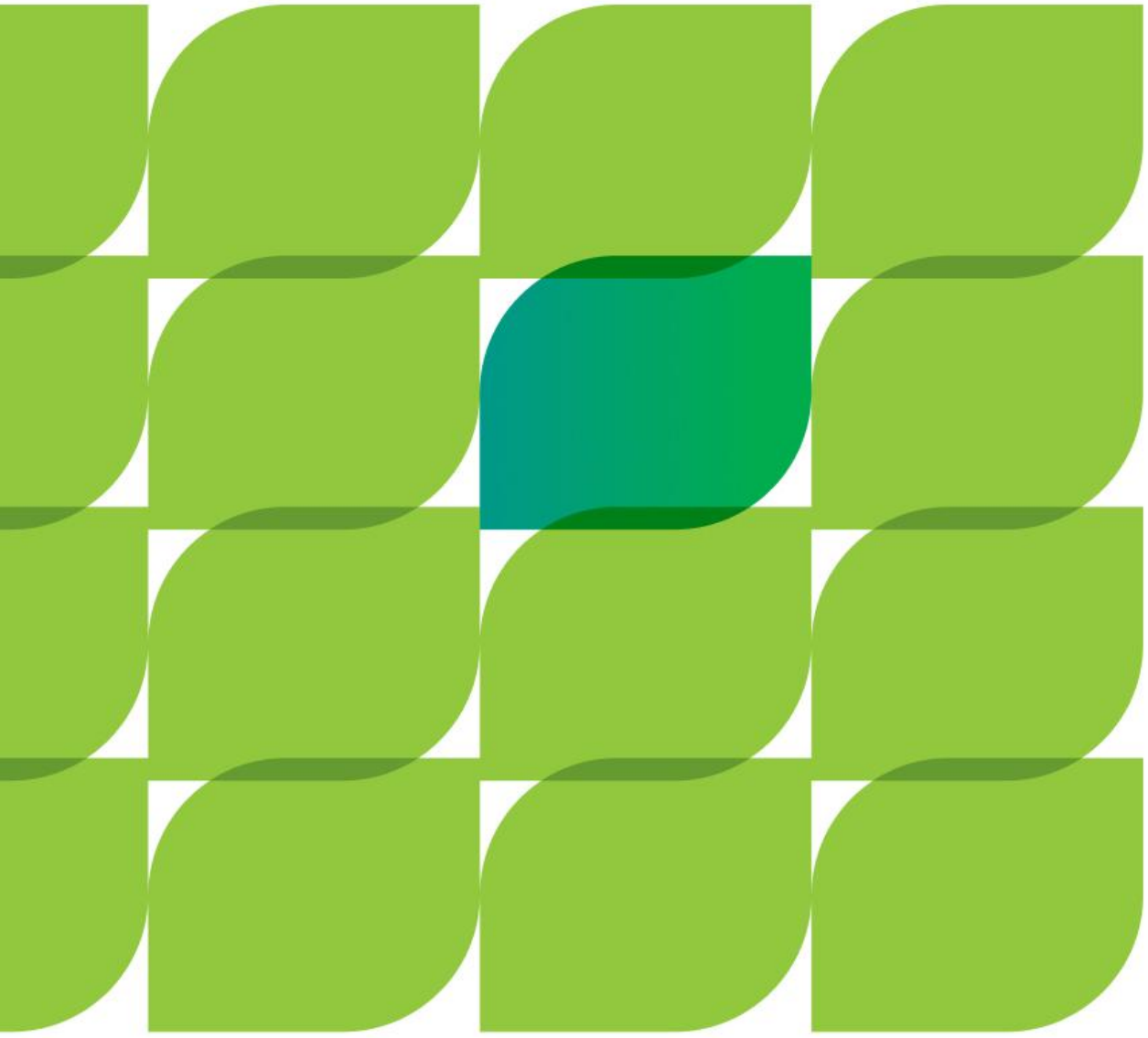
Digital 4 Sustainability
Skills for Europe's Twin Transition

D2.2 European Digital Sustainability Skills Strategy

Building Skills for the Twin Transition in Europe



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About the Digital4Sustainability project

Digital4Sustainability is a pioneering initiative aimed at accelerating Europe's twin transition by equipping its workforce with the essential skills needed to drive sustainability-focused innovation. In response to the pressing need to achieve climate neutrality and meet the Sustainable Development Goals (SDGs), the project will develop a forward-thinking Digital Sustainability Skills Strategy as well as cutting-edge learning programmes. These efforts will address the urgent and emerging skills needs of European industry, empowering its workforce to develop sustainable technologies that support Environmental, Social, and Governance (ESG) practices. By aligning closely with industry needs throughout the project, Digital4Sustainability will help European companies, particularly small and medium-sized enterprises (SMEs), achieve long-term competitiveness and growth through digital and sustainable transformation.

Funded by the Erasmus+ Programme of the European Union, this 4-year project unites 28 members of the Digital Large-Scale Partnership (hereinafter "Digital LSP") under the Pact for Skills, spanning 13 EU countries. The consortium includes digital and sustainability experts, business associations, universities, and Vocational Education and Training (VET) providers.

The Digital4Sustainability Project Consortium

The Digital4Sustainability project consortium is an Erasmus+ Alliance for Sectoral Cooperation on Skills, bringing together 28 partners and Associated partners from 13 EU countries.

	Partners	Acronym	Country
1	Adecco Formazione Srl	Adecco Training	Italy
2	Adecco Italia Holding Spa	Adecco Holding	Italy
3	As Bcs Koolitus	BCS KOOLITUS	Estonia
4	Asociatia Cluj IT	CLUJ IT CLUSTER	Romania
5	Badgebox Srl	BadgeBox	Italy
6	CEFRIEL Societa Consortile A Responsabilita Limitata	CEFRIEL	Italy
7	Cooperatie Eduserpro U.A.	Eduserpro	Netherlands
8	Digital Technology Skills Limited	DTSL	Ireland
9	DIGITALEUROPE AISBL	DIGITALEUROPE	Belgium
10	European DIGITAL SME Alliance	DIGITAL SME	Belgium
11	Fast Lane Institute For Knowledge Transfer GmbH	FAST LANE	Germany
12	Gospodarska Zbornica Slovenije	GZS CCIS	Slovenia
13	Gospodarska Zbornica Slovenije Center Za Poslovno Usposabljanje	GZS CPU	Slovenia
14	IVSZ - Digitalis Vallalkozasok Szovetsege	IVSZ	Hungary
15	Matrix Internet Applications Limited	MATRIX INTERNET	Ireland
16	National College Of Ireland	NCI	Ireland
17	Profil Klett d.o.o.	PK	Croatia

18	Sdruzenie Bulgarska Asociacia Na Softuernite Kompanii - Basscom	BASSCOM	Bulgaria
19	Stichting Hogeschool Utrecht	HU	Netherlands
20	Tekenable Limited	TEKenable	Ireland
21	Universidad De Alcala	UNI ALCALA	Spain
22	Universidad Internacional De La Rioja SA	UNIR	Spain
23	Universität Koblenz	UNI KO	Germany
24	National University of Science and Technology Politehnica Bucharest	POLITEHNICA Bucharest	Romania

	Associated partners	**Acronym**	**Country**
1	Asociacija Infobalt	INFOBALT	Lithuania
2	SKILLNET IRELAND Company Limited By Guarantee	SKILLNET IRELAND	Ireland
3	The Council of European Professional Informatics Societies	CEPIS	Belgium
4	Universidad Complutense De Madrid	UCM	Spain

1. Table of Contents

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List of abbreviations and acronyms

Abbreviation	Term
CEDEFOP	Centre Européen pour le Développement de la Formation Professionnelle
CEN	Comité Européen de Normalisation
CODES	Coalition for Digital Environmental Sustainability
e-CF	European e-Competence Framework (EN 16234-1)
EQF	European Qualifications Framework
ESCO	European Skills, Competences, Qualifications and Occupations
ESG	Environmental, social, and governance
HE	Higher Education
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
VET	Vocational Education and Training

2. Executive summary

Digital transformation is increasing the need for professionals in digital sustainability, particularly those developing and managing sustainable digital solutions. However, the shortage of skilled experts has created a significant skills gap, slowing progress in this field.

