022), Transformation of Industry Ecosystems in Cities and Regions: A Generic Pathway for Smart and Green Transition. Sustainability, 14, 9694. https://doi.org/10.3390/ su14159694

[136] Komninos, N., Kakderi, C., Panori, A., Garcia, E., Fellnhofer, K., Reid, A., Cvijanović, V., Roman, M. A., Deakin, M., & Mora, L. (2021). Intelligence and Co-Creation in Smart Specialisation Strategies: Towards the Next Stage of RIS3. *archiDOCT*, *17*(9 (1)).

[137] Eurofound (2021). The digital age: Implications of automation, digitisation and platforms for work and employment, Challenges and prospects in the EU series. *Publications Office of the European Union*, Luxembourg.

[138] Kolade, O., & Owoseni, A. (2022). Employment 5.0: The work of the future and the future of work. *Technology in Society*, *71*, 102086

[139] Mouthaan, M., Frenken, K., Piscicelli, L., & Vaskelainen, T. (2023). Systemic sustainability effects of contemporary digitalization: A scoping review and research agenda. Futures, 149, 103142. https://doi.org/10.1016/j.futures.2023.103142; Meijer, A. (2024). Perspectives on the twin transition: Instrumental and institutional linkages between the digital and sustainability transitions. *Information Polity*, (Preprint), 1-17

[140] Diodato, D., Huergo, E., Moncada-Paternò-Castello, P., Rentocchini, F., & Timmermans, B. (2023). Introduction to the special issue on 'the twin (digital and green) transition: handling the economic and social challenges'. Industry and Innovation, 30(7), 755-765

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where it is slightly less than half of that. Some employment in coal mining also persists in Slovenia, Greece, and Spain. Conversely, many regions, including coastal and remote areas, have significant potential for renewable energy production, albeit with specific adaptation challenges. So, disparities may arise when examining specific indicators of geographical industrial structures and assessing the regional potential for expanding various forms of (renewable) energy generation.

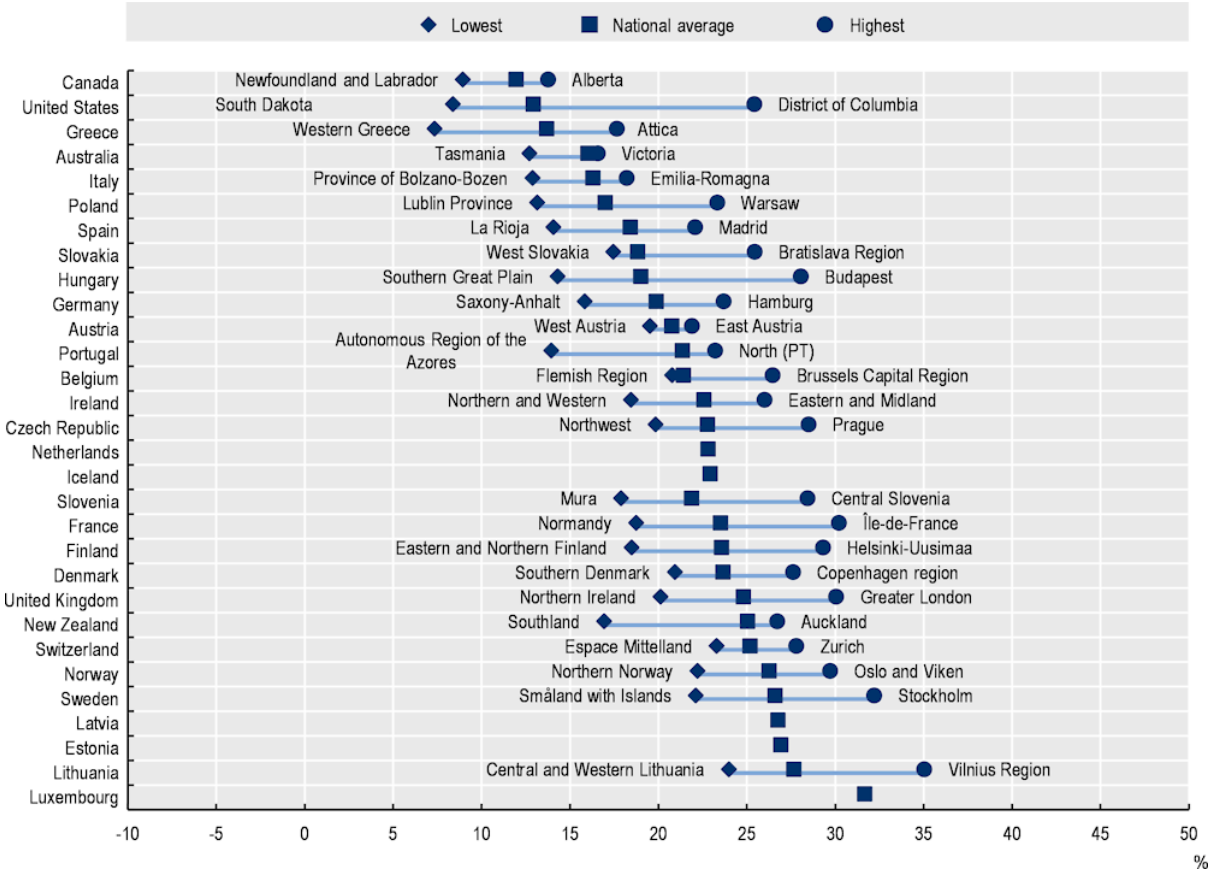


***Figure 6: Regional disparities in green jobs within countries. Source: OECD (2023)***[141]

For example, according to 2019 estimations GDP effects were expected to be highest in Latvia, given its strong dependency on fossil fuel imports, yet employment effects are likely to be moderate. The employment impacts of climate action policies would be positive and substantial in Belgium, Spain and Germany, where employment increases by up to 1% of total employment. In contrast, the effects on GDP and employment would be negligible in Denmark, given its advanced adoption of renewables and energy efficiency (i.e. the additional investment needed to achieve $CO_2$ emissions reduction targets is minimal). Conversely, the impact on Poland's GDP and overall employment growth is also

[141] OECD (2023). *Job Creation and Local Economic Development: Bridging the Great Green Divide*, OECD Publishing, Paris, https://doi.org/10.1787/21db61c1-en.

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projected to be small, due to the fact that the substantial job losses expected in Poland's coal production sector are likely to offset gains in other sectors.

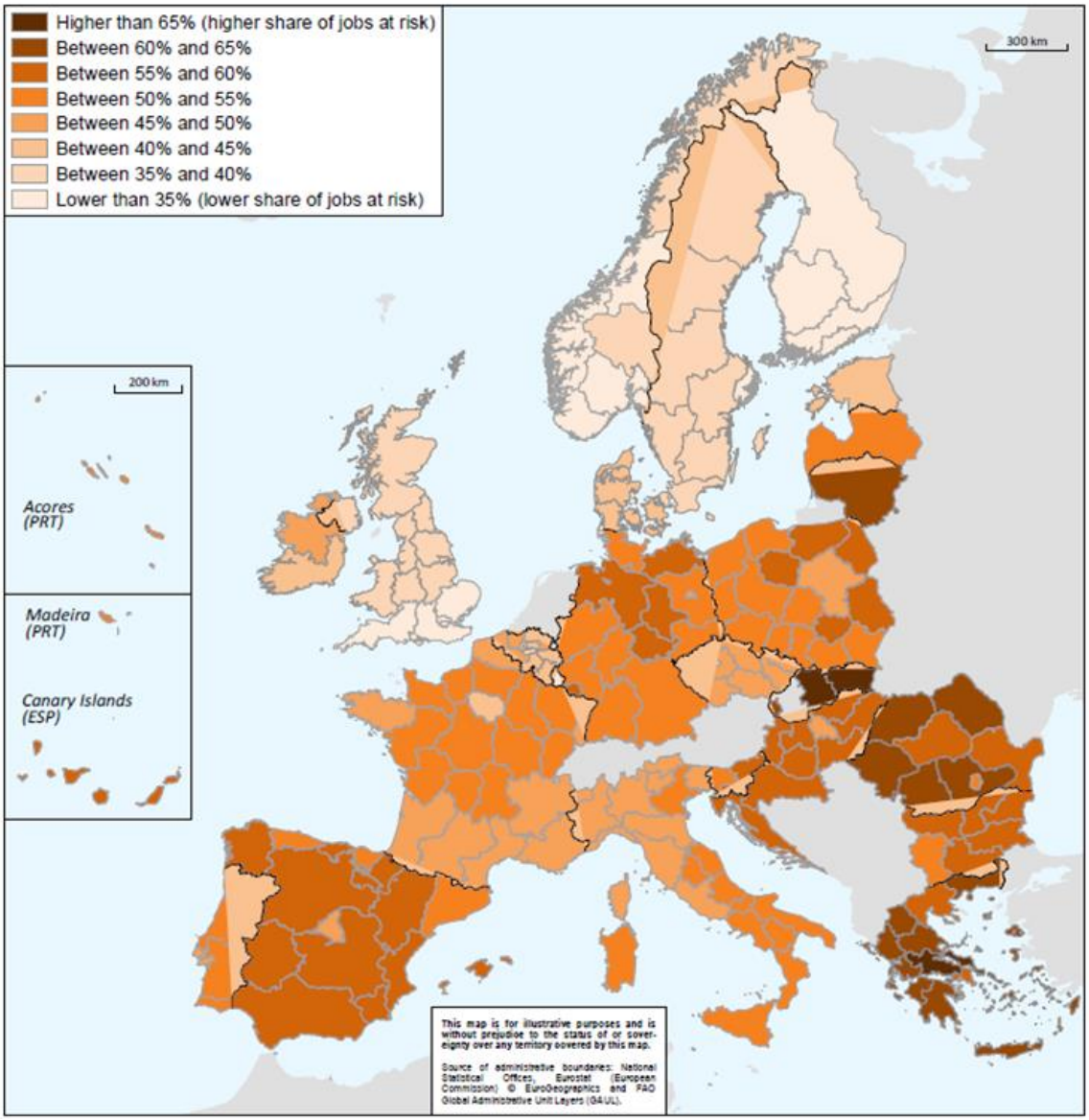


***Figure 7: Risk of automation across European TL2 regions, 2016. Source: OECD (2019)***[142]

Consequently, both opportunities and threats may have a regional emphasis, highlighting the need to account for regional differences and specific needs when designing policies to promote the green and digital transition. Apart from targeted reskilling and retraining to facilitate labour market transitions, cross-border approaches can also bring significant added value, enabling transition challenges to be addressed more effectively and emerging opportunities to be exploited mutually.

[142] OECD (2019). *Regions in Industrial Transition: Policies for People and Places*, OECD Publishing, Paris, *https://doi.org/10.1787/c76ec2a1-en*.

*This project has received funding from the European Union's Horizon Europe under Grant Agreement No 101132559.*

## 3.2 Green and digital industrial transition based on technological capabilities

### 3.2.1 Industrial diversification for addressing regional vulnerabilities due to the two transitions

The opportunities provided by the combination of the decarbonisation and digitalisation of industry sectors have recently been expressed in the literature of economic geography. Based on the acknowledgement that there is an uneven distribution of capabilities and specialisations across territories, economic geography has largely focused on their different abilities to diversify and create new activities. Two frameworks have gained great momentum in studies within this field: the recombinant knowledge approach, as the principal mechanism underlying new knowledge generation (Schumpeter, 1939; Nelson and Winter, 1982[143]), and related variety, as a key driver for the recombination of existing knowledge that leads to the creation of new industrial paths (Boschma, 2017; Neffke et al., 2011; Balland et al., 2019)[144,145].

Within this context, literature emphasises that green and digital technologies have significant properties that might alter the dynamics of industrial/technological branching. Green technologies, due to their broad range and complexity, can be associated with higher economic benefits and larger spillovers (Barbieri et al., 2020a[146]) and, unlike other technological domains, which mainly rely on related diversification, the development of new green technologies require diversification across both related (green and non-green) (Van Den Berge and Weterings, 2014; Montresor and Quatraro, 2020[147]) and unrelated knowledge domains (Tanner, 2014; Quatraro and Scandura, 2019[148]). As Barbieri et al.

[143] Nelson, R. R., & Winter, S. G. (1982). An evolutionary theory of economic change Harvard University Press. *Cambridge, MA and London*

[144] Boschma, R. (2017). Relatedness as driver of regional diversification: A research agenda. *Regional Studies*, *51*(3), 351-364; Neffke, F., Henning, M., & Boschma, R. (2011). How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic geography*, *87*(3), 237-265; Balland, P. A., Boschma, R., Crespo, J., & Rigby, D. L. (2019). Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional studies*, *53*(9), 1252-1268

[145] Besides its contribution to the theoretical understanding of the main factors of regional difersification and interregional differences, related variety has also been used as a framework for place-based policies such as smart specialization, facilitating regions to assess the potential costs and benefits of alternative technological trajectories (Balland et al, 2019).

[146] Barbieri, N., Marzucchi, A., & Rizzo, U. (2020a). Knowledge sources and impacts on subsequent inventions: Do green technologies differ from non-green ones?. *Research Policy*, *49*(2), 103901

[147] Montresor, S., & Quatraro, F. (2020). Green technologies and Smart Specialisation Strategies: a European patent-based analysis of the intertwining of technological relatedness and key enabling technologies. *Regional Studies*, *54*(10), 1354-1365; Van Den Berge, M., & Weterings, A. (2014). Relatedness in eco-technological development in European regions. *Papers in Evolutionary Economic Geography*, *14*(13), 1-30

[148] Quatraro, F., & Scandura, A. (2019). Academic inventors and the antecedents of green technologies. A regional analysis of Italian patent data. *Ecological Economics*, *156*, 247-263; Tanner, A. N. (2014). Regional branching reconsidered: Emergence of the fuel cell industry in European regions. *Economic Geography*, *90*(4), 403-427

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(2022, 3[149]) mention, 'green and non-green technical knowledge exhibit complementarities so that the development of non-green technologies generates positive externalities for the development of green knowledge and vice-versa'.

On the other hand, digital technologies seem to negatively moderate the effect of 'relatedness' (Montresor and Quatraro, 2020; Santoalha and Boschma, 2021[150]), which describes the tendency of regions to create new industrial paths out of pre-existing activities (Frenken and Boschma, 2007[151]). The adoption of new digital technologies broadens the effect of transition since it does not only refer to technologies but leads to a wider systems' change affecting past sociotechnical configurations such as infrastructures, training and skills, institutions, markets and business models (Fouquet and Hippe, 2022; Geels et al., 2021[152]). Although territories vary significantly in their digital technological capabilities local endowment of these technologies does not only predict excellence in related technological fields (Buarque et al., 2020, Balland and Boschma, 2021; Xiao and Boschma, 2022[153]) but also a higher probability to engage in unrelated diversification activities (Antonietti and Montresor, 2021[154]).These findings can have significant implications to place based innovation policies, such as the Smart Specialisation and the theoretical and empirical framework that has been developed over the potential risks and benefits of adopting different diversification strategies.

### 3.2.2 Which are green and digital technologies

Green and digital technologies have significant properties that might alter the dynamics of employment, industrial/technological branching and create prospects for extroversion in global trade networks, but they also generate greater competition and regional vulnerabilities. On the one hand, green technologies, i.e. technologies that enable a decreased environmental impact and/or reduce anthropogenic pressure on natural

[149] Barbieri, N., Consoli, D., Napolitano, L., Perruchas, F., Pugliese, E., & Sbardella, A. (2022). Regional technological capabilities and Green opportunities in Europe. *The Journal of Technology Transfer*, 1-30

[150] Santoalha, A., & Boschma, R. (2021). Diversifying in green technologies in European regions: does political support matter?. *Regional Studies*, *55*(2), 182-195; Montresor, S., & Quatraro, F. (2017). Regional branching and key enabling technologies: Evidence from European patent data. *Economic Geography*, *93*(4), 367-396

[151] Frenken, K., & Boschma, R. A. (2007). A theoretical framework for evolutionary economic geography: industrial dynamics and urban growth as a branching process. *Journal of economic geography*, *7*(5), 635-649

[152] Fouquet, R., & Hippe, R. (2022). Twin transitions of decarbonisation and digitalisation: A historical perspective on energy and information in European economies. *Energy Research & Social Science*, *91*, 102736; Geels, F. W., Pinkse, J., & Zenghelis, D. (2021). Productivity opportunities and risks in a transformative, low-carbon and digital age. *The Productivity Institut e Working Paper*, (009)

[153] Buarque, B. S., Davies, R. B., Hynes, R. M., & Kogler, D. F. (2020). OK Computer: the creation and integration of AI in Europe. *Cambridge Journal of Regions, Economy and Society*, *13*(1), 175-192; Balland, P. A., & Boschma, R. (2021). Mapping the potentials of regions in Europe to contribute to new knowledge production in Industry 4.0 technologies. *Regional Studies*, *55*(10-11), 1652-1666; Xiao, J., & Boschma, R. (2022). The emergence of Artificial Intelligence in European regions: the role of a local ICT base. *The Annals of Regional Science*, 1-27

[154] Antonietti, R., & Montresor, S. (2021). Going beyond relatedness: Regional diversification trajectories and Key Enabling Technologies (KETs) in Italian regions. *Economic Geography*, *97*(2), 187-207

*This project has received funding from the European Union's Horizon Europe under Grant Agreement No 101132559.*

resources, encompass a broader range of objectives and knowledge inputs and are therefore acknowledged to be more complex (De Marchi, 2012[155]). They also seem to have a larger impact on subsequent inventions and therefore can be associated with higher economic benefits and larger spillovers (Barbieri et al., 2020[156]). Therefore, the existence of green technological capacities creates further prospects for regional diversification.

On the other hand, digital technologies are General Purpose Technologies that can be applied to a wide range of domains. Although they may be treated as a homogeneous block, they differ substantially both from one another and from standard technologies. Their horizontal applicability may facilitate the creation of complementarities between different elements of a system's architecture, accelerating thus the transition of industries towards more green paths. Also, their radical impact on the consumption/demand side, the mobilisation of resources and the connection and networking of heterogenous actors may challenge incumbents and affect the socio-technical regime, reducing the barriers to sustainability innovation (Antonietti and Montresor, 2021)[157].

Existing literature focuses on the identification of green and digital technologies separately, mainly based on the use of patent classes. WIPO has created the IPC Green Inventory based on essential green technologies identified by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), while OECD ENV-TECH collects ninety-five environment related technologies grouped into eight technology groups. Additionally, other classifications such as YO2 and YO2S, which focus on specific environmental technologies, and YO4S, which covers new technological developments, are not fully represented in these datasets. Recent studies, such as Favot et al. (2023)[158], demonstrate how different methodologies, including IPC and CPC code-based classifications, can yield diverse results in identifying green technologies.

With regards to digital technologies, again the IPC categorisation does not provide a single field of digital technologies, but instead these have to be collected from 3-digit or 4-digit technological fields. For instance, WIPO suggests a search strategy for identifying specific technologies, such as Artificial Intelligence (AI), through a combination of keyword, CPC, and IPC searches, as highlighted in the World Intellectual Property Report 2022: The

[155] De Marchi, V., (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. Research Policy, 41(3), 614-623

[156] Barbieri, N., Marzucchi, A., Rizzo, U., (2020) Knowledge sources and impacts on subsequent inventions: Do green technologies differ from non-green ones? Research Policy, 49(2), 103901, ISSN 0048-7333

[157] Antonietti, R., & Montresor, S. (2021). Going beyond relatedness: Regional diversification trajectories and Key Enabling Technologies (KETs) in Italian regions. Economic Geography, 97(2), 187-207

[158] Favot, M., Vesnic, L., Priore, R., Bincoletto, A., & Morea, F. (2023). Green patents and green codes: How different methodologies lead to different results. *Resources, Conservation & Recycling Advances, 18, 200132*

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Direction of Innovation[159]. Similarly, the UK Patent Office proposes a list of IPCs to identify Internet of Things (IoT) technologies. However, these approaches don't cover the full spectrum of digital technologies. A review of various methodologies shows the use of patent databases (e.g., PATSTAT, Derwent) and different search strategies (including keyword and topic searches) to capture a broader range of digital technologies, such as AI, robotics, autonomous vehicles, and Industry 4.0 enablers (Foster-McGregor et al., 2019[160]; Youtie et al., 2017[161]; Santarelli et al., 2022[162]). These diverse methodologies illustrate how different approaches can lead to varying results in identifying digital technologies. Other studies use keyword text search in patent abstracts[163].

To date, there is no consensus on what constitutes twin transition technologies or how to effectively measure them. Furthermore, there is limited understanding of how digital technologies contribute to or interact with the green transition. However, examples of convergence between digital and green technologies can help illustrate this relationship. For instance, advancements like energy-efficient data centres, digital tools for climate adaptation, and automation integrated into sustainable production processes are examples of digital technologies playing a role in environmental sustainability. Additionally, innovations like smart grids and energy storage systems further demonstrate how digital technologies are increasingly embedded within green transition efforts, as highlighted in recent studies on sustainability transitions (e.g., Mäkitie et al., 2023)[164]. These examples offer a clearer picture of how digital and green innovations work together to drive twin transitions.

## 3.3 EU policies on green, digital and twin technological transition of industrial sectors and regions

The green, digital and twin transitions create regional vulnerabilities due to varying industrial structures across EU regions. Different regions face unique challenges based on their economic bases, existing industrial capacities, and levels of digital infrastructure. The European Union has introduced several policies to address these emerging inequalities

[159] World Intellectual Property Organization (2022). World intellectual property report 2022: The direction of innovation. WIPO. https://www.wipo.int/publications/en/details.jsp?id=4594

[160] Foster-McGregor, N., O. Nomaler, and B. Verspagen (2019). Measuring the creation and adoption of new technologies using trade and patent data.

[161] Youtie, J., A. L. Porter, P. Shapira, S. Woo, and Y. Huang (2017). Autonomous systems: A bibliometric and patent analysis. Technical report, Studien zum deutschen Innovations system.

[162] Santarelli, E., J. Staccioli, and M. Vivarelli (2022). Automation and related technologies: a mapping of the new knowledge base. The Journal of Technology Transfer, 1–35.

[163] Buarque, B. S., Davies, R. B., Hynes, R. M., & Kogler, D. F. (2020). OK Computer: the creation and integration of AI in Europe. *Cambridge Journal of Regions, Economy and Society,* 13(1), 175-192

[164] Mäkitie, T., Hanson, J., Damman, S., & Wardeberg, M. (2023). Digital innovation's contribution to sustainability transitions. Technology in Society, 73, 102255. https://doi.org/10.1016/j.techsoc.2023.102255

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and ensure a balanced and inclusive transition. These policies aim to mitigate the unequal impacts of the two transitions, by **promoting economic diversification, investing in infrastructure, supporting workforce transition and ensuring social inclusion**.

The Commission's documents on the Green Deal and the Just Transition Mechanism highlight the unequal territorial impact of the green transition as 'not all countries, regions and cities start the transition from the same point or have the same capacity to respond'. The Just Transition Mechanism and the Just Transition Fund aim to support sectors and regions that depend more on carbon-intensive processes. The JTM draws on sources of funding (Just Transition Fund) (Regulation (EU) 2021/1056)[165] from the EU budget and the European Investment Bank (EIB) to leverage the necessary private and public resources. The JTM focuses on the **economic diversification of territories and the reskilling**, and inclusion in the labour market.

The Commission also highlights the need to **help Member States put in place territorial transition plans**, and invest in the development of the necessary skills that will facilitate the transition to green jobs (i.e. for emerging job opportunities in the green economy). According to the **European Green Deal Investment Plan**, Member States could be further encouraged to use existing state aid rules to mitigate the social and regional impacts of decarbonisation. This includes supporting workers affected by industrial (e.g. coal mines) closures, **investing in SMEs and start-ups, as well as to up- and reskilling the workforce**. Additionally, **co-investment in key enabling technologies and breakthrough innovations** is promoted to unlock substantial private investments. These initiatives particularly focus on regions most affected by the transition, ensuring that the benefits of the green economy are widely and equitable shared.

The 2020 Communication document on **Stepping up Europe's 2030 climate ambition emissions** (EC,2020)[166] which aims to reduce greenhouse gas emissions by 55%, recognises that the twin transition will have significant implications across sectors and regions, potentially widening inequalities. On the one hand, carbon-intensive industries, such as energy, manufacturing, and transport and heavy industries, such as steel, cement, and chemicals, will experience the most substantial impacts, as they are required to decarbonize and adopt greener technologies. Regions heavily dependent on fossil fuels, particularly in areas like Poland or northern Spain, face potential job losses and economic decline, increasing the gap between these areas and those with advanced renewable energy infrastructures. The Just Transition Fund seeks to address this by providing

[165] European Parliament and Council of the European Union (2021). E*stablishing the Just Transition Fund*. (Regulation (EU) 2021/1056). PE/5/2021/REV/1, OJ L 231, p. 1–20. Brussels, 24.06.2021

[166] Stepping up Europe's 2030 climate ambition investing in a climate neutral future for the benefit of our people. (Communication). COM/2020/562 final. Brussels, 17.09.2020

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financial aid to vulnerable regions and workers, helping them transition toward greener industries.

On the other hand, the digital transition poses additional risks of inequality, as regions with **better digital infrastructure and innovation capacity—such as urban or more affluent regions—stand to benefit more from this shift**. Rural and less digitally developed areas may fall behind, exacerbating the digital divide. The **Digital Europe Programme** and the **Territorial Agenda 2030** highlight the need for targeted investments in digital connectivity and skills development to address these challenges and ensure that both the green and digital transitions are inclusive and equitable. These initiatives, alongside tailored regional strategies, are crucial to minimizing territorial disparities while promoting sustainable and digital growth across the EU. Similarly, the **Proposal for a Counsil Recommendation on Ensuring a Fair Transition Towards Climate Neutrality**[167], addresses the unequal impact of the green transition on different sectors especially on energy intensive, hard-to-abate 'brown industries' and that Member States should put in place comprehensive policy packages (based on the Annual Sustainable Growth Strategies-ASGS[168], the Euro area recommendations and the Country Specific recommendations).

On the other hand, EU's digital strategy has limited refence to potential spatial inequalities that may emerge from digital transformation, and mainly focuses on setting of standards and safeguarding the principles of the European Single Market. An exception to this is EU's **Industrial Strategy** and the **Digital Europe Programme**. The Industrial Strategy highlights the need to ensure a fair transition for carbon intensive regions. The strategy is underpinned by a set of inter-connected and reinforcing elements: (i) certainty for industry and a deeper and more digital single market, (ii) upholding a global level playing field, (iii) a shift to climate neutrality, (iv) building a more circular economy, (v) embedding industrial innovation, (vi) skilling and re-skilling, and (vii) investment and financing the transition. The strategy is framed around industrial ecosystems, taking into account all players within a value chain. It prefers the ecosystem rather than the sectoral approach as it better incorporates the systemic importance of all the horizontal and vertical links among economic actors. It also recognises the importance of activities that are ancillary

[167] European Commission (EC) (2021). *Ensuring a fair transition towards climate neutrality.* (Proposal for a Council Recommendation). COM/2021/801 final. Strasbourg, 14.12.2021

[168] The Annual Sustainable Growth Strategies focus on general economic, employment, and social policy priorities for the next 12 to 18 months highlights key challenges and offers policy recommendations aimed at fostering sustainable growth, inclusiveness, and convergence across the Union. The recommendations aim at addressing structural weaknesses, promoting job creation, enhancing social protection systems, and supporting economic recovery efforts. Member States are encouraged to integrate these priorities into their national economic strategies for the upcoming year, ensuring alignment with the broader objectives of resilience, sustainability, and cohesion within the EU.

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to industry, such as supply of raw material, research and innovation, the provision of business services, or access to distribution networks (EC, 2021c)[169].