The Alliances for Sectoral Cooperation on Skills[1] work together to develop strategic approaches and foster cooperation in creating concrete skills development solutions, addressing labour market gaps that hinder growth.

In this context, the European Digital Sustainability Skills Strategy ("Skills Strategy") tackles the complex and interconnected nature of sustainability, where digital technologies play a central role in driving environmental, social, and economic progress. It aligns with a comprehensive understanding of sustainability that integrates digital innovation to foster long-term, equitable growth, ensuring that the needs of both present and future generations are met.

The concept of *"digital sustainability"* encompasses both the digital transition and the broader shift towards sustainability, integrating digital technologies with sustainable practices.

By prioritising *digital sustainability*, this Skills Strategy ensures that digital technologies are harnessed not only for technological advancement but also as powerful tools for long-term, inclusive, and sustainable development, ultimately contributing to the resilience and prosperity of society.

It goes beyond the environmental and digital aspects, embracing a more comprehensive approach that incorporates social, economic, and technological dimensions. Recognising digital innovations as key enablers of sustainability, it promotes solutions that improve efficiency, reduce environmental impact, and advance social equity among other things.

[1] Blueprint for sectoral cooperation on skills, https://employment-social-affairs.ec.europa.eu/policies-and-activities/skills-and-qualifications/working-together/blueprint-sectoral-cooperation-skills_en

This Skills Strategy presents a structured approach, with defined objectives and actions, guided by a well-defined vision and mission, to address the skills shortage in digital sustainability across Europe.

2.1 Vision

A sustainable skilled society in which digital technologies are used to achieve goals aimed at social, economic, and environmental sustainability in Europe.

2.2 Mission

To equip digital professionals with the competences and skills necessary to steer digital innovation towards social, economic and environmental sustainability.

The Skills Strategy aims to inspire collaboration between higher education, vocational education and training (VET), and industry stakeholders across various sectors, to address the skill gaps in the digital sustainability job market and to anticipate its evolution. Through policy recommendations, it will also guide national and European policies towards the creation of an enabling environment to develop the skills required to support the twin transition of digital sustainability in Europe.

3. Introduction

This document was developed through a collaborative methodology bringing together different stakeholders in a process encompassing knowledge exchange, co-creation of solutions, and the integration of best practices across sectors and Countries. Continuous engagement with consortium partners ensured alignment with industry needs while fostering shared ownership, strengthening the Skills Strategy's relevance and impact.

The process began with a comprehensive Skills Needs Analysis, which identified key gaps and trends shaping this Skills Strategy and serving as its foundational document. This Analysis highlights essential skill trends for both current and future digital sustainability professionals, as well as SME owners, decision-makers, and policymakers in the field. Additionally, it defines role profiles to support the development of a skilled workforce in digital sustainability.

Following a review of skills needs and profiles through desk research, expert focus groups, and feedback from various stakeholders, a process for improving the Skills Strategy will be developed to revise and, where necessary, update it. A more detailed description of both the methodology used in the development of the Skills Strategy and of the Monitoring, evaluation, and continuous improvement process is available in Annex B and C.

The Skills Strategy is structured as follows:

Chapter 3 "Digital sustainability" provides an overview of the rise of digital sustainability, its relevance in both EU and national contexts, the shift from a focus on green to a broader sustainability perspective, and its impact on labour markets and skill needs. It also offers a summary of EU policies and regulations related to digital sustainability.

The analysis continues with the presentation of the vision and mission that guide the Skills Strategy (Chapter 4). The vision outlines the long-term aspirations and overall direction, providing a framework for its future development. The mission, in turn, defines the Skills Strategy's concrete purpose and specific objectives, detailing the practical actions required to achieve the broader vision

Chapter 5, "Scope of the Skills Strategy," examines the concept of digital sustainability, its key characteristics, and its connection to the Skills Strategy. It also identifies key stakeholders, distinguishing between those directly addressed by the Skills Strategy and those for whom the Skills Strategy is intended. The chapter also highlights skill gaps within the workforce, emphasising the urgent need for upskilling and reskilling across various industries. Additionally, the section outlines the development of learning programmes, providing an overview of their key characteristics and structure.

Chapter 6 "Skills Strategy strategic objectives and key actions" offers a comprehensive overview of the six strategic objectives of the Skills Strategy, detailing the key actions associated with each.

Where relevant, this section also outlines policy recommendations for policymakers aiming to enhance outreach and facilitate the successful implementation of the Skills Strategy and its key takeaways.

The conclusion summarises the key insights and strategic directions outlined in the Skills Strategy, reinforcing its commitment to advancing digital sustainability. It also reflects on the main objectives, key actions, and expected outcomes, highlighting the importance of a collaborative, multi-stakeholder approach in achieving long-term impact.

In the annexes, further information can be found regarding the relevant EU policies and strategies, the methodology used for Skills Strategy development, as well as the monitoring, evaluation, and continuous improvement process.

4. Digital sustainability

This chapter explores the rise of digital sustainability, its importance at both EU and national levels, and the shift from a green focus to a broader sustainability approach. Additionally, it outlines how the Skills Strategy aligns with and supports the EU's strategic objectives and main policies.

4.1 The rise of digital sustainability

The rise of digital sustainability has become a pivotal focus in both the European Union and national contexts, reflecting the growing recognition of the need to integrate digital technologies into broader sustainability objectives. While the initial focus was on "green" initiatives, the scope has expanded over time.

Sustainability encompasses environmental preservation, social well-being, and economic resilience. Since the publication of the Brundtland Report in 1987[2], which laid the foundation for balancing these concepts, sustainability has remained central to global policy. The United Nations' Sustainable Development Goals (SDGs)[3] provide a framework for addressing challenges such as poverty, inequality, clean energy, and climate action.

Despite the potential of digital technologies to drive a more sustainable society, organisations face significant barriers in this transition, one of the most critical being the skills mismatch.

In particular, after the development of the Coalition for Digital Environmental Sustainability ("CODES") Framework[4], digital sustainability is defined in a more comprehensive way that goes beyond focusing only on the environment, incorporating digital innovation that aims to proactively enable, accelerate, and scale development that is both environmentally and socially sustainable. This broader concept underscores the role of digital technologies not just in reducing environmental impact, but in fostering holistic, sustainable progress across multiple dimensions of society.

Simultaneously, the digital revolution is transforming economies and societies through innovations like the Internet of Things (IoT), artificial intelligence (AI), and digitalisation of processes. These advancements enhance global connectivity, create new economic models, and optimise processes across industries.

Crucially, digitalisation and sustainability should not be considered as separate trajectories but part of a strategic integration where digital solutions can drive sustainable progress, and sustainability principles can ensure responsible technological development. While digital technologies offer significant benefits, their growing use also brings environmental and social

[2] G.H. Brundtland (United Nations, 1987), Our Common Future: Report of the World Commission on Environment and Development, https://www.un-documents.net/ocf-ov.htm .
[3] United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development. https://sdgs.un.org/2030agenda
[4] Coalition for Digital Environmental Sustainability (CODES). (2022). Action Plan for a Sustainable Planet in the Digital Age. https://doi.org/10.5281/zenodo.6573509

challenges. It is therefore essential to ensure that digitalisation itself is sustainable[5]. The trend is driven not only by technology and sustainability concerns but also by the European political agenda, which has been translated into several policies urging organisations to take concrete action[6].

In this context, the need for a workforce that is both digitally skilled to address sustainability challenges and sustainability-skilled to tackle digital challenges is more critical than ever. This highlights the importance of upskilling and reskilling initiatives to equip workers for the evolving demands of a digitally enabled, sustainable economy[7].