The **New Industrial Strategy**[170] was announced in March 2020 with the vision to develop a green and circular economy and support a digital transformation of society. It aims to make Europe an accelerator and enabler of change, innovation and growth and outlines three main drivers for its industrial transformation: global competition, climate neutrality and a digital future. The updated strategy has further developed the industrial ecosystems approach, showing that the impact of the crisis was uneven between the different ecosystems (with most of them having sizeable losses, with the exception of the digital ecosystem) (Figure 8).

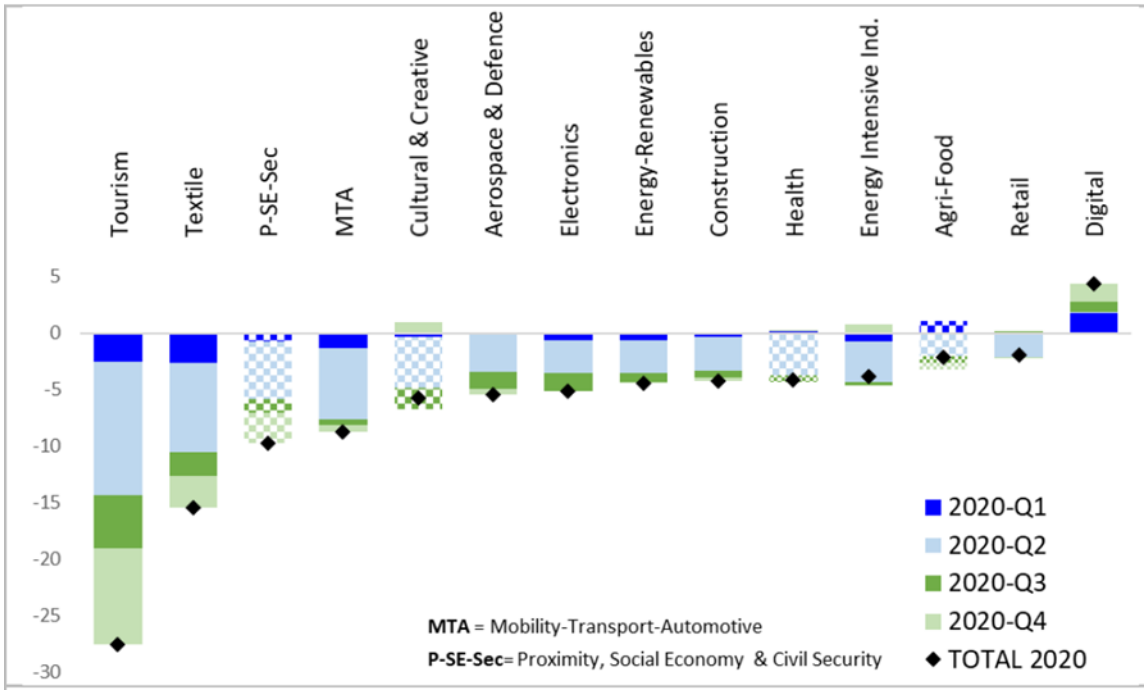


***Figure 8: Change in turnover due to the green and digital transformation by ecosystems. Source: EC (2021c)***

It also reveals barriers to the European Single Market, some of them being horizontal across all industrial ecosystems and some specific within individual ecosystems. It highlights the significance of European **industrial sovereignty**, i.e. its strategic autonomy in key technologies and access to raw materials, particularly since the interdependencies of global value chains revealed during the pandemic exposed vulnerabilities.

[169] European Commission (EC) (2021c). *A Green and Digital Transformation of the EU*. Ministerial Declaration.
[170] European Commission (EC) (2020). *A New Industrial Strategy for Europe*. (Communication). COM/2020/ 102 final. Brussels, 10.03.2020. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0102

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The **Digital Europe Programme**[171] focuses on building the EU's digital capabilities in key areas like artificial intelligence, cybersecurity, and advanced digital skills, aiming to ensure that the benefits of digital transformation are widely shared across regions and Member States. The programme acknowledges the **unequal impact of the digital transition** on different regions and countries due to **disparities in digital infrastructure, technological readiness, and skill levels**. Regions with weaker digital infrastructure and lower levels of digital skills are more vulnerable to being left behind. This imbalance risks widening the **digital divide** between more digitally advanced Member States and regions, and those that struggle with limited access to digital tools, connectivity, and innovation ecosystems. To address this, the programme emphasizes targeted investments in digital infrastructure, skills development, and support for lagging regions to improve their digital capabilities, ensuring that all areas can participate in and benefit from the digital transformation.

Other relevant programs are the **Digital Innovation Hubs (DIHs)** which are supported by cohesion funds to help businesses, especially SMEs, become more competitive through digital technologies. DIHs provide access to expertise, testing facilities, and funding opportunities to facilitate digital transformation. Investments in high-speed internet and digital infrastructure are crucial for enabling the digital transition. Cohesion Policy funds support the expansion of digital connectivity in underserved and rural areas, helping to bridge the digital divide. The “Digital Strategy” underscores the importance of digital connectivity and innovation in the EU’s future growth (EC, 2020). Finally, **Connecting Europe Facility (CEF)**[172] supports the development of digital infrastructure across Europe, addressing digital divide issues by improving connectivity in underserved areas.

Apart from green and digital transition policies, there is **a list of dedicated and coordinated policies that aim to address disparities at the territorial level**, such as the Regional Development Funds and the social cohesion policy, particularly through Smart Specialisation, the Recovery and Resilience Facility, and the Territorial Agenda.

The most recent **Report on Economic, Social and Territorial Cohesion**[173] published on 27 March 2024, presented an assessment of the state of cohesion in the Union. The report emphasises that green and digital transitions pose unique challenges for regions with varying capacities. **Coastal, Mediterranean, and Southeastern regions are particularly vulnerable to climate change**, risking annual GDP losses of over 1%. These transitions could **exacerbate regional disparities, especially in regions lagging behind in digitalization or heavily dependent on carbon-intensive industries.** Addressing these

[171] European Parliament and Council of the European Union (2021). Establishing the Digital Europe Programme and repealing Decision (EU) 2015/2240. (Regulation). PE/13/2021/INIT, OJ L 166, 11.5.2021, p. 1–34. Brussels, 29.03.2021.
[172] Regulation (EU) 2021/1153 of the European Parliament and of the Council of 7 July 2021 establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014 (Text with EEA relevance)
[173] European Commission (EC) (2022). Ninth report on economic, social and territorial cohesion. Publications Office of the European Union, Luxemburg. https://ec.europa.eu/regional_policy/information-sources/cohesion-report_en

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disparities requires targeted policy responses. Although EU regions have benefited from significant investments aimed at enhancing energy efficiency, renewable energy, and digital infrastructure, Cohesion Policy funding for 2021-2027 continues to emphasize the integration of these transitions, with €100 billion allocated for green projects and €40 billion for digital development.

The **European Union's Cohesion Policy** is a key tool for promoting balanced development across its member states, addressing regional disparities, and supporting economic, social, and territorial cohesion. It is one of the main tools to address regional inequalities arising from the twin transition, since it promotes the green and digital transitions, while simultaneously tackling inequalities related to industrial transformation. More specifically, the first two priorities of the cohesion policy for 2021-2027 are related to the two transitions, by promoting (i) a **more competitive and smarter Europe through innovative and smart economic transformation and regional ICT connectivity** (including actions on developing skills for smart specialisation, industrial transition and entrepreneurship) and (ii) a **greener, low-carbon transitioning towards a net zero carbon economy and resilient Europe through clean and fair energy transition**, green and blue investment, the circular economy, climate change mitigation and adaptation, risk prevention and management, and sustainable urban mobility. Besides these two thematic priorities, cohesion policy includes a social perspective by promoting a social and inclusive Europe implementing the European Pillar of Social Rights and a Europe closer to citizens by fostering the sustainable and integrated development of all types of territories and local initiatives.

The main funding mechanisms of the Cohesion Policy support actions to reduce regional imbalances. First, the **European Regional Development Fund** (ERDF) aims to support structural adjustments in regions that are lagging behind and aid the transformation of declining industrial areas. It does so by promoting sustainable development and tackling environmental challenges, with a particular focus on addressing the needs of the least advantaged regions. The ERDF supports investments in innovation, digitalisation, energy transition, and circular economy with specific emphasis given to *"tackling environmental and climate challenges, in particular the transition towards a climate-neutral economy by 2050, to harnessing the potential of digital technologies for innovation purposes, and to support the development of functional urban areas"*[174]. In fact, for achieving thematic concentration of resources, regions are classified in categories (more developed regions, transition regions, less developed regions). Second, the **Cohesion Fund**, assists less economically developed regions in transitioning to a low-carbon, climate-resilient

[174] European Parliament and Council of the European Union (2021). *European Regional Development Fund and on the Cohesion Fund*. (Regulation (EU) 2021/1058). Brussels, 24.06.202. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1058

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economy. Third, the **Just Transition Fund** (JTF), specifically targets regions heavily dependent on fossil fuels or high-emission industries, providing financial support to mitigate socio-economic impacts and promote economic diversification and reskilling.

Within the Cohesion Policy framework, regions are encouraged to develop Smart Specialisation Strategies (S3) that identify their unique strengths and competitive advantages. These strategies ensure that investments are made in areas where regions have the most potential, **promoting innovation, digital transition and industrial transformation** in a way that is tailored to local needs and contexts. The "Smart Specialisation Platform" provides guidance on developing these strategies, which are essential for fostering regional development and innovation (EC, 2020). Deepening the S3 by **encompassing the sustainability dimension** provides a new opportunity and a new direction for Smart Specialisation agenda and Cohesion Policy which has already led to the building of innovation-led and entrepreneurial-led capabilities at local, city and regional scales. The result of this blending will create the next generation innovation strategies which some call "Smart Specialisation Strategies for Sustainability" (S4) (McCann and Soete, 2020)[175]. These new strategies are based on local policy initiatives which focus on regional environmental challenges, favour the **green diversification of regional technologies** (Montresor and Quatraro, 2019)[176] and build upon existing knowledge from their S3 experience on how to motivate, induce and coordinate entrepreneurship and exchange experiences with other regions.

A pilot initiative called **"Smart Specialisation Strategies for Sustainability" (S4)** was launched in Seville by the President of the Committee of the Regions (CoR), and the Director for Growth and Innovation of the JRC, as a voluntary update to the Smart Specialisation Strategies, with a stronger focus on Sustainability (EU Science Hub, 2021). At the same time, a new publication examines how S3 can encompass the green dimension, evolving into place-based innovation strategies for sustainability, aligning thus Smart Specialisation not only with the Green Deal goals, but also with the UN 2030 Agenda and the Sustainable Development Goals (SDGs). The publication highlights three main aspects: i) the selection of new (greener) thematic priority areas, building upon the classic Smart Specialisation process but delivering at the same time environmental and social goals, ii) their translation into transformation roadmaps by connecting local innovation with global commons and iii) their implementation by securing policy coherence and

[175] McCann, P., & Soete, L. (2020). *Place-based innovation for sustainability*. Publications Office of the European Union. https://doi.org/10.2760/250023

[176] Montresor, S., & Quatraro, F. (2018). Green technologies and Smart Specialisation Strategies: a European patent-based analysis of the intertwining of technological relatedness and key enabling technologies. *Regional Studies, 54*, 1354 - 1365

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coordination among different policy levels. (Nakicenovic et al., 2021[177]; Carayannis and Grigoroudis, 2022[178]). The report also highlights the interrelation of regions and encourages policy makers to look each region not as a separate place but as a part of a collective future. The new challenge for innovation policy is to shift the focus from the innovation process to the achievement of the required transformational change, as "growth has not only a rate, but a direction and a reach" (McCann and Soete, 2020, p.10)[179]. They stress the need to re-arrange priorities, making sustainable development as the overriding strategic priority.

Finally, the EU has established the **Recovery and Resilience Facility (RRF)**[180] as a response to the significant economic and social impact of the COVID-19 pandemic. It is the core component of the EU's *NextGenerationEU* recovery plan, representing a fund of €723.8 billion (in grants and loans) to promote long-term growth and address challenges exposed by the crisis. Its primary purpose is to provide financial support to EU Member States for investments and reforms that foster a sustainable and resilient recovery, while also advancing the twin green and digital transitions. Under this programme Member States are required to develop National Recovery and Resilience Plans (NRRPs)[181] outlining how they intend to use RRF funds to support the twin transition while addressing regional disparities and social inequalities. The programme also supports investments in areas like **broadband expansion** and **digital and green upskilling**, particularly targeting regions that need it most to avoid further exacerbating regional inequalities.

The **Territorial Agenda 2030**[182] addresses the territorial impacts of the green, digital, and twin transitions by emphasizing the importance of spatial planning and place-based approaches to ensure these shifts do not exacerbate existing disparities between regions. It highlights that not all regions are equally equipped to manage these transitions—**rural, remote areas, or those with weaker industrial and innovation capacities face greater vulnerabilities.** The agenda calls for **tailored policies** that consider local strengths and challenges, focusing on improving digital infrastructure, fostering innovation, and

[177] Nakicenovic, N., Zimm, C., Matusiak, M. and Ciampi Stancova, K. (2021) Smart Specialisation, Sustainable Development Goals and Environmental Commons, EUR 30882 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-43552-5, doi:10.2760/43732, JRC126651.

[178] Carayannis, E. G., & Grigoroudis, E. (2022). Towards an Ambidextrous, Robust and Resilient Impact Assessment of Sustainable Smarter Specialisation Strategies (AR2IA/S4). Journal of the Knowledge Economy, 1-43

[179] McCann, P., & Soete, L. (2020). *Place-based innovation for sustainability*. Publications Office of the European Union. https://doi.org/10.2760/250023

[180] European Commission (EC) (2020). *Establishing a Recovery and Resilience Facility*. (Proposal for a Regulation). COM/2020/408 final. Brussels, 28.05.2020

[181] European Commission (EC) (202). Guidance to Member States Recovery and Resilience Plans. (Staff Working Document). SWD/2021/12 final PART ½. Brussels, 22.01.2021

[182] Territorial Agenda of the European Union (2021). *Territorial agenda 2030: A future for all places*. Informal meeting of Ministers responsible for spatial planning, territorial development, and/or territorial cohesion, Germany. https://territorialagenda.eu/wp-content/uploads/TA2030_jun2021_en.pdf

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enhancing skills development. It also emphasizes the importance of a just transition, ensuring that regions dependent on carbon-intensive industries or low-skilled labor are supported through financial aid and strategic investments to create new economic opportunities.

A recent report on "The Future of EU Cohesion: Effects of the Twin Transition on Disparities across European Regions" (Maucorps et al., 2023) identifies significant challenges and potential inequalities that may arise from the green and digital twin transitions in Europe. First, there is the potential for growing existing regional disparities. Wealthier, innovation-driven regions, particularly those specializing in knowledge-intensive services or high-tech manufacturing, are well-positioned to benefit from the transitions. In contrast, regions with weaker industrial bases, lower innovation potential, and inadequate infrastructure—particularly in Southern and Eastern Europe—are at risk of falling further behind. Second, there is an unequal growth potential as regions with strong education systems, high-skilled employment, and robust innovation ecosystems are better equipped to capitalize on the twin transitions (Figures 9 and 10). Metropolitan areas and regions with advanced manufacturing industries are also expected to see greater economic benefits, while more rural or less industrialized areas face potential disadvantages.

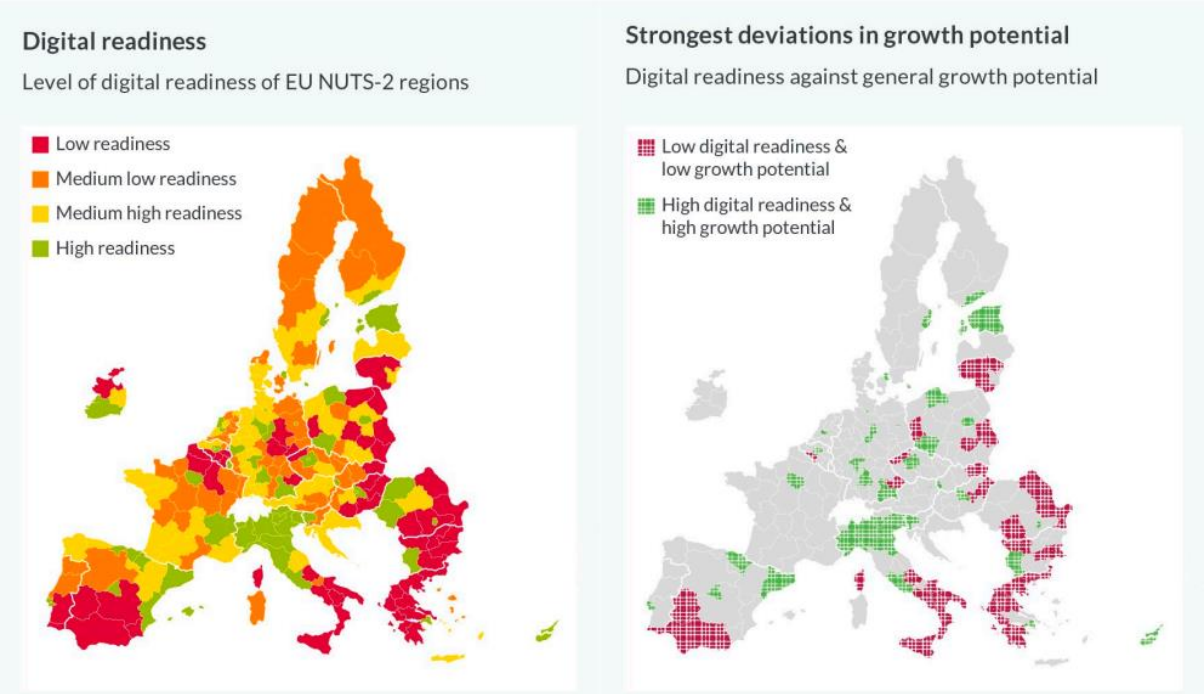


**Figure 9*: Readiness for the digital transition leading to deviations in economic growth potential (left) and strongest deviations from general economic growth potential for EU NUTS-2 regions caused by the digital transition (right). Source:*** **Maucorps et al., 2023**

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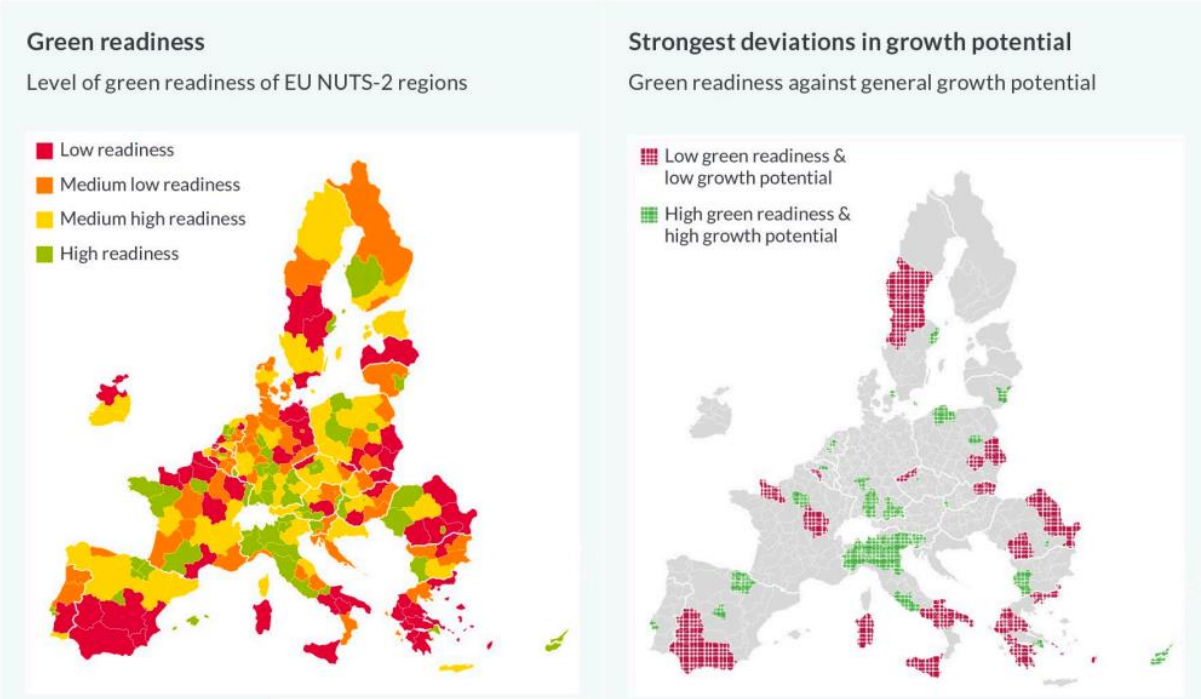


**Figure 10*: Readiness for the green transition leading to deviations in economic growth potential (left) and strongest deviations from general economic growth potential for EU NUTS-2 regions caused by the green transition (right).* Source: (Maucorps et al., 2023)[183]**

## 3.4 Concluding remarks

Territories across Europe vary significantly in their industrial structures, technological capabilities, and the skill levels of their populations. As a result, the green, digital, and twin transitions will impact them differently. The interplay between these capabilities, regional endowments, and vulnerabilities may either reveal new opportunities for economic diversification or reduce future prospects for growth.[184].

The analysis of EU policy documents addressing industrial green, digital, and twin transitions, along with territorial inequalities (Figure 11), reveals that policies focused on the green transition take a more territorial approach. They aim to support regions and sectors undergoing structural changes as they shift from traditional or declining industries to more sustainable, innovative, and competitive sectors—particularly in carbon-intensive industries. In these cases, the focus is primarily on facilitating the green

[183] Maucorps, A., Römisch, R., Schwab, T., & Vujanović, N. (2023). The future of EU cohesion: Effects of the twin transition on disparities across European regions (Research Report No. 467). Bertelsmann Stiftung & The Vienna Institute for International Economic Studies (wiiw). https://wiiw.ac.at/the-future-of-eu-cohesion-effects-of-the-twin-transition-on-disparities-across-european-regions-dlp-6560.pdf

[184] Cicerone, G., Faggian, A., Montresor, S., & Rentocchini, F. (2022). Regional artificial intelligence and the geography of environmental technologies: does local AI knowledge help regional green-tech specialization?. Regional Studies, 1-14

*This project has received funding from the European Union's Horizon Europe under Grant Agreement No 101132559.*

transition, largely through upskilling and reskilling initiatives, with fewer references to investments in innovation creation. **Territories benefiting from the Just Transition Fund are selected based on their vulnerability to the green transition**, i.e., regions whose economies rely on fossil fuels, such as coal mining and other carbon-intensive industries, **without an emphasis on their digital transformation needs**. In contrast, documents addressing the digital transition focus primarily on the presence (or absence) of digital skills and infrastructures in EU regions.

Support for economic diversification is directed towards creating jobs and industries in green sectors, such as renewable energy, sustainable agriculture, and green manufacturing, as well as in digital sectors like AI. However, discussions on future opportunities based on the evaluation of combined existing specializations and capabilities are relatively scarce. Smart specialization strategies, which encourage regions to build on their specific strengths to modernize and diversify their industrial base, could help fill this gap. These strategies, alongside other financial instruments like the Recovery and Resilience Facility, promote the development of targeted national and regional policies that reflect the unique characteristics of each territory. As a result, they are more likely to identify and address the specific inequalities emerging from the twin transitions across different regions.

In sum, these policies collectively aim to ensure that the EU's industrial base remains competitive while providing support to regions most affected by the decline of traditional industries. By promoting diversification, reskilling, and investment in innovation, they help regions and sectors navigate the twin transitions toward a more sustainable and digitally integrated economy.

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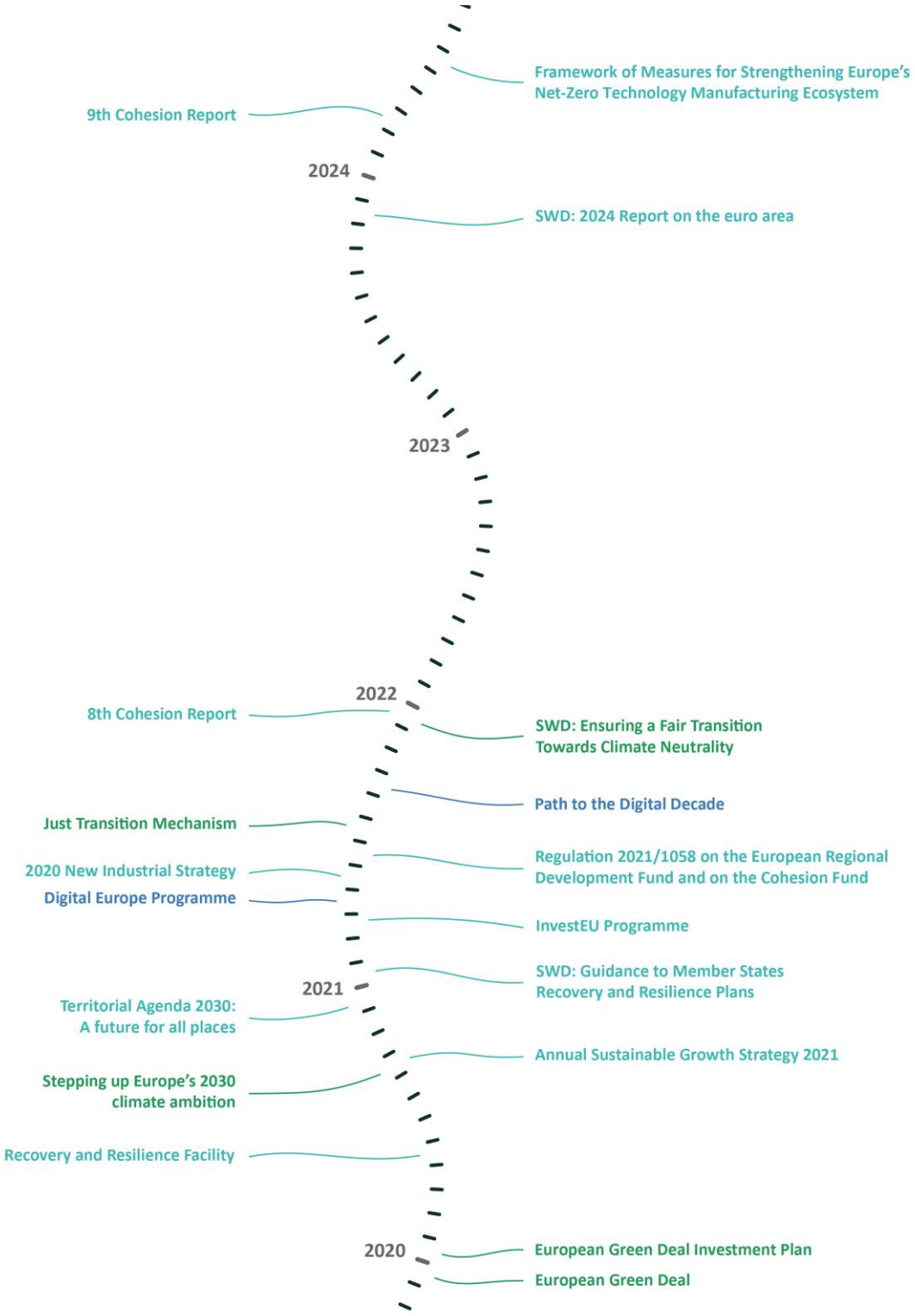


***Figure 11. Green, Digital and Twin transition policies discussing industrial transformation and territorial inequalities***

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# 4 Twin transition and consumer behaviour

Third, the two transitions reshape the skills landscape, affecting everyday life and societal participation. Tasks, such as shopping, banking, and accessing government services are increasingly done online, while monitoring and managing environmental aspects, such as energy consumption, also often requires digital literacy. The digital transition fosters new forms of civic engagement through online platforms, creates new opportunities to access information, facilitates the understanding of complex issues (such as climate change), allows the participation to democratic processes, but also creates new threats related to digital privacy and misinformation. These changes necessitate access to digital tools and the internet, along with a baseline of knowledge and critical thinking skills. Those lacking these skills (and/or relevant infrastructures) may find it difficult to fully participate in society.