This transformation is creating new opportunities while also presenting challenges, such as the need for a skilled workforce and overcoming access barriers. It requires a strategic focus on ensuring that all individuals have access to the necessary education and training to thrive in the digital sustainability landscape.

4.2 EU Policy and legislation

The expression "twin transition", introduced by the European Commission in 2020, is the first to highlight the interconnectedness of technological advancement and sustainability. This concept first appeared in the *Digital Compass: the European way for the Digital Decade Strategy (2021)*[8], which underscores the interconnected nature of environmental sustainability and technological innovation, emphasising how these two areas hold the potential to mutually reinforce and support each other.

By leveraging digital technologies, such as AI, blockchain, and the Internet of Things, Europe aims to drive more sustainable practices across industries, reducing resource consumption and improving efficiency. Through an integrated approach, organisations can ensure that technological progress is aligned with environmental objectives, making sustainability a core aspect of Europe's digital future.

Over the years, stimulating this approach has become increasingly crucial to the European Union's strategic agenda and closely interconnected with many objectives and strategies identified at the European level, shaping its long-term vision for a sustainable and competitive future.

[5] CODES Framework, Shift 2: Mitigate Negative Impacts – Ensure sustainable digitalization to mitigate negative environmental and social impacts.

[6] See for example: European Commission (2020), A New Industrial Strategy for Europe, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0102; European Commission (2022), Towards a Green, Digital and Resilient Economy: Our European Growth Model, available at: https://commission.europa.eu/system/files/2022-03/our-european-growth-model_en.pdf; France 22 (2022), Toulouse Call for a Green and Digital Transition in the EU, available at: https://presidence-francaise.consilium.europa.eu/en/news/toulouse-call-for-a-green-and-digital-transition-in-the-eu/; CapGemini (2024), The Dual Transition: The Path to a Digital and Sustainable Economy, available at: https://www.capgemini.com/research/the-dual-transition

[7] Digital4Sustainability (2024). Roles and Skills Needs Analysis Report, https://digital4sustainability.eu/project-resources/.

[8] European Commission, Communication on 2030 Digital Compass: the European way for the Digital Decade, COM(2021) 118 final, Brussels, 9 March 2021, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021DC0118 .

Digital sustainability policies encompass a wide range of areas, reflecting the increasing importance of integrating technological developments with sustainability. For these policies to be successful, the development of digital skills and necessary educational reforms is crucial in ensuring that individuals and businesses can adapt to the evolving landscape

Many initiatives, particularly at the European level, reinforce the commitment to both a sustainable and digital future. For instance, the European Commission has highlighted the significance of digital transformation and ICT-related topics, declaring this period as "Europe's Digital Decade"[9]. Central to this vision is the Digital Skills Strategy[10], adopted in 2020, which aims to accelerate digitalisation across various sectors. To turn these ambitions into reality, the Digital Compass was introduced, establishing clear and measurable targets. One of its four key pillars focuses on fostering a highly skilled digital workforce, ensuring that Europe remains competitive in the ever-evolving digital landscape.

Further policies and EU initiatives related to the Skills Strategy include the European Green Deal[11]and the EU's digital strategy, *A Europe Fit for the Digital Age*[12], both of which are closely interconnected and support a more sustainable digital future. Several European programmes align with these objectives, such as the Digital Europe Programme[13], Next Generation EU[14], the European Social Fund Plus (ESF+)[15], and the European Education Area[16]. These initiatives aim to enhance digital skills, support economic recovery, and foster sustainable and inclusive education, ensuring that Europe remains competitive and resilient in the face of global challenges.

These initiatives are further strengthened by the Industry 5.0 [17] approach, introduced by the European Commission in 2024. Building on the foundations of Industry 4.0, this approach places research and innovation at the heart of the transition towards a sustainable, human-centric, and resilient European industry.

Furthermore, as part of the European Commission's 2025 work programme[18], an initial set of Omnibus proposals has been introduced to streamline various legislative measures, alongside a record number of initiatives focused on simplification. The first series of Omnibus packages will

[9] Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme 2030, OJ L 323, 19 December 2022. https://eur-lex.europa.eu/eli/dec/2022/2481/oj

[10] European Commission, Shaping Europe's Digital Future, COM(2020) 67 final, 19 February 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0067

[11] European Commission, The European Green Deal, COM(2019) 640 final, 11 December 2019. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640

[12] European Commission, A Europe Fit for the Digital Age. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en

[13] European Commission, Digital Europe Programme. https://digital-strategy.ec.europa.eu/en/activities/digital-programme

[14] European Commission, NextGenerationEU. https://commission.europa.eu/strategy-and-policy/eu-budget/eu-borrower-investor-relations/nextgenerationeu_en

[15] European Commission, European Social Fund Plus (ESF+). https://employment-social-affairs.ec.europa.eu/policies-and-activities/funding/european-social-fund-plus-esf_en

[16] European Commission, European Education Area. https://education.ec.europa.eu/about-eea

[17] European Commission, Industry 5.0. https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/industry-50_en

[18] European Commission, 2025 Commission work programme and annexes. https://commission.europa.eu/publications/2025-commission-work-programme-and-annexes_en

address sustainability and is expected in early 2025, followed by a Digital Package later in the year.

More recently, through the EU Competitiveness Compass[19], the European Commission sets out a strategic vision for strengthening Europe's long-term industrial and economic competitiveness. A key pillar of this approach is the competitiveness-driven approach to decarbonisation, embodied in the Clean Industrial Deal, which aims to align sustainability with economic growth. A skilled workforce is essential to achieving these objectives. Investing in upskilling and reskilling initiatives, particularly in digital and green technologies, will enable workers to adapt to new industrial processes and drive the transition to a sustainable economy.

Finally, further reinstating actions proposed within the EU Competitiveness Compass, the Union of Skills[20] initiative was launched. It places a strong emphasis on developing green and digital skills as a key driver of the clean and circular economy. Among its four key strands, it includes upskilling and reskilling for the digital and green transition, aiming to help workers acquire future-oriented competencies in STEM fields, AI, robotics, and energy efficiency, ensuring they can adapt to evolving industrial demands. To accelerate progress, the Union of Skills will be expanding specialised training initiatives, such as Net-Zero Industry Academies, which will equip industries with the skills needed for a successful green transformation. By prioritising green skills, the Union of Skills aims to prepare Europe's workforce for a more sustainable, resilient, and competitive economy.

[19] European Commission, A new plan for Europe's sustainable prosperity and competitiveness. https://commission.europa.eu/priorities-2024-2029/competitiveness_en

[20] European Commission, The Union of Skills, COM(2025) 90 final, 5 March 2025. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0090

5. Vision and mission

After identifying the key concepts, skills gaps, and main needs, this chapter presents both the vision, which outlines long-term goals and provides a framework for future development, and the mission, which defines the specific purpose and objectives of the Skills Strategy, detailing the practical actions required to achieve the broader vision.

The vision and mission provide a foundation for the objectives that the Skills Strategy aims to achieve through the actions outlined in Chapter 6.

5.1 Vision

A sustainable skilled society in which digital technologies are used to achieve goals aimed at social, economic, and environmental sustainability in Europe.

Vision

A sustainable skilled society in which digital technologies are used to achieve goals aimed at social, economic, and environmental sustainability in Europe.

The vision entails a sustainable digital society where innovations in digital technologies are strategically leveraged to accelerate progress toward achieving the United Nations Sustainable Development Goals ("SDGs")[21]. By aligning digital transformation with sustainability principles, it is possible to drive impactful action across key areas such as quality education (SDG 4), sustainable industry and infrastructure (SDG 9), reduce inequality within and among Countries (SDG 10), responsible consumption and production (SDG 12) and climate action (SDG 13)[22]and ensuring that digital advancements contribute to social equity, environmental stewardship, and economic prosperity for all.

[21] United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development. https://sdgs.un.org/2030agenda

[22] Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, Goal 12. Ensure sustainable consumption and production patterns, Goal 13. Take urgent action to combat climate change and its impacts

5.2 Mission

To equip digital professionals with the competences and skills necessary to steer digital innovation towards social, economic and environmental sustainability.