## 4.1 EU policies affecting the Green Transition pathway and digital transformation in the context of consumer behaviour

An important aspect of European policy regarding the Green Transition and consumer behaviour is the implementation of measures that support and encourage consumers to make sustainable choices. This includes providing accessible information and incentives. In this context, the Commission's Communication on the **Green Deal**[185] highlights consumer protection and empowerment, advocating for informed consumer choices, particularly in energy consumption, circular economy practices, and sustainable diets. Additionally, the Green Deal addresses the importance of effective price signals, such as carbon pricing and tax reforms, to promote sustainable consumer behaviour by internalising environmental costs.

The European Union's **new Consumer Agenda**[186], spanning from 2020 to 2025, places a strong emphasis on both green and digital transition among its five key priorities (green transition's priority is streamlined in actions 4, 5 and 6). Acknowledging a growing consumer interest in climate neutrality and environmental preservation, the Consumer Agenda aims to empower consumers from all financial backgrounds with enhanced information to contribute actively (through informed decision-making) without imposing specific lifestyles or discriminating socially. Central to this approach is the provision of better information on product sustainability, enhanced protection against practices like greenwashing and early obsolescence, and promotion of the right to repair under revised

[185] European Commission (EC) (2019). *The European Green Deal*. (Communication). COM/2019/640 final. Brussels, 11.12.2019

[186] European Commission (EC) (2020). *New Consumer Agenda - Strengthening consumer resilience for sustainable recovery*. (Communication). COM/2020/696 final. Brussels, 13.11.2020

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legislation[187]. By recognising the significant role of businesses in achieving the green transition, the new Consumer Agenda also highlights that the Commission is committed to collaborating with economic operators to encourage voluntary commitments toward sustainable consumption beyond legal requirements, underscoring thus an EU strategy to foster a marketplace where sustainability is integral to both consumer choice and corporate responsibility. All these actions of the new Consumer Agenda align with broader EU strategies (such as: the Circular Economy Strategic Plan, the Renovation Wave[188], the Farm to Fork Strategy, the EU biodiversity strategy, etc.).

It is worth noting that the in the Council Conclusions on the new Consumer Agenda[189], the Member States have '*welcomed the Commission's intention to propose measures in order to promote sustainable consumption by improving consumers' right to accurate and effective information, and to better protect them against certain practices such as unsubstantiated green claims and greenwashing*'.

The **EU new Circular Economy Action Plan**[190] (which was introduced in March 2020 as part of the European Green Deal and promotes a sustainable, resource-efficient, and circular economy), marks a significant shift towards sustainability in product production and consumption. According to this Action Plan, a key aspect of green transition is integrating the consumer perspective, focusing on product longevity, ease of repair, improved recycling rates, and promoting second-hand markets and rental models. This Plan also aims to empower consumers by prioritising sustainability criteria in product manufacturing and enhancing consumer information on issues such as: the product lifespan, the repair services, the sustainability labels at the point of sale, etc. It also advocates for the utilisation of value-added tax (VAT) rates, as a tool to incentivise circular economy activities among final consumers and thus to promote circular economy activities that target final consumers (e.g. recycling, reuse, etc.).

The **Fit for 55 package**[191] represents another crucial policy initiative that advances the EU green transition and at the same time ensures that consumers are well-informed and can make choices that support the green transition. 'Fit for 55' frames the green transition as a collective responsibility involving consumers, households, and individuals, marking the

[187] De Almeida, L., & Esposito, F. (2023). Consumers and the green transition between saying and doing: promising consumer empowerment while restricting consumers' choices is dangerous. *Yearbook of European Law*, Vol.42 pp 407-427.

[188] European commission (EC) 2020. A renovation wave for Europe - greening our buildings, creating jobs, improving lives. (Staff working document). SWD/2020/550 final. Brussels, 14.10.2020

[189] Council conclusions on the New Consumer Agenda 2021/C 154/05. (2021). *Official Journal*, C 154, 6-10. CELEX: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XG0430(03)

[190] European Commission (EC) (2020). *A new Circular Economy Action Plan For a cleaner and more competitive Europe*. (Communication). COM/2020/98 final. Brussels, 11.03.2020.

[191] European Commission (EC) (2021). *'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality.* (Communication). COM/2021/550 final. Brussels, 14.07.2021

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first explicit recognition of their role in climate change mitigation. Despite this, it makes minimal reference to consumers, acknowledging them only 6 times. The package also provides consumers (and especially younger generations) with clear and accurate information about the environmental impact of products, so that to encourage them to adopt more sustainable choices.

The 2021 Communication document regarding the update of the 2020 **new Industrial Strategy**[192] highlights the importance of consumer behaviour in achieving sustainability goals. Namely, it underscores the growing consumer awareness and consumers' role in pushing for greener markets, by stating that: '*Finally, this unprecedented year showed that the demand for sustainable products is rising, and consumers are increasingly aware of the environmental impact of their choices*'. The **Green Deal industrial plan for the Net-Zero age**[193] reiterates the need to allow consumers to make their choices based on transparent and reliable information on the sustainability, durability and carbon footprint of the products, and highlights that market transparency is a tool facilitating uptake of technologically and environmentally superior net zero products.

In March 2022, the EC **proposed a Directive on empowering consumers for green transition**[194] (the proposal was one of the initiatives set out in the New Consumer Agenda and the Circular Economy Action Plan and follows up on the European Green Deal). The primary rationale behind the proposed measures is to update the previous Consumer Law to ensure consumers are protected and can actively contribute to the green transition. Empowering consumers and offering them with cost-saving opportunities are seen as essential components of the sustainable product policy framework**.** As part of this framework**, an Impact assessment report**[195] was also published, presented several policy actions designed to facilitate the needed changes in consumer behaviour to achieve climate and circularity objectives under the European Green Deal. This proposed initiative, which was considered as a self-standing and developed in full coherence with the upcoming Green Claims Initiative and the Sustainable Products Initiative (adopted together with this initiative), also aimed to address certain misleading commercial practices which prevent consumers from making sustainable consumption choices, such

[192] Coal mining accounts for less than 1% of total employment in any EU Member State, yet regional employment shares can be much higher.

[193] European Commission (EC) (2023). *A Green Deal Industrial Plan for the Net-Zero Age.* (Communication). COM/2023/62 final. Brussels, 01.02.2023

[194] European Commission (EC) (2022). *Proposal for a Directive of the European Parliament and of the Council amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and better information.* COM/2022/143 final. Brussels, 30.03.2022

[195] European Commission (EC) (2022). *Impact Assessment Report - Accompanying the Document Proposal for a Directive of The European Parliament and of the Council, amending Directives 2005/29/EC and 2011/83/EU, as regards empowering consumers for the green transition through better protection against unfair practices and better information.* Staff Working Document: SWD/2022/85 final. Brussels, 30.03.2022

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as early (or premature) obsolescence and greenwashing. It also sought to improve the transparency and credibility of sustainability labels and digital information tools. According to the impact assessment report, the provision of better information on products' durability/lifespan and reparability was identified as the best option to empower consumers for the green transition (this was strongly favoured by consumer organisations and citizens). This argument is in line with a 2018 EU behavioural study on **Consumers' Engagement in the Circular Economy**[196], which made several policy recommendations towards this direction. Furthermore, in the Impact Assessment Report a number of policy options were identified, assessed and prioritised.

The **Directive on empowering Consumers for the green transition**[197] was formally adopted by the European Parliament and the Council in February 2024. This Directive amends two existing consumer law Directives: The Consumer Rights Directive and the Unfair Commercial Practices Directive and shall enter into practice from 27 September 2027. Based on this Directive, there will be harmonised label for products in the EU, providing information on the commercial sustainability guarantee. Additionally, environmental characteristics, social characteristics, and circularity aspects will be included in the list of main product characteristics. This ensures that traders' practices can be assessed for misleading information based on these criteria.

In addition, with regard to food products, the **Farm to Fork Strategy**[198] focused on a legislative proposal for a sustainable food system and examines ways to create a sustainable food labelling framework that covers (in synergy with other relevant initiatives) the nutritional, climate, environmental and social aspects of food products.

Another key policy document that recognised the role of consumers in accelerating the green transition is the proposal for a **Directive on Green Claims**[199] (adopted by the Commission in March 2023)**.** This proposed new Directive aims to support the green transition by empowering consumers to make informed choices and by enhancing consumer participation in circular economy and towards more sustainable consumption behaviour. This document recognises several barriers to boosting the potential of green

[196] European Commission, Consumers, Health, Agriculture and Food Executive Agency, Cerulli-Harms, A., Porsch, L., Suter, J. et al., Behavioural study on consumers' engagement in the circular economy – Executive summary, {CEU}, 2018, https://data.europa.eu/doi/10.2818/921596

[197] European Parliament (EP) and Council of the European Union (2024). *Directive (EU) 2024/825 amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and through better information.* PE/64/2023/REV/1, OJ L, 2024/825. Strasbourg, 28 February 2024

[198] European Commission (EC) (2020). A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system. (Communication). COM/2020/381 final. Brussels, 20.05.2020

[199] European Commission (EC) (2023). *Proposal for a Directive of the European Parliament and of the Council on: substantiation and communication of explicit environmental claims (Green Claims Directive)*. COM/2023/166 final. Brussels, 22.3.2023

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markets in the EU (mainly due to a lack of trust in the credibility if environmental claims and the proliferation of misleading commercial practices -such as greenwashing - related to the environmental sustainability of products). It is also worth noting that during an assessment of 232 active ecolabels in the EU it was concluded that almost half of the labels' verification was either weak or not carried out. For this reason, the key measures of this Directive proposal include: (i) clear criteria on how companies should prove their environmental claims and labels, (ii) requirements for these claims and labels to be checked by an independent and accredited verifier, and (iii) new rules on governance of environmental labelling schemes to ensure they are solid, transparent and reliable.

Households and final consumers may also play a crucial role in the Union's demand for net-zero technologies. Hence, as reported in the **Net Zero Industry Act (2023)**[200] public support schemes incentivising the purchase of such products, particularly for vulnerable low- and lower-middle-class households, are essential to accelerate the green transition[201]. These support schemes, set up at national, local, or regional levels, should enhance the sustainability and resilience of EU net-zero technologies. Therefore, public authorities should ensure these schemes are open, transparent, and non-discriminatory to increase demand for net-zero technology products across the European Union. Additionally, Member States should provide easily accessible information for consumers on a free website to maximise the efficiency of these schemes.

Another important aspect of European policy is to ensure that consumers are financially protected from the potential impacts of the green transition. In October 2020, the EC published the Commission's **Recommendation on energy poverty**[202], aimed at the Member States to address the energy poverty situation in which many households find themselves. Three years later, the 2023 **Energy Efficiency Directive**[203], which includes provisions for energy-saving obligations and promotes energy efficiency improvements in buildings, underlines the key role of consumers in energy consumption and emphasises that *'in accordance with the energy poverty recommendation, Member States should provide consumers with information and tools to enable them to manage their energy consumption effectively'*. This latter directive also recognises that: (i) well-informed

[200] European Commission (EC) (2023). *Proposal for a Regulation of the European Parliament and of the Council on: Establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act).* COM/2023/161 final. Brussels, 16.03.2023

[201] For instance: (a) under the solar rooftop initiative of the EU solar strategy (COM(2022) 221), Member States are encouraged to establish national programs supporting widespread rooftop solar energy deployment, (b) the REPowerEU plan (COM/2022/230 final) urges Member States to utilize supporting measures to encourage the adoption of heat pumps.

[202] European Commission (EC) (2020). *Recommendation (EU) 2020/1563 on energy poverty.* C/2020/9600 OJ L 357, 27.10.2020, p. 35–41. Brussels, 14.10.2020

[203] European Parliament and Council of the European Union (2023). *Directive (EU) 2023/1791 on energy efficiency and amending Regulation (EU) 2023/955.* PE/15/2023/INIT, OJ L 231, 20.9.2023, p. 1–111. Strasbourg, 13.09.2023

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consumers are more likely to adopt energy-efficient practices, thereby promoting significant overall energy savings, as well as that (ii) 'energy poverty can limit the ability of consumers to invest in energy-efficient technologies.' So, EU policies must address these economic challenges to ensure that all consumers can participate in the green transition. The **Fit for 55 package** also makes some implicit references to consumers' inequality and energy poverty aiming to protect vulnerable consumers and emphasising that the benefits of reduced energy consumption should be experienced by all individuals.

Furthermore, as outlined in a **SWD accompanying the Council Recommendation on ensuring a fair transition towards climate neutrality**[204], specific measures were proposed to mitigate the social and economic impacts on consumers. These measures include tackling energy poverty and providing solutions for vulnerable consumers. In this context, in October 2021, a 'toolbox' named '**Tackling rising energy prices**'[205] was presented by the Commission to help Member States to support in the short term the energy consumers (an industry) but also to empower them in the medium-term by: (i) providing them with information and options on how they can participate in the energy market (for example with faster and easier switching of suppliers), as well as (ii) by boosting their role in the energy market.