Mission

To equip digital professionals with the competences and skills necessary to steer digital innovation towards social, economic and environmental sustainability.

The mission provides a strategic basis for translating the vision into actionable steps, outlining clear pathways and initiatives that drive progress, inspire collaboration, and ensure the effective implementation of relevant actions to achieve the desired outcomes.

It also highlights the need to foster the development and enhancement of digital professionals by equipping them with the skills necessary to drive digitalisation in a way that promotes a better and more sustainable future for all.

6. Scope of the Skills Strategy

This Chapter defines the boundaries and focus of the Skills Strategy, outlining its main stakeholders, target audiences and key focus areas.

6.1 Digitalisation for sustainability

Regarding the relationship between "digital" and "sustainability", many different terms are used. In this Skills Strategy, the focus is specifically on "digital sustainability", where digital tools, data, and technologies are harnessed to enable, accelerate and scale solutions that address sustainability issues while also considering potential rebound effects on social or environmental sustainability. These solutions are not limited to the preservation of our natural resources and energy efficiency but include the whole range of possible sustainability goals as described by the SDGs. (i.e. social equity and enhancing the overall well-being of society.)

This broad understanding of sustainability is aligned with the vision set forth by the CODES[23], particularly Shift 3, focused on directing and encouraging innovations towards digitalisation for sustainability. It outlines six key areas of innovation that must be taken into consideration to foster digitalisation for sustainability: creating a digital twin of the planet, enabling a circular economy, promoting sustainable consumption, supporting a common knowledge establishing networked and agile governance, and prioritising digital technologies that drive the transition to a green, just economy for all of society.

[23] CODES Framework (2022).

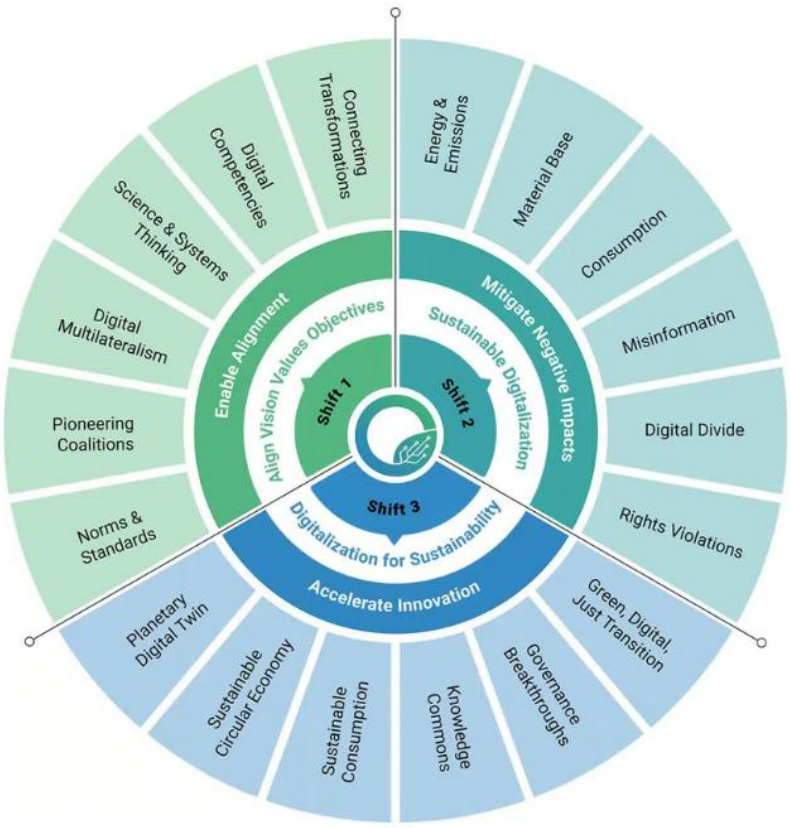

Figure 1 - CODES Framework

Therefore, in the context of CODES, the concept of digital sustainability encompasses a comprehensive understanding of sustainability, aligned with the SDGs. It emphasises the importance of meeting the needs of the present without compromising the ability of future generations to meet their own needs. It promotes a holistic approach to sustainability that integrates environmental, social, and economic dimensions, aiming for long-term, inclusive, and equitable progress.

By adopting this broad perspective, the Skills Strategy promotes objectives and actions aimed at preparing the workforce for these challenges.

6.2 Stakeholders

As a large number of stakeholders are involved at various levels and in different capacities in the implementation of the strategic objectives described in Chapter 6, they have been divided in into two distinct groups: "primary" and "secondary".

A primary stakeholder group is one whose continuous involvement is critical for the success of the Skills Strategy, while secondary stakeholder groups, though less essential for its implementation, play an important role in achieving its goals.

The descriptions below present the relevant stakeholders and their roles and interests in relation to the Skills Strategy.

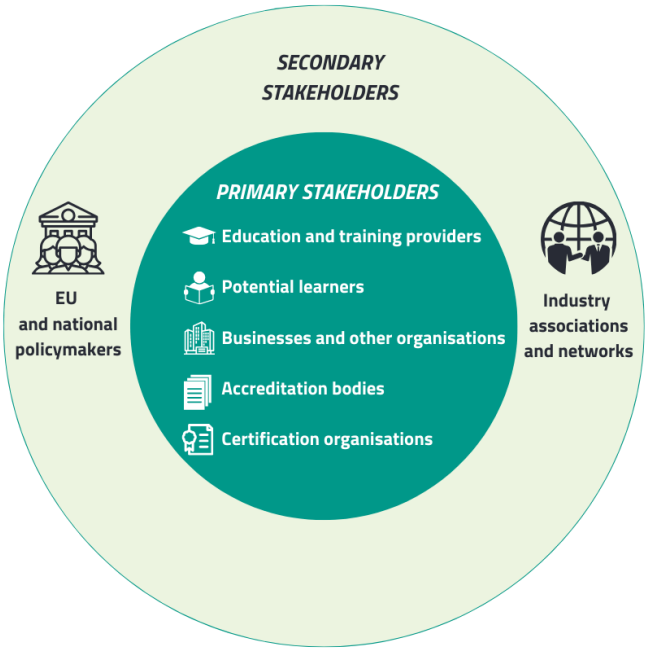

Figure 2 - European Digital Sustainability Skills Strategy Stakeholders

Primary stakeholders

- **Education and Training Providers**

Education and training providers, namely formal education and training providers (VET providers), higher VET providers, including higher education institutes, internal training departments of organisations, and independent trainers and teachers, play a key role in shaping and delivering educational programmes that equip learners with both foundational and advanced skills in digital sustainability. They are also crucial in offering learning programmes tailored to the evolving needs of the workforce.

These providers are essential in both developing interdisciplinary training programmes that merge digital innovation with sustainability expertise and aligning curricula with the skills needed for emerging roles in digital sustainability, ensuring that the workforce is prepared for new opportunities in this field.

By integrating sustainability principles with cutting-edge digital technologies, education and training providers support Europe's policy goals. They are also vital in addressing skill shortages across critical sectors, ensuring workers are equipped to navigate the evolving landscape of digital sustainability. As industries evolve, training providers must remain agile, continuously adapting their offerings to reflect technological advancements, regulatory changes, and shifts in

industry needs. In doing so, they help bridge the skills gap, empowering individuals and businesses to contribute to the transition towards a more sustainable, digitally advanced economy.

Equipping education and training providers with the necessary skills in digital sustainability will strengthen their capacity to design effective programmes. This includes enhancing both content and organisational aspects, integrating new and emerging topics, and ensuring better alignment with market needs in the sector.