Furthermore, the above mentioned SWD (Accompanying the Council Recommendation on ensuring a fair transition towards climate neutrality) highlighted the need to review the composition of tax-benefit and social protection systems in order to align with the requirements arising from the green transition (this review should ensure among others that accompanying policies do not lock consumers into specific technologies). It also suggests that 'financial incentives and support mechanisms are essential to encourage consumers to adopt green technologies.' While a growing number of consumers consider climate concerns in their purchasing decisions, price remains a critical factor influencing consumer behaviour. According to a recent study by the Boston Consulting Group (BCG)[206], even though 80% of consumers express concern about sustainability, fewer than 7% are willing to pay a premium for sustainable products and services. Furthermore, according to a recent OECD survey[207], while 65% of respondents are willing to make personal compromises to their lifestyles for the benefit of the environment, 63% also agreed that environmental policies should not impose extra financial costs. Hence, by

[204] European Commission (EC) (2021). *Accompanying the Proposal for a Council Recommendation on: Ensuring a fair transition towards climate neutrality*. (Staff Working Document). SWD/2021/452 final. Strasbourg, 14.12.2021

[205] European Commission (EC) (2021). *Tackling rising energy prices: a toolbox for action and support*. (Communication). COM/2021/660 final. Brussels, 13.10.2021

[206] Boston Consulting Group. (2022). *Less than 7% of Consumers Pay a Premium for Sustainable Products and Services Today, but 40% Could Be Convinced to Make Sustainable Choices.* https://www.bcg.com/press/13september2022-consumers-sustainable-choices

[207] OECD (2023), How Green is Household Behaviour?: Sustainable Choices in a Time of Interlocking Crises, OECD Studies on Environmental Policy and Household Behaviour, OECD Publishing, Paris, https://doi.org/10.1787/2bbbb663-en.

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making sustainable options more affordable in the near future it is likely to reduce the financial burden on consumers and promote sustainable consumers' behaviour and wider adoption of green practices.

The **EU's initiative on Web 4.0 and virtual worlds: a head start in the next technological transition** (EC, 2023)[208] is closely linked to consumer behaviour by shaping how individuals interact with technology and engage in digital environments. As virtual worlds offer new forms of immersive experiences and personalised services, they will influence consumer preferences and expectations, from digital shopping to interactive entertainment. By prioritising user safety, privacy, and consumer protection within these digital spaces, the policy aims to build consumer trust and confidence, ensuring that as technology evolves, it aligns with users' rights and interests, thereby fostering a more secure and user-friendly digital marketplace.

Chapter VI of the **European Declaration on Digital Rights and Principles for the Digital Decade**[209] directly influences consumer behaviour by emphasising the importance of sustainable digital products and services. By ensuring that consumers have access to clear and accurate information about the environmental impact and energy consumption of digital technologies, the policy empowers individuals to make informed and responsible choices. This transparency is designed to drive demand for eco-friendly digital solutions and encourage more sustainable consumption patterns, aligning consumer choices with broader environmental and social goals. The commitment to developing and deploying technologies with minimal negative impact supports a shift towards a more conscientious and environmentally aware consumer base.

The White Paper on **Artificial Intelligence - A European Approach to Excellence and Trust**[210] emphasises the impact of AI on consumer behaviour by highlighting the importance of data in driving economic growth and societal well-being. As AI applications expand, a significant portion of data will shift from consumer-related to industry-related sources, creating new opportunities for Europe. To foster trust, the regulatory framework must ensure AI systems comply with EU rules, particularly those protecting fundamental rights and consumer rights. This approach aims to build consumer confidence in AI, ensuring safety and respect for rights, thereby promoting the adoption of AI technologies. Additionally, the framework must address the specific challenges posed by AI, such as opacity, to ensure effective enforcement of existing consumer protection laws.

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[208] European Commission (EC) (2023). *An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition*. (Communication). COM/2023/442 final. Strasbourg, 11.07.2023

[209] European Commission (EC) (2022). *European Declaration on Digital Rights and Principles for the Digital Decade*. (Communication). COM/2022/28 final. Brussels, 26.1.2022,

[210] European Commission (EC) (2020). *White Paper on Artificial Intelligence - A European approach to excellence and trust*. COM/2020/65 final. Brussels, 19.2.2020

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The **European strategy for data**[211] aims to reshape consumer behaviour across various sectors by enhancing data access and utilisation. It promotes conscious consumption patterns through improved energy use and product traceability, leading to healthier and more sustainable lifestyles. Sector-specific legislation, such as the Digital Content Directive, empowers consumers by granting them contractual rights over their data.

The **2030 Digital Compass: the European Way for the Digital Decade**[212] aims to significantly influence consumer behaviour by integrating digital technologies with sustainability goals. The introduction of the Digital Product Passport, beginning with electric vehicle batteries, will empower consumers by providing detailed, accessible information about products throughout their lifecycle, enhancing resource efficiency and supporting sustainable choices. In manufacturing, advancements like 5G connectivity, AI, and 3D printing will enable on-demand production tailored to consumer needs, reducing waste and improving efficiency. The initiative also emphasises modernising justice systems and enforcing consumer rights in the digital realm, ensuring that digital transformation aligns with European values and enhances legal protections for consumers.

The **Digital Europe Programme**[213] has a significant impact on consumer behaviour by promoting sustainable and efficient digital solutions. The integration of AI and smart technologies aims to lower carbon footprints by optimising energy consumption through smart appliances and providing digital access to essential services, thus reducing the need for physical presence. The initiative includes the development of smart meters and apps, which empower consumers to monitor and control their energy usage in real-time, leading to cost savings and more sustainable consumption patterns. Additionally, the programme addresses consumer protection by ensuring the sustainability of digital solutions and enhancing the digital skills of citizens, particularly children, to safeguard against online risks. The focus on developing a common EU Energy Saving Reference Framework further exemplifies the commitment to providing consumers with tools to manage their energy consumption effectively and contribute to broader climate goals.

The **Digital Competence Framework for Consumers** (Brečko and Ferrari, 2016)[214] provides a comprehensive guide to understanding and managing consumer behaviour in the digital marketplace. It emphasises the importance of being aware of the impact of

[211] European Commission (EC) (2020). *A European strategy for data.* (Communication). COM/2020/66 final. Brussels, 19.02.2020

[212] European Commission (EC) (2021). *2030 Digital Compass: the European way for the Digital Decade*. (Communication) . COM/2021/118 final. Brussels, 09.03.2021

[213] European Commission (EC) (n.d.). The Digital Europe Programme. https://digital-strategy.ec.europa.eu/en/activities /digital-programme

[214] Brečko, B., Ferrari, A., edited by Vuorikari R., Punie Y. (2016). The Digital Competence Framework for Consumers; Joint Research Centre Science for Policy Report; EUR 28133 EN; doi:10.2791/838886.

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one's digital consumer actions on society and the environment and encourages using digital tools to make responsible choices. Consumers are urged to understand the data privacy implications of their online activities, such as the sharing and selling of personal data, and the profiling based on their behaviour. The framework highlights the necessity of knowing how to protect personal data, recognise potential fraud, and understand the different data protection rules that may apply internationally. Additionally, it underscores the need for vigilance in online purchasing, especially regarding product safety standards and the risks of addiction associated with online shopping. By fostering awareness and responsible behaviour, the framework aims to empower consumers to navigate the digital marketplace effectively and ethically.

## 4.2 Concluding remarks

The EU policy documents addressing the green, digital, and twin transitions increasingly recognize the inequalities that can arise among consumers based on various characteristics, including location, income level, education, and other socio-economic factors, although the extent and depth of this discussion can vary (Figure 12).

In addition to providing accessible, transparent information to support consumers in making sustainable choices, measures also include improving product sustainability information, promoting the right to repair, and combating greenwashing. The Circular Economy Action Plan further advocates for promoting second-hand markets and product longevity, using VAT incentives to encourage sustainable consumer practices. At the same time, the digital transition plays a vital role in shaping consumer behaviour, through access to information, personalisation and engagement, digital awareness, e-commerce etc.

These policies also highlight emerging inequalities. While consumers are encouraged to adopt greener behaviours, **affordability remains a challenge**, and the transition to more sustainable practices and technologies can disproportionately

affect low-income consumers, which may struggle to invest in energy-efficient technologies and new digital products, exacerbating inequalities. To address this, EU policies call for financial incentives, transparent pricing, and protection against energy poverty to ensure that all consumers can participate in the transition, but **they miss to discuss and deal with the complexity of consumer behavior changes in response to both transitions**.

In summary, while EU policies actively promote sustainable consumer behaviour through both green and digital transitions, they also strive to mitigate inequalities by ensuring access to affordable green technologies and digital resources. By addressing the economic challenges faced by disadvantaged groups, EU policies aim to create an

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inclusive framework that supports all consumers in participating in the transition toward a more sustainable and digitally integrated future.

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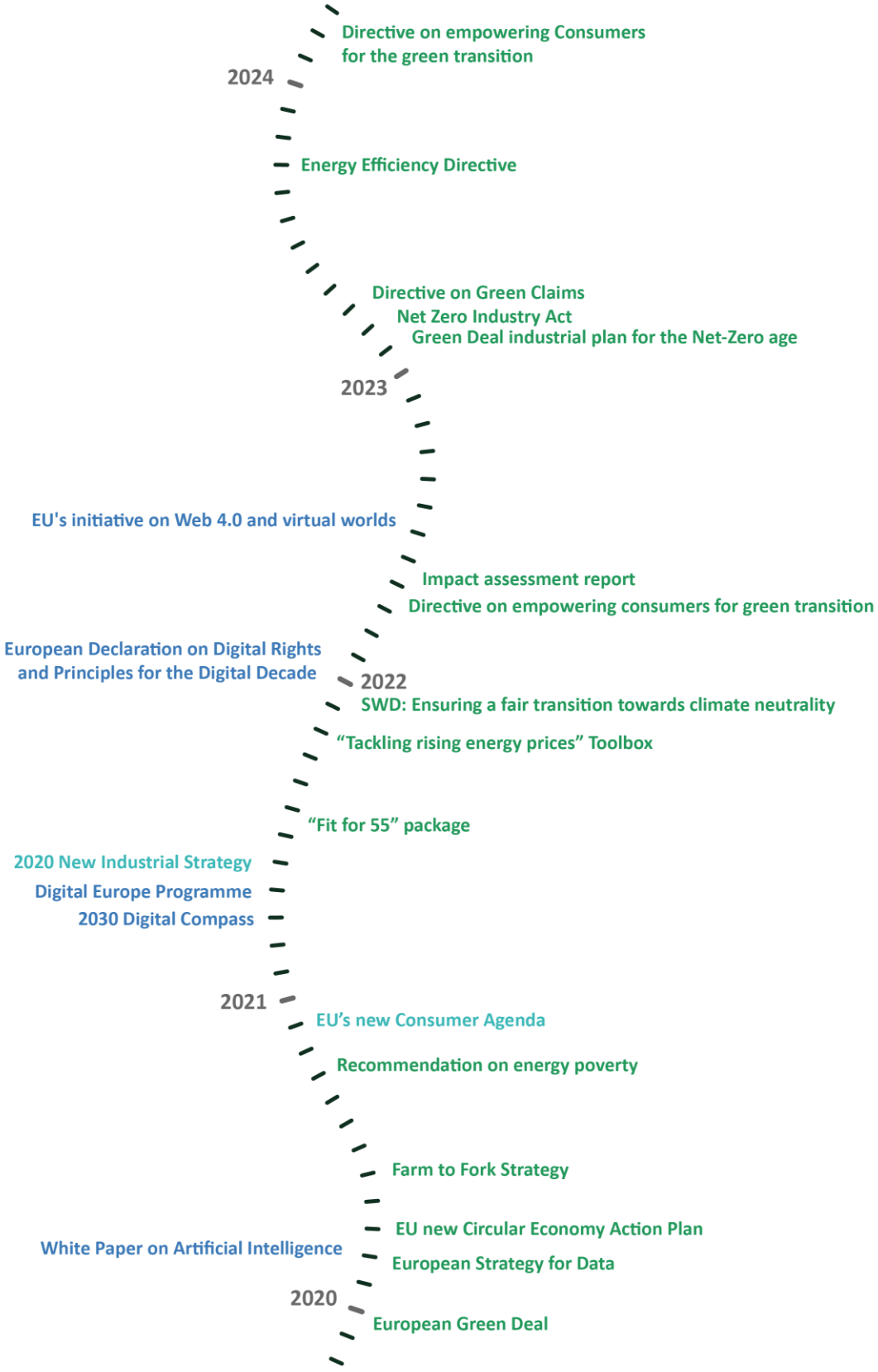


***Figure 12: EU green, digital and twin transition policies discussing consumer behaviour timeline***

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# 5 Main funding mechanisms

The European Union (EU) has several key funding mechanisms to support skills development, industrial transition, territorial development and consumer protection in the context of the green and digital transitions. Although not exhaustive, this section outlines some of the most important funding sources and mechanisms:

The **Just Transition Fund** aims to support regions most affected by the transition to a low-carbon economy, helping to mitigate the associated socio-economic impacts. It finances projects that promote economic diversification and re-skilling of workers in sectors and regions affected by the green transition. This includes support for education and training programmes tailored to the needs of emerging green sectors. The Just Transition Mechanism (JTM), which specifically targets the regions and sectors most impacted by the green transition and offers financial assistance and training or re-skilling programs to counteract job displacement and foster economic diversification, draws from **the Just Transition Fund**, as well as resources from the **European Investment Bank (EIB)**. Local authorities and communities are encouraged (see for example the European Climate Pact) to utilise the Just Transition Fund and Mechanism to support reskilling and job creation in regions most impacted by the transition.

The **ESF+**[215] (which focuses on improving employment opportunities, strengthening social inclusion, combating poverty, and enhancing education and skills) is also crucial for EU's sustainable future, as seen: (a) in the 'Circular Economy Action Plan' (March 2020), emphasising skills, education, and jobs and fostering social innovation projects that contribute to environmental sustainability; and (b) in the 'European Climate Pact', focusing: (i) on the development of green skills essential for employment in the green economy (ii) ensuring that these programmes are accessible to everyone and (iii) encouraging participation in the Pact for Skills, which mobilises stakeholders to up-skill and re-skill workers.

With a budget of €99.3 billion for 2021-2027, ESF+ supports among others a skilled workforce for the green economy. For example, it is projected that the circular economy could create 700,000 new jobs by 2030. ESF+ funds vocational training, upskilling, and reskilling, ensuring inclusive and competitive growth. ESF+ is likely to provide €5.8 billion for green skills and jobs.

**Erasmus+**, the EU's programme to support education, training, youth and sport in Europe, with regard to green transition provides opportunities for:

[215] European Parliament and the council of European Union (2021). Establishing the European Social Fund Plus (ESF+) and repealing Regulation. (Regulation EU 2021/1057). Brussels, 24.06.2021

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(a) skills development and partnerships in the education and youth sectors, with a focus on climate literacy (as mentioned in the European Climate Pact and the SWD (2023) 68 final).

(b) cooperation and exchange among educational institutions, enabling the sharing of best practices and innovative approaches to green education, as well as to the development of skills and competencies necessary for the green transition (as mentioned in the Recommendation on Learning for Green Transition and Sustainable Development).

(c) together with **LIFE**, and **Horizon Europe**, may also offer critical financial support to promote education for sustainable development, as well as funding for research, innovation, and projects aimed at advancing sustainability (green transition goals. Specifically, **Horizon Europe** includes several initiatives focused on developing new green technologies and sustainable practices, which often involve training and upskilling components.

It is also noteworthy that approximately one-third of the **European Regional Development Fund** (ERDF) and the **Cohesion Fund** is allocated for goals, aiming to address regional disparities in the green and digital transition, particularly in the jobs sector. Besides, one of the 5 key policy objectives supported by the **ERDF** for the period 2021-2027 is 'a greener, low carbon transitioning towards a net zero carbon economy and resilient Europe (including energy transition, the circular economy, climate change mitigation, risk management and sustainable urban mobility). In addition, **ERDF** adds €8.9 billion for skills, education and training infrastructure (as mentioned in CSW document: Investment needs assessment and funding availabilities to strengthen EUs Net Zero Technology manufacturing capacity).

The **Recovery and Resilience Facility (RRF),** while not exclusively focused on skills development, with its €672.5 billion budget, seems to be a good opportunity to plan and finance investments and reforms that support - among others - a recovery focused on jobs while embracing at the same time the green and digital transitions. Besides, according to this Regulation, at least 37% of the recovery and resilience plan's total allocation should be dedicated to the green transition.

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# 6 Conclusion

EU policy documents addressing the green, digital, and twin transitions reveal a fragmented approach to skills, sectoral development, and territorial impacts. While both transitions are seen as essential to Europe's future competitiveness, their treatment in policy documents lacks a comprehensive and cohesive framework, particularly concerning their effects on regional development and labor markets.

The green transition policies focus on specific sectors and regions, primarily targeting carbon-intensive industries undergoing structural shifts. They emphasize upskilling and reskilling workers in these sectors, yet often fail to consider the broader digital transformation's potential impact on green skills. The focus is largely territorial, aimed at mitigating the economic disruption in regions dependent on fossil fuels, such as those supported by the Just Transition Fund. However, there is limited discussion on how digitalization could both facilitate this transition and create new opportunities or challenges for the workforce.

Conversely, digital transition policies provide a clearer understanding of the inequalities created by digital transformation, such as the digital divide and disparities in access to technology and training. They emphasize addressing these inequalities by fostering digital literacy and skills development, particularly for disadvantaged groups. Yet, there is little integration of how the digital and green transitions interact, with few references to the synergies or conflicts between the two in policy frameworks.

Overall, the twin transition's impact on regional development, skills, and sectors remains somewhat underexplored in EU policy documents. While smart specialization strategies and regional policies aim to build on territorial strengths, there is a gap in addressing the intertwined nature of the green and digital transitions. This disconnect could lead to fragmented efforts, particularly in regions with diverse industrial and technological capacities, potentially widening inequalities across Europe.

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# 7 Annex

| A/A | Date of publication | Type of publication | Reference according to EU system | CELEX | NAME | DIRECTORATE |
|---|---|---|---|---|---|---|
| 1 | Monday, June 18, 2012 | Synthesis report | - | - | Green skills and environmental awareness in vocational education and training | European Commission |
| 2 | Monday, April 1, 2013 | Review | - | - | Promoting green jobs throughout the crisis: A handbook of best practices in Europe | Directorate-General for Employment, Social Affairs and Inclusion |
| 3 | Thursday, December 1, 2016 | Policy Report | - | - | The Digital Competence Framework for Consumers | European Commission, Joint Research Centre |
| 4 | Friday, February 24, 2017 | Report | - | - | Digital Single Market: Making the Most of Digital Opportunities in Europe | European Commission |
| 5 | Wednesday, April 26, 2017 | Staff Working Document | SWD/2017/201 final | 52017SC0201 | Establishing a European Pillar of Social Rights | European Commission |
| 6 | Monday, May 1, 2017 | Report | - | - | DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use | European Commission, Joint Research Centre |
| 7 | Wednesday, January 17, 2018 | Communication | COM/2018/97 final | 52018DC0097 | Action Plan: Financing Sustainable Growth | European Commission |
| 8 | Wednesday, January 17, 2018 | Communication | COM/2018/22 final | 52018DC0022 | Digital Education Action Plan | European Commission |
| 9 | Wednesday, April 11, 2018 | Communication | COM/2018/183 final | 52018DC0183 | A New Deal for Consumers | European Commission, Secretariat-General |
| 10 | Monday, October 1, 2018 | Report | - | - | Behavioural study on consumers' engagement in the circular economy | European Commission |
| 11 | Saturday, March 30, 2019 | Policy Report | - | - | Key competences for lifelong learning | Directorate-General for Education, Youth, Sport and Culture |
| 12 | Thursday, July 4, 2019 | Staff working Document | SWD/2019/579 | - | Sustainable growth for all: choices for the future of social Europe | European Commission |

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|---|---|---|---|---|---|---|
| 13 | Wednesday, December 11, 2019 | Communication | COM/2019/640 final | 52019DC0640 | The European Green Deal +Annex: Roadmap - Key actions | European Commission, Secretariat-General |
| 14 | Tuesday, January 14, 2020 | Communication | COM/2020/21 final | 52020DC0021 | Sustainable Europe Investment Plan - European Green Deal Investment Plan | Directorate-General for Economic and Financial Affairs |
| 15 | Tuesday, January 14, 2020 | Communication | COM/2020/14 final | 52020DC0014 | A strong social Europe for just transitions | Directorate-General for Employment, Social Affairs and Inclusion |
| 16 | Wednesday, February 19, 2020 | White Paper | COM/2020/65 final | - | On Artificial Intelligence - A European approach to excellence and trust | European Commission |
| 17 | Wednesday, February 19, 2020 | Communication | COM/2020/67 final | 52020DC0067 | Shaping Europe's digital future | Directorate-General for Communications Networks, Content and Technology |
| 18 | Wednesday, February 19, 2020 | Communication | COM/2020/66 final | 52020DC0066 | A European strategy for data | European Commission |
| 19 | Tuesday, March 10, 2020 | Communication | COM/2020/102 final | 52020DC0102 | A New Industrial Strategy for Europe | European Commission, Secretariat-General |
| 20 | Wednesday, March 11, 2020 | Communication | COM/2020/98 final | 52020DC0098 | A new Circular Economy Action Plan: For a cleaner and more competitive Europe | Directorate-General for Environment |
| 21 | Wednesday, May 20, 2020 | Communication | COM/2020/381 final | 52020DC0381 | A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system | Directorate-General for Health and Food Safety |
| 22 | Thursday, May 28, 2020 | Proposal for a regulation | COM/2020/408 final | 52020PC0408 | Establishing a Recovery and Resilience Facility | European Parliament, Council of the European Union |
| 23 | Tuesday, June 16, 2020 | Council conclusions | 2020/ C202 I/01 | 52020XG0616(01) | Council conclusions on shaping Europe's digital future | Council of the European Union |
| 24 | Thursday, June 18, 2020 | Regulation | PE/20/2020/INIT | 32020R0852 | On the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 | European Parliament, Council of the European Union |
| 25 | Wednesday, July 1, 2020 | Communication | COM/2020/274 final | 52020DC0274 | European Skills Agenda for sustainable competitiveness, social fairness and resilience | Directorate-General for Employment, Social Affairs and Inclusion |

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|---|---|---|---|---|---|---|
| 26 | Wednesday, July 1, 2020 | Communication | COM/2020/276 final | 52020DC0276 | Youth Employment Support: a Bridge to Jobs for the Next Generation | European Commission |
| | Thursday, September 17, 2020 | Communication | COM/2020/562 final | 52020DC0562 | Stepping up Europe's 2030 climate ambition-Investing in a climate-neutral future for the benefit of our people | European Commission |
| 27 | Wednesday, September 30, 2020 | Communication | COM/2020/625 final | 52020DC0625 | on achieving the European Education Area by 2025 | European Commission |
| 28 | Wednesday, September 30, 2020 | Staff working document/ communication | SWD/2020/209 final | 52020SC0209 | Digital Education action Plan 2021-2027 Resetting education and training for the digital age | Directorate-General for Education, Youth, Sport and Culture |
| 29 | Wednesday, October 14, 2020 | Recommendation | (EU) 2020/1563 | 32020H1563 | Energy poverty | European Commission |
| 30 | Wednesday, October 14, 2020 | Communication | COM/2020/662 final | 52020DC0662 | A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives | Directorate-General for Energy |
| 31 | Friday, October 30, 2020 | Council Recommendation | 2020/C 372/01 | 32020H1104(01) | A Bridge to Jobs – Reinforcing the Youth Guarantee and replacing the Council Recommendation of 22 April 2013 on establishing a Youth Guarantee | Council of the European Union |
| 32 | Friday, November 13, 2020 | Communication | COM/2020/696 final | 52020DC0696 | New Consumer Agenda - Strengthening consumer resilience for sustainable recovery | European Commission, Secretariat-General |
| 33 | Tuesday, November 24, 2020 | Council Recommendation | 2020/C 417/01 | 32020H1202(01) | Recommendation on vocational education and training (VET) for sustainable competitiveness, social fairness and resilience | Council of the European Union |
| 34 | Wednesday, December 9, 2020 | Communication | COM/2020/788 final | 52020DC0788 | European Climate Pact | Directorate-General for Climate Action |
| 35 | Wednesday, December 16, 2020 | Joint Communication | JOIN/2020/18 final | 52020JC0018 | The EU's Cybersecurity Strategy for the Digital Decade | European Commission |
| 36 | Friday, January 22, 2021 | Staff Working Document | SWD/2021/12 final PART ½ | - | Guidance to Member States Recovery and Resilience Plans | European Commission |
| 37 | Tuesday, February 16, 2021 | Opinion (own | EESC 2020/01255 | 52022IE1255 | Opinion of the European Economic and Social Committee on Towards an EU strategy for | European Economic and Social Committee |

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|---|---|---|---|---|---|---|
| | | initiative opinion) | | | enhancing green skills and competences for all | |
| 38 | Thursday, February 18, 2021 | Regulation | 2021/2041 L57 | 32021R 0241 | Establishing the Recovery and Resilience Facility | European Parliament, Council of the European Union |
| 39 | Monday, February 22, 2021 | Council conclusions | 2021/C 154/05 | 52021X G0430( 03) | Council conclusions on the New Consumer Agenda | Council of the European Union |
| 40 | Wednesday, February 24, 2021 | Communic ation | COM/2021/ 82 final | 52021D C0082 | Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change | Directorate-General for Climate Action |
| 41 | Wednesday, March 3, 2021 | Report | - | - | Union of equality : strategy for the rights of persons with disabilities 2021-2030 | Directorate-General for Employment, Social Affairs and Inclusion |
| 42 | Thursday, March 4, 2021 | Staff working document | COM/2021/ 102 final | 52021D C0102 | The European Pillar of Social Rig hts Action Plan | Directorate-General for Employment, Social Affairs and Inclusion |
| 43 | Tuesday, March 9, 2021 | Communic ation | COM/2021/ 118 final | 52021D C0118 | 2030 Digital Compass: the European way for the Digital Decade | Directorate-General for Communications Networks, Content and Technology |
| 44 | Friday, March 26, 2021 | Regulation | (EU) 2021/523 L107 | 32021R 0523 | Establishing the InvestEU Programme and amending Regulation (EU) 2015/1017 | European Parliament, Council of the European Union |
| 45 | Thursday, April 29, 2021 | Regulation | PE/13/2021/ INIT | 32021R 0694 | Establishing the Digital Europe Programme and repealing Decision (EU) 2015/2240 | European Parliament, Council of the European Union |
| 46 | Wednesday, May 5, 2021 | Communic ation | COM/2021/ 350 final | 52021D C0350 | Updating the 2020 New Industrial Strategy: Building a stronger Single market for Europe's recovery | Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| 47 | Wednesday, May 5, 2021 | Staff Working Document | SWD/2021/ 352 final | 52021S C0352 | Strategic dependencies and capacities (accompanying the: Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery) | Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| 48 | Wednesday, May 12, 2021 | Staff Working Document | SWD/2021/ 141 final | 52021S C0141 | Towards a monitoring and outlook framework for the zero-pollution ambition | Directorate-General for Environment |

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|---|---|---|---|---|---|---|
| | | | | | (accompanying: Pathway to a Healthy Planet for All) | |
| 49 | Wednesday, May 12, 2021 | Decision | EU 2021/764 L167 | 32021D 0764 | Establishing the Specific Programme implementing Horizon Europe – the Framework Programme for Research and Innovation, and repealing Decision 2013/743/EU | Council of the European Union |
| 50 | Wednesday, May 12, 2021 | Staff Working Document | SWD/2021/ 140 final | 52021S C0140 | Digital Solutions for Zero Pollution (Accompanying the document: Pathway to a Healthy Planet for All) | Directorate-General for Environment |
| 51 | Monday, May 17, 2021 | Regulation | (EU) 2021/783 L172 | 32021R 0783 | Establishing a Programme for the Environment and Climate Action (LIFE), and repealing Regulation (EU) No 1293/2013 | European Parliament, Council of the European Union |
| 52 | Thursday, June 24, 2021 | Regulation | PE/48/2021/ INIT | 32021R 1058 | on the European Regional Development Fund and on the Cohesion Fund | European Parliament, Council of the European Union |
| 53 | Wednesday, June 30, 2021 | Regulation | PE/5/2021/ REV/1 | 32021R 1056 | Establishing the Just Transition F und | European Parliament, Council of the European Union |
| 54 | Wednesday, June 30, 2021 | Regulation | PE/27/2021/ REV/1 | 32021R 1119 | Establishing the framework for achieving climate neutrality and amending Regulations (EC) No401/2009 and (EU) 2018/1999 (European Climate law) | European Parliament, Council of the European Union |
| 55 | Wednesday, June 30, 2021 | Regulation | (EU) 2021/1057 | 32021R 1057 | Establishing the European Social Fund Plus (ESF+) and repealing Regulation | European Parliament, Council of the European Union |
| 56 | Friday, July 2, 2021 | Regulation | (EU) 2021/1078 | 32021R 1078 | Supplementing Regulation (EU) 2021/523 of the European Parliament and of the Council by setting out the investment guidelines for the InvestEU Fund | Directorate-General for Economic and Financial Affairs |
| 57 | Wednesday, July 7, 2021 | Regulation | PE/52/2021/ INIT | 32021R 1153 | establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014 | European Parliament, Council of the European Union |