- **Potential learners**

The potential learners are diverse and encompass individuals with varying levels of education, experience, and professional roles[24] not only in terms of their current work but also in relation to their levels of work experience. Some may be at the beginning of their careers, while others have years of experience and are seeking opportunities for reskilling or upskilling. This diversity makes it essential to adopt a flexible and inclusive approach to learning, ensuring that training programmes cater to those looking to acquire new skills, enhance their existing expertise, or transition into a completely new field. These learners are likely to come from various sectors, including technology, business, government, and academia, all with a shared goal of leveraging digital innovations to promote sustainability. They will engage with the learning programmes to bridge the existing skills gap and rebalance the demand and supply of skills within the field of digital sustainability.

- **Businesses and other organisations**

Businesses of all sizes, non-governmental organisations, and public administrations play a pivotal role in driving digital sustainability, provided they have a workforce with the right skills. Whether in the private or public sector, they lead the adoption of digital technologies and sustainable practices, making them key players in achieving both digital and sustainability objectives.

By developing employees' skills, organisations can foster innovation, enhance efficiency, and meet sustainability targets, while also contributing to broader societal goals.

Businesses are central to the Skills Strategy, as they provide the practical context in which digital sustainability skills are demanded and applied. They drive job creation, shape business models, and lead by example in integrating technology and sustainable practices. Investing in workforce development not only strengthens long-term competitiveness but also supports broader economic and environmental goals, helping to build a skilled and resilient workforce.

- **Accreditation Bodies**

[24] The EQF levels from 4 to 7 encompass a progression from specialised knowledge at the upper secondary level (EQF 4), through practical and theoretical skills at the post-secondary (EQF 5) and bachelor's degree (EQF 6) levels, to highly specialised knowledge and independent research at the master's degree level (EQF 7). https://europass.europa.eu/en

Accreditation bodies play a vital role in relation to the Skills Strategy by ensuring the quality and credibility of digital sustainability learning programmes. They establish rigorous frameworks for evaluating and certifying learning programmes and their providers, assuring that qualifications meet recognised standards. By setting benchmarks for training and education providers, accreditation bodies help create a structured and valid approach to skills development. Their oversight guarantees that training programmes adhere to quality standards and, for example, remain both up-to-date and relevant.

- **Certification Organisations**

Certification organisations are essential in validating and recognising individuals' skills and competencies in digital sustainability. By issuing credentials that demonstrate expertise, they provide professionals with tangible proof of their abilities, increasing employability and career progression opportunities. These organisations work closely with industry stakeholders to ensure that certifications reflect the latest technological advancements and sustainability practices, making them valuable assets for businesses seeking skilled talent.

In addition to recognising formal education and training, certification organisations encourage lifelong learning by offering pathways for professionals to upskill and reskill. As digital sustainability continues to evolve, the availability of industry-recognised certifications enables individuals to stay relevant in the job market. Their involvement in the Skills Strategy ensures that professionals not only acquire the necessary competencies but also gain recognition for their expertise, reinforcing the overall success of the digital and green transitions.

Secondary stakeholders

- **Industry associations and networks**

Fostering collaboration with education providers, industry associations, networks, and umbrella organisations can contribute to aligning training and education with industry needs, particularly in emerging fields like digital sustainability. These organisations also help businesses, especially SMEs with limited resources, navigate the complexities of adopting new technologies and sustainable processes.

Through guidance, resources, and networking opportunities, industry bodies enable enterprises to build the capabilities needed to succeed in a digital and sustainable economy. By working with training providers, they help shape curricula to reflect evolving skill requirements, bridging gaps in the labour market. Additionally, they offer valuable insights into future workforce needs, ensuring educational programmes remain future-focused. Their role in promoting continuous learning and innovation strengthens industrial competitiveness and ensures employees possess both the technical expertise and adaptability required for the twin transition. Examples of such

networks include European Digital Innovation Hubs (EDIHs)[25], Clusters [26]and the European Green Digital Coalition (EGDC)[27].

- **Policymakers**

Governmental bodies and public institutions at national and European levels are essential for creating policies and frameworks that foster skill development in alignment with digital sustainability. These bodies play a decisive role in shaping the regulatory environment, ensuring that training and workforce development are targeted towards the skills needed for the green and digital transformations.

This Skills Strategy offers guidance on developing supportive frameworks and securing funding opportunities to enhance digital sustainability skill-building initiatives. By aligning workforce development with European sustainability goals, such as the European Green Deal and digital transformation objectives, governmental bodies and public institutions can ensure that the necessary skills are developed to drive the success of these transitions across industries and sectors. Their involvement is key to ensuring that the Skills Strategy is effectively implemented, and that the workforce is adequately prepared to meet the challenges of both the digital and green transitions.

6.3 Skills and roles

For the purposes of this Skills Strategy, it is also important to specify certain concepts and reference frameworks related to skills and roles, also considering the already existing frameworks in Europe.

Skills are the abilities individuals develop through education, training, and experience, allowing them to perform tasks and functions effectively. In the context of this Skills Strategy, the focus is on those skills that relate to digitalisation for sustainability. These are all those skills related to the designing, developing, deploying and regulating of digital technologies to secure sustainable economic, environmental and social development [28] . These skills merge digital/ICT with sustainability. Digital professionals working on and with technologies and innovations in support of sustainability in the broadest sense need the skills to do so effectively. Besides digital sustainability skills, they also need more general skills related to sustainability, as well as transversal ("soft") skills, such as the ability to work in a team.

Skills are intrinsically linked to roles, as they define the specific abilities required to fulfil the responsibilities associated with each job. For example, a digital sustainability role may require both technical expertise in ICT and a strong understanding of sustainability principles.

[25] European Commission, European Digital Innovation Hubs Network. https://european-digital-innovation-hubs.ec.europa.eu/it/home
[26] European Commission, Cluster policy https://single-market-economy.ec.europa.eu/industry/cluster-policy_en
[27] The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors. https://www.greendigitalcoalition.eu/
[28] Digital4Sustainability (2024). Needs Analysis, based on CODES, 2022.

Existing frameworks across Europe, such as the European e-Competence Framework (e-CF)[29], the European ICT Professional Role Profiles[30] and the European Skills, Competences, Qualifications, and Occupations (ESCO)[31] and the GreenComp framework, provide structured approaches to defining the skills required for ICT and digital professionals. These frameworks outline the specific competencies needed for various roles within the digital and sustainability sector, helping to align training, qualifications, and job profiles with industry standards.

The European ICT Professionals Role Profiles[32] were developed in a European context, involving a large number of different stakeholders. They offer a structure and provide a generic set of 30 ICT role profiles that aim to cover all the professional roles in the field of ICT, ranging from more managerial roles to highly specialised roles.

This set of profiles serves as an essential reference tool for understanding the diverse occupations in the digital domain, providing clarity on the skills, competences, and qualifications required to excel in each role. By specifying the competences, responsibilities and tasks associated with each position, these profiles enable both employers and employees to better understand the expectations within the sector, ensuring that the right individuals are placed in roles that match their qualifications. 9 role profiles of this framework can be recognised in the field of digital sustainability. Based on that selection, 10 digital sustainability role profiles can be formulated.

These profiles are aligned with other European standards, in particular with the e-CF, which standardises the competences needed for ICT professionals. The e-CF categorises 40 competences for ICT professionals, providing a common language for competences, skills, and proficiency levels. Each one of the ICT Professional Role Profiles contains a number of those competences.

They also connect with other European skills and qualifications frameworks, ensuring that the defined roles are consistent with recognised educational and professional standards. As a result, the profiles create a common language for ICT occupations, facilitating job mobility and the ability to assess qualifications across different EU member states.

For instance, the e-CF serves as a fundamental resource also for the development of ESCO, a key initiative designed to support the Europe 2020 Skills Strategy and the New Skills Agenda for Europe. It provides a classification system for European skills, competences, qualifications, and occupations with a scope much wider than the ICT profiles.

[29] CEN - European Committee for Standardization/ TC 428 (2019). e-Competence Framework (e-CF) – A common European Framework for ICT Professionals in all sectors - Part 1: Framework. Brussels: CEN-CENELEC. European norm EN 16234-1:2019. https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

[30] CEN Workshop Agreement, European ICT professionals role profiles CWA 16458-1, 2018. https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf

[31] European Commission, European Skills, Competences, Qualifications and Occupations. https://esco.ec.europa.eu/en

[32] CEN Workshop Agreement (2018). CWA 16458-1 European ICT professionals role profiles - Part 1: 30 ICT profiles. Brussels: CEN. https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf

ESCO describes, identifies and classifies professional occupations and skills relevant to the EU labour market and education and training area and systematically shows the relationships between them[33]. Regarding digital sustainability, ESCO focuses in particular on green and the environmental impact of ICT. For this purpose, the following roles are currently included in ESCO: ICT environmental manager (1330.10) and green ICT consultant (2511.7). Due to the specific focus on green, these profiles can be considered a further refinement of the Digital Sustainability Manager and the Digital Sustainability Consultant. Furthermore, ESCO has several roles related to specific sectors, such as energy analyst (3112.5), water quality analyst (2133.13) and air pollution analyst (2133.14). These are specialisations of the more general role of Sustainability Data Analyst. ESCO also has roles related to sustainability in general, such as sustainability manager (1213.8) or health safety and environmental manager (1213.7). Like general roles in ICT and digital, such as the ICT manager, these general roles in the field of sustainability fall outside the scope of digital sustainability.

Furthermore, GreenComp[34] is a reference framework for sustainability competences. It provides a common ground for learners and guidance to educators, providing a consensual definition of what sustainability as a competence entails. GreenComp consists of 12 competences. This framework can be used to identify the main sustainability-related skills and knowledge that are needed in digital sustainability roles. This can be divided into specific sustainability topics and more cross-cutting, transversal skills. In particular, the very general skills that are not directly related to sustainability are considered most relevant when it comes to digital sustainability[35]. These are critical thinking, teamwork, willingness to learn, exploratory thinking, and strategic thinking. As for cross-cutting skills and attitudes related to sustainability, flexible and adaptable implementation and valuing sustainability are considered most important.

6.4 Learning programmes

Most learning programmes do not explicitly focus on digital sustainability[36]. Instead, they primarily address either digitalisation or sustainability, incorporating elements of the other only in certain aspects and dedicated university degrees, such as Master's programmes in digital sustainability, are limited. Existing digitalisation courses should integrate sustainability perspectives, while sustainability programmes must also incorporate digital skills.

[33] European Commission, ESCO. https://esco.ec.europa.eu/en/about-esco
[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, DOI:10.2760/13286, JRC128040
[35] Digital4Sustainability (2024). Needs Analysis.
[36] Digital4Sustainability (2024). Needs Analysis.

However, addressing skills gaps and shortages cannot rely solely on higher education institutions, as eventual curriculum changes do not reach the current workforce. Upskilling and reskilling will be essential, starting with basic sustainability skills and progressing through modular and short learning programmes tailored to workforce needs. Strengthening collaboration between universities, training institutions, and organisations will be key to achieving this objective.

Additionally, adapting re- and upskilling initiatives requires consideration of both the European policy landscape and national commitments to digital sustainability. Aligning skills development with these contexts will ensure effective implementation. As digital technologies continue to evolve and their intersection with sustainability becomes ever more critical, it is essential that learning programmes are carefully tailored to meet their emerging needs.

In the context of this Skills Strategy, the learning programmes will span VET and higher VET, covering a range of complexity levels from EQF Level 4 to EQF Level 7. This progression from foundational knowledge at EQF Level 4 to more advanced, specialised competencies at EQF Level 7 ensures that learners at different stages of their careers can develop the expertise needed for both technical roles and management/consultancy positions within the field of digital sustainability. These programmes will address key areas such as sustainable digital technologies, circular economy models, and digital tools for environmental monitoring, offering learners a comprehensive understanding of how to leverage technology to promote sustainability across various sectors.

It is important to emphasise that the primary focus of these learning programmes will be on formal education, ensuring that learners receive accredited, structured training that is recognised across the sector. This formal approach guarantees that participants not only gain the necessary practical and theoretical knowledge, but also obtain qualifications that reflect their expertise, enabling them to meet the growing demand for skilled professionals in digital sustainability.

By fostering a clear alignment between training programmes and industry needs, this Skills Strategy will help close the skills gap, enabling a workforce capable of supporting the transition to a more sustainable and digitally-enabled future.

7. Skills Strategy strategic objectives and key actions

This Chapter outlines **strategic objectives** and **key actions** aimed at fostering a future-ready workforce, bridging skill gaps, and aligning educational and training efforts with emerging market demands. By focusing on digital sustainability, this approach seeks to empower professionals with the skills required to navigate technological advancements while contributing to Europe's broader sustainability goals. The following sections detail the **core objectives**, **concrete actions** and **policy recommendations** needed to implement an effective and forward-looking Skills Strategy. The actions are presented with a list of short-term milestones, covering a period of 36 months from the publication of this Skills Strategy, as well as long-term milestones that extend beyond this period.

Strategic objectives	*1. Monitor the demand for and supply of digital sustainability skills and roles*	*2. Facilitate and guide education and training*	*3. Develop, maintain and promote a validation framework for learning outcomes*	*4. Raise awareness*	*5. Promote a supporting regulatory framework*	*6. Strengthen cooperation*
Actions	**1.1** Identify existing and emerging digital sustainability skills and roles **1.2** Monitor changes in digital sustainability skills and roles **1.3** Map existing training and education offering to determine skills gaps and shortages	**2.1** Maintain educational profiles for digital sustainability roles **2.2** Maintain flexible curricula based on educational profiles **2.3** Based on the curricula, showcase flexible learning programmes for a specific context **2.4** Provide, update and maintain learning resources	**3.1** Develop, maintain and promote a certification framework, including micro-credentials **3.2** Design, maintain and promote a quality label for digital sustainability learning programmes	**4.1** Establish pathways to share resources and best practices for digital sustainability challenges **4.2** Organise awareness raising initiatives and campaigns to steer interest in digital sustainability topics and learning opportunities	**5.1** Develop a roadmap for integrating digital sustainability skills into existing education policies and frameworks at national and European levels. **5.2** Advocate for financial and regulatory frameworks supporting skills development for digital sustainability	**6.1** Build and maintain a community of digital sustainability stakeholders **6.2** Facilitate collaboration between education and training providers and industry to develop, promote, and deliver digital sustainability training programmes. **6.3** Encourage cross-border and cross-sectoral mobility

Figure 3 - Table with strategic objectives and actions

7.1 Monitor the demand for and supply of digital sustainability skills and roles

Skills and subsequently roles are at the heart of this Skills Strategy. Skills come together in the competences people have and, in the roles, people fulfil with specific tasks and responsibilities. Skills and roles go hand-in-hand. Therefore, the first strategic objective of this Skills Strategy is about identifying relevant skills and roles, monitoring changes and mapping the demand and supply of those skills.

SO1 Monitor the demand for and supply of digital sustainability skills and roles	
Actions	**Short-term milestones**
1.1 Identify existing and emerging digital sustainability skills and roles	The most relevant skills and roles in the field of digital sustainability are identified
1.2 Monitor changes in digital sustainability skills and roles	A process is designed to monitor changes in digital sustainability skills and roles
1.3 Map existing training and education offering to determine skills gaps and shortages	The existing training and education offering is mapped and analysed to determine skills gaps and mismatches
Stakeholders involved	
Education and training providers, potential learners, Businesses and other organisations that need digital sustainability skills	
Long-term milestones	
Periodical review of relevant skills and roles in the field of digital sustainability, following the change monitoring process.	

Figure 4 - Strategic Objective 1: Actions and Milestones

7.1.1 Identify existing and emerging digital sustainability skills and roles

Skills

To identify the skills needs for digital sustainability professionals, a multi-method approach can be used[37] encompassing various data collection techniques and involving different target groups at both European and national levels. This includes literature review, analysis of the market, trend reports and analysis of job postings. In addition, questionnaires can be distributed to organisations in need of digital sustainability skills.