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| 58 | Wednesday, July 14, 2021 | Regulation | (EU) 2021/1229 | 32021R1229 | on the public sector loan facility under the Just Transition Mechanism | European Parliament, Council of the European Union |
| 59 | Wednesday, July 14, 2021 | Communication | COM/2021/550 final | 52021DC0550 | Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality | European Commission, Secretariat-General |
| 60 | Wednesday, September 15, 2021 | Communication | COM/2021/573 final | 52021DC0573 | New European Bauhaus Beautiful, Sustainable, Together | European Commission, Joint Research Centre |
| 61 | Wednesday, September 15, 2021 | Staff working document | SWD/2021/574 final | 52021PC0574 | Proposal for a Decision on establishing the 2030 Policy Programme 'Path to the Digital Decade' | European Parliament, Council of the European Union |
| 62 | Wednesday, October 13, 2021 | Communication | COM/2021/660 final | 52021DC0660 | Tackling rising energy prices: a toolbox for action and support | European Commission |
| 63 | Friday, October 29, 2021 | Resolution | P9_TA(2020)0371 | - | A strong social Europe for Just transition: European Parliament resolution on 2020/2084(INI) | European Parliament |
| 64 | Monday, November 1, 2021 | Report | - | - | Report on Labour Shortages and Surpluses | European Labour Authority |
| 65 | Thursday, December 9, 2021 | Communication | COM/2021/761 final | 52021DC0761 | Better working conditions for a stronger social Europe: harnessing the full benefits of digitalisation for the future of work | Directorate-General for Employment, Social Affairs and Inclusion |
| 66 | Friday, December 10, 2021 | Council Recommendation | COM/2021/773 final | 52021DC0773 | on individual learning accounts | European Parliament, Council of the European Union |
| 67 | Tuesday, December 14, 2021 | Proposal for Council Recommendation | COM/2021/801 final | 52021DC0801 | Council Recommendation on ensuring a fair transition towards climate neutrality | Directorate-General for Employment, Social Affairs and Inclusion |
| 68 | Tuesday, December 14, 2021 | Staff working document | SWD/2021/452 final | 52021SC0452 | Accompanying the Proposal for a Council Recommendation on ensuring a fair transition towards climate neutrality | Directorate-General for Employment, Social Affairs and Inclusion |
| 69 | Wednesday, December 15, 2021 | Communication | COM/2021/800 final | 52021DC0800 | Sustainable Carbon Cycles | Directorate-General for Climate Action |
| 70 | Monday, December 20, 2021 | Report | | - | The green employment and skills transformation: insights from a European Green Deal skills forecast scenario | European Centre for the Development of Vocational Training |

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| 71 | Saturday, January 1, 2022 | Technical Report | - | - | Green Skills and Knowledge Concepts: Labelling the ESCO classification | European Commission |
| 72 | Wednesday, January 12, 2022 | Science for Policy Report | - | - | GreenComp: the European sustainability competence framework | Joint Research Centre |
| 73 | Tuesday, January 18, 2022 | Communic ation | COM/2022/ 16 final | 52022D C0016 | A European strategy for universities | European Commission |
| 74 | Monday, January 24, 2022 | Staff Working Document | SWD/2022/ 16 final | - | For a resilient, innovative and digital mobility ecosystem. Scenarios for a transition pathway | Directorate-General for Internal Market, Industry, E ntrepreneurship and SMEs |
| 75 | Wednesday, January 26, 2022 | Declaration | COM/2022/ 28 final | 52022D C0028 | on Digital Rights and Principles for the Digital Decade | European Commission |
| 76 | Wednesday, January 26, 2022 | Staff Working Document | SWD/2022/ 14 final | - | on establishing Digital Rights and Principles for the Digital Decade | European Commission |
| 77 | Sunday, February 27, 2022 | Regulation | 2043/435 L63 | 32023R 0435 | amending Regulation (EU) 2021/241 as regards REPowerEU chapters in recovery and resilience plans and amending Regulations (EU) No 1303/2013, (EU) 2021/1060 and (EU) 2021/1755, and Directive 2003/87/EC | European Parliament, Council of the European Union |
| 78 | Tuesday, March 1, 2022 | Report | - | - | DigComp 2.2, The Digital Competence framework for citizens – With new examples of knowledge, skills and attitudes | European Commission, Joint Research Centre |
| 79 | Tuesday, March 8, 2022 | Communic ation | COM/2022/ 108 final | 52022D C0108 | REPowerEU: Joint European Action for more affordable, secure and sustainable energy | European Commission, Secretariat-General |
| 80 | Wednesday, March 30, 2022 | Proposal for a directive | COM/2022/ 143 final | 52022P C0143 | Empowering consumers for the green transition through better protection against unfair practices and better information | Directorate-General for Justice and Consumers |
| 81 | Wednesday, March 30, 2022 | Staff Working Document | SWD/2022/ 85 final | 52022S C0085 | Impact assessment report (Accompanying the document: Proposal for a directive amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through | Directorate-General for Justice and Consumers |

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| 82 | Tuesday, April 5, 2022 | Proposal for a directive | COM/2022/156 final | 52022PC0156 | Proposal of a Directive on industrial emissions (integrated pollution prevention and control) | Directorate-General for Environment |
| 83 | Wednesday, April 6, 2022 | Decision | PE/83/2021/REV/1 | 32022D0591 | On a General Union Environment Action Programme to 2030 | European Parliament, Council of the European Union |
| 84 | Wednesday, May 18, 2022 | Communication | COM/2022/230 final | 52022DC0230 | REPowerEU Plan | European Commission, Secretariat-General |
| 85 | Wednesday, May 18, 2022 | Communication | COM/2022/221 | 52022DC0221 | EU Solar Energy Strategy | European Commission, Secretariat-General |
| 86 | Tuesday, May 31, 2022 | Commission Notice | 2022/C214/01 | 52022XC0531(01) | Guidance on Recovery and Resilience Plans in the context of REPowerEU | European Commission, Secretariat-General |
| 87 | Thursday, June 16, 2022 | Recommendation | ST/9795/2022/INIT | 32022H0627(01) | Learning for the green transition and sustainable development | Council of the European Union |
| 88 | Thursday, June 16, 2022 | Recommendation | ST/8944/2022/INIT | 32022H0627(03) | On individual learning accounts 2022/C 243/03 | Council of the European Union |
| 89 | Monday, June 27, 2022 | Recommendation | ST/9107/2022/INIT | 32022H0627(04) | On ensuring a fair transition towards climate neutrality | Council of the European Union |
| 90 | Wednesday, June 29, 2022 | Science for Policy Report | - | - | Towards a green and digital future | Joint Research Centre |
| 91 | Wednesday, June 29, 2022 | Communication | COM/2022/289 final | 52022DC0289 | 2022 Strategic Foresight Report - Twinning the green and digital transitions in the new geopolitical context | European Commission, Secretariat-General |
| 92 | Wednesday, July 5, 2022 | Communication | COM/2022/332 final | 52022DC0332 | A New European Innovation Agenda | European Commission |
| 93 | Tuesday, August 2, 2022 | Staff working document | SWD/2022/205 final | - | Digital Economy and Society Index (DESI) 2022 (Thematic chapters) | European Commission, Secretariat-General |
| 94 | Thursday, September 1, 2022 | Study/ Communication | COM/2023/439 | - | Study supporting the evaluation of the Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults | Directorate-General for Employment, Social Affairs and Inclusion |

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| 95 | Monday, October 3, 2022 | Technical Report | - | - | Digital Skills and Knowledge Concepts: Labelling the ESCO classification | Directorate-General for Employment, Social Affairs and Inclusion |
| 96 | Wednesday, October 12, 2022 | Proposal for a decision | COM/2022/526 final | 52022PC0526 | on a European Year of Skills 2023 | Directorate-General for Employment, Social Affairs and Inclusion |
| 97 | Thursday, November 10,2022 | Joint Communication | JOIN/2022/49 final | 52022JC0049 | EU Policy on Cyber Defence | European Commission |
| 98 | Friday, December 2, 2022 | Discussion Paper | - | - | The Possible Implications of the Green Transition for the EU Labour Market | European Commission's Directorate-General for Economic and Financial Affairs |
| 99 | Friday, December 16, 2022 | Council Recommendation | 2022/C 243/01 | 32022H0627(01) | on learning for the green transition and sustainable development | Council of the European Union |
| 100 | Monday, December 19, 2022 | Decision | PE/50/2022/REV/1 | 32022D2481 | On digital operational resilience for the financial sector and amending Regulations (EC) No 1060/2009, (EU) No 648/2012, (EU) No 600/2014, (EU) No 909/2014 and (EU) 2016/1011 | European Parliament, Council of the European Union |
| 101 | Wednesday, December 21, 2022 | Opinion (own initiative opinion) | EESC 2022/01049 | 52022IE1049 | Opinion of the European Economic and Social Committee on SMEs, social economy enterprises, crafts and liberal professions / Fit for 55 | European Economic and Social Committee |
| 102 | Wednesday, February 1, 2023 | Communication | COM/2023/62 final | 52023DC0062 | A Green Deal Industrial Plan for the Net-Zero Age | European Commission, Secretariat-General |
| 103 | Tuesday, March 14, 2023 | Council conclusions | 2023/C 95/03 | 52023XG0314(01) | Council conclusions on skills and competences for the green transition | Council of the European Union |
| 104 | Thursday, March 16, 2023 | Proposal for regulation | COM/2023/161 final | 52023PC0161 | Establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act) | Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| 105 | Wednesday, March 22, 2023 | Proposal for a directive | COM/2023/166 final | 52023PC0166 | on substantiation and communication of explicit environmental claims (Green Claims Directive) | Directorate-General for Environment |

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| 106 | Thursday, March 23, 2023 | Staff working Document | SWD/2023/68 | - | Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity | European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| 107 | Tuesday, April 18, 2023 | Proposal for a recommendation | COM/2023/206 final | 52023DC0206 | on improving the provision of digital skills in education and training | Directorate-General for Education, Youth, Sport and Culture |
| 108 | Wednesday, May 10, 2023 | Regulation | PE/11/2023/REV/1 | 32023R0955 | Establishing a Social Climate Fund and amending Regulation (EU) 2021/1060 | European Parliament, Council of the European Union |
| 109 | Thursday, May 11, 2023 | Decision | (EU) 2023/936 | 32023D0936 | On a European Year of Skills | European Parliament, Council of the European Union |
| 110 | Thursday, July 6, 2023 | Policy Report | - | - | Employment and social developments in Europe 2023 | Directorate-General for Employment, Social Affairs and Inclusion |
| 111 | Tuesday, July 11, 2023 | Communication | COM/2023/442 final | 52023DC0442 | An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition | European Commission |
| 112 | Monday, July 17, 2023 | Staff Working Document | SWD/2023/460 final | - | Evaluation of the council recommendation on 19/12/2016 on upskilling pathways: New opportunities for adults | Council of the European Union |
| 113 | Thursday, July 27, 2023 | Staff Working Document | SWD/2023/283 final | - | Co-creation of a transition pathway for a more resilient, digital and green retail ecosystem | Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs |
| 114 | Wednesday, September 13, 2023 | Directive | PE/15/2023/INIT | 32023L1791 | On energy efficiency and amending Regulation (EU) 2023/955 | European Parliament, Council of the European Union |
| 115 | Thursday, September 14, 2023 | Report | - | - | Skills in transition: the way to 2035 | European Centre for the Development of Vocational Training |

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| 116 | Wednesday, September 27, 2023 | Communication | COM/2023/570 final | 52023DC0570 | Report on the state of the Digital Decade + ANNEX for Country reports | Directorate-General for Communications Networks, Content and Technology |
| 117 | Wednesday, November 29, 2023 | Recommendation | 2024/236 | 32024H0236 | Means to address the impact of automation and digitalisation on the transport workforce | Directorate-General for Mobility and Transport |
| 118 | Thursday, December 21, 2023 | Staff working Document | SWD/2023/717 final | - | Impact Assessment Report accompanying the document Proposal for a Regulation of the European Parliament and the Council: Establishing an EU Talent Pool | European Commission |
| 119 | Monday, February 5, 2024 | Communication | COM/2024/1 final | 52024SC0001 | on the European Year of Youth 2022 | European Commission |
| 120 | Wednesday, January 10, 2024 | Communication | COM/2024/63 final | 52024DC0063 | Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society | Directorate-General for Climate Action |
| 121 | Wednesday, February 21, 2024 | White Paper | COM/2024/81 final | 52024DC0081 | How to master Europe's digital infrastructure needs? | Directorate-General for Communications Networks, Content and Technology |
| 122 | Wednesday, March 6, 2024 | Directive | (EU) 2024/825 | 32024L0825 | Amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and through better information | European Parliament, Council of the European Union |
| 123 | Wednesday, March 20, 2024 | Communication | COM/2024/131 final | 52024DC0131 | Labour and skills shortages in the EU: an action plan | European Commission |
| 124 | Wednesday, March 27, 2024 | Report | - | - | Ninth report on economic, social and territorial cohesion | European Commission |

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