In this identification exercise, special attention will be given to these three categories, which are particularly relevant to this Skills Strategy

[37] Digital4Sustainability (2024). Needs Analysis.

- **Specific digital sustainability-related skills** refer to the expertise and competencies required to effectively design, implement, manage, and assess digital solutions that promote sustainability. Some examples include sustainable IT operation and development, ICT energy consumption and carbon footprint, ICT for development, development of digital solutions for social good, smart cities, carbon data modelling and scenario mapping.
- More **general sustainability competences** refer to the broad set of skills and knowledge required to understand, implement, and promote sustainability across various sectors, like having a holistic systems view and being able to frame a problem in sustainability terms.
- **Transversal competences** refer to a set of broad, adaptable skills that are transferable across different sectors and job roles like teamwork, exploratory thinking and a willingness to learn.

Figure 5 - Overview of essential skills for digital sustainability professionals

All these 3 categories imply a general knowledge on sustainability related trends, concepts, regulations, standards and policies, such as Environmental, Social and Governance (ESG) reporting, the Sustainable Development Goals (SDGs), circular business models and economy, Farm to Fork strategies, waste prevention and minimisation, and social inclusion.

Roles

To effectively meet and anticipate the market's digital sustainability needs, it is essential that professionals are trained for roles that align with these demands. Job titles vary widely, with similar titles describing different roles and vice versa. While a general understanding of a job exists, variations arise based on context. The challenge is to define key digital sustainability roles that are both broad enough to be simple and specific enough to align with job market details.

Role profiles offer structure and clarity by grouping common job elements into a consistent description. They are broader and less specific than job descriptions. Because of their higher level of abstraction, well-defined role profiles serve as archetypes, from which specific job functions

are derived. A clear set of role profiles provides a useful foundation for various activities, including personal development and the creation of educational programmes for training purposes. The European ICT professionals' role profiles[38] offers such a structure and provides a generic set of 30 ICT role profiles.

Currently, nine of these general ICT role profiles are identifiable in the context of digital sustainability[39].

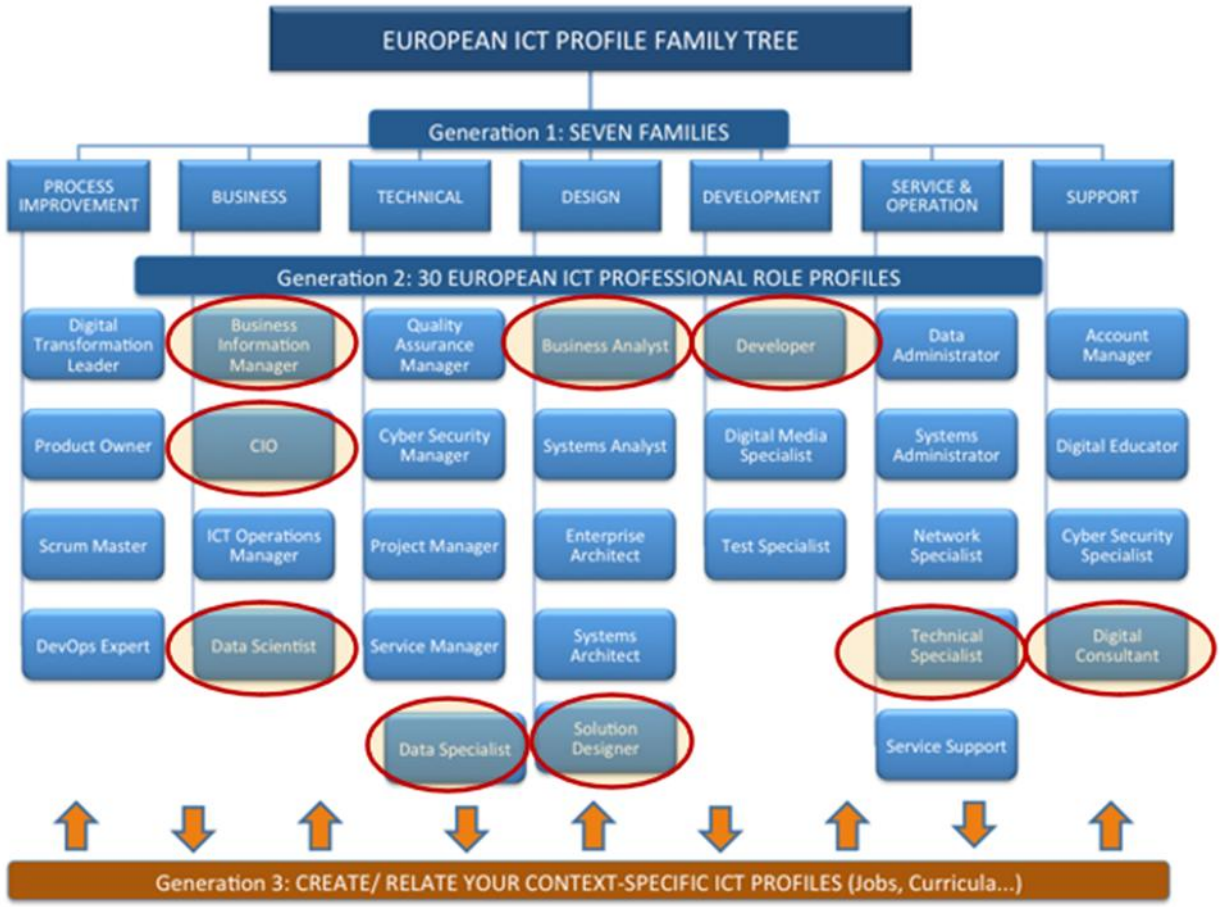

Figure 6 - CEN CWA 16458 Selection of nine relevant role profiles to the field of digital sustainability

When applied to digital sustainability, this results in ten digital sustainability role profiles that can be grouped into three main areas:

- **Management & Consultancy**
  Digital Sustainability Lead, Digital Sustainability Manager, Digital Sustainability Consultant.
- **Data processing & Analysis**

[38] CEN Workshop Agreement (2018). CWA 16458-1 European ICT professionals role profiles - Part 1: 30 ICT profiles. Brussels: CEN. https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf
[39] Digital4Sustainability (2024). Needs Analysis.

Sustainability Business Analyst, Sustainability Data Scientist, Sustainability Data Analyst, Sustainability Data Engineer.

- **Development & Operations**

  Sustainability Solution Designer, Software Developer For Sustainability, Sustainability Technical Specialist.

The figure below illustrates the transition from nine general ICT role profiles to ten digital sustainability role profiles. This expansion highlights the growing importance of data within digital sustainability. While the general ICT role profiles include only two data-related roles—data scientist and data specialist—digital sustainability demands a more detailed approach, resulting in the introduction of three key data-focused roles: sustainability data scientists, analysts, and engineers. The figure also provides examples of these roles in practice, often linked to specific sectors (e.g., agriculture, energy) or application areas (e.g., smart cities). For instance, a smart cities technician falls under the broader category of a sustainability technical specialist.

These specific positions support the various sustainable development goals[40], each in their own way.

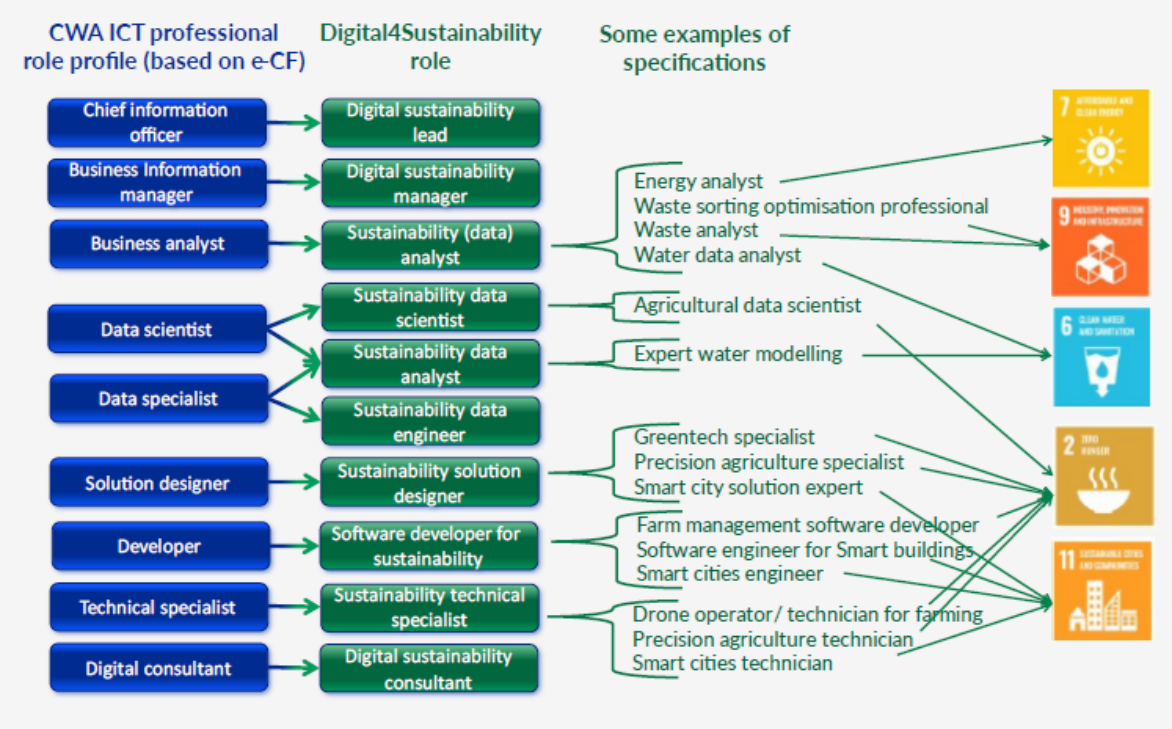

Figure 7 -Digital Sustainability Role Profiles, examples and links to SDGs

[40] United Nations (2015). SDGS.

While sustainability may be a factor in other roles, they fall outside the scope of this Skills Strategy because sustainability is neither a core component nor the primary focus of the skills, knowledge, competences, and tasks required for those roles. Professionals in other ICT roles may benefit from sustainability skills to some extent, but their work is not fundamentally defined by them. In such cases, other skills are more critical, and the role can still be performed effectively with limited sustainability expertise.

DIFFERENT SHAPED PROFESSIONALS

A key development is the need for professionals with multiple specialisations. Professionals should be specialised in digital, in sustainability, and in the field of application, for example, agriculture, energy, or finance. Professionals with three specialisations are often referred to as "M-shaped professionals", which is considered the minimum requirement for individuals working in digital sustainability roles. Those with additional specialisations are highly valued and are known as "comb-shaped professionals". Many ICT professionals, though, are still specialists with a single speciality. They are so-called "I-shaped" professionals, with a deep and thorough specialisation in one specific area, represented by the "I" vertical line. The π-shaped professionals have two specialisations, hence the two vertical lines. The horizontal bar at the top in the T-, π-, m-, and comb-shaped refers to a skillset and aptitude that enables these kinds of professionals to work together with other disciplines.

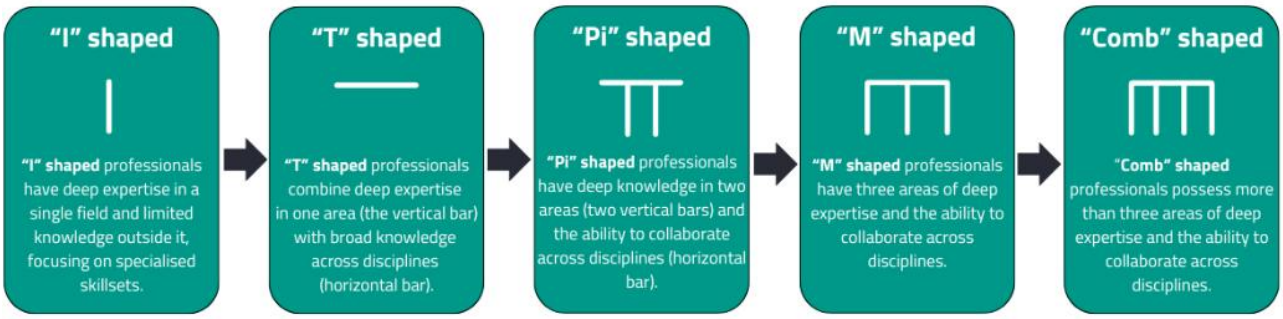

Figure 8 - Different Shaped Professionals

Upskilling digital[41] professionals with sustainability knowledge and skills is the fastest way to meet the need for digital sustainability professionals. It is also possible to upskill sustainability professionals with the skills needed for digital professionals. Given that digital solutions are central to the transition towards digital sustainability, it is logical that this shift will require greater effort, as digital professional skills play a more prominent role in these positions. Reskilling people from other fields is also an option, which will require even more effort but is necessary given the

[41] Digital4Sustainability (2024). Needs Analysis

shortage in the digital sector in particular. The evolving nature of this field makes upskilling and reskilling more challenging, as the specific skills required for different jobs and contexts, such as regional conditions, various sectors, and company sizes, are still emerging and subject to change.

7.1.2 Monitor changes in digital sustainability skills and roles

To identify future demand for new or emerging skills and roles, expert groups, to be consulted on a regular basis, are crucial to gain insight into future scenarios[42]. These insights are gathered through online meetings held at both national and European levels where experts are specifically asked to provide their views on the short- and long-term demand for digital sustainability skills and roles.

Ongoing exchanges with all stakeholders involved both in the development and in the monitoring of the Skills Strategy, as explained in the Annexes B and C, are essential to effectively monitoring changes in digital sustainability skills and roles. Continuous dialogue ensures that emerging trends, evolving industry needs, and shifting policy frameworks are identified and addressed in a timely manner. This collaborative approach allows for the Skills Strategy to remain relevant, adaptable, and aligned with the dynamic landscape of digital sustainability.

7.1.3 Map existing training and education offering to determine skills gaps and shortages

The range of learning programmes currently available is largely focused on digital for sustainability management and advisory roles[43]. However, most learning programmes are not explicitly about digital for sustainability or the twin transition in general. They are mostly programmes that focus on either digital or sustainability and have the other as a kind of add-on in some parts of the programme. There are some specialised, specific programmes that deal with digital solutions for sustainability, such as ICT in sustainable cities. These, mainly short programmes, are very relevant but have the limitation that they only focus on one very specific aspect of sustainability and its digital solutions. Finally, there are courses that help upskill professionals engaged in digital for sustainability, such as SME owners. These are courses such as ICT tools for sustainability for entrepreneurs. This situation results in a gap between the demand and supply for both skills and roles. In this context, identifying current training and education offerings is even more crucial, as it allows for the mapping and assessment of the existing landscape of digital learning opportunities for sustainability against market needs. Given that the current educational offerings in digital skills for sustainability primarily focus on vocational

[42] Digital4Sustainability (2024). Needs Analysis.
[43] Digital4Sustainability (2024). Needs Analysis.

education and training programmes (EQF 4/5) or higher vocational education and training (EQF 6/7), this mapping exercise could begin with an analysis of these existing programmes.

These learning programmes can be offered by public and private universities, VET providers, training providers, vendors or in-house training departments.

7.2 Facilitate and guide education and training

The second strategic objective of this Skills Strategy focuses on supporting training and education providers to meet the demand for digital sustainability professionals and the required skills.

SO2 Facilitate and guide education and training supply of digital sustainability skills and roles	
Actions	**Short-term milestones**
2.1 Maintain educational profiles for digital sustainability roles	A set of educational profiles based on digital sustainability role profiles at different EQF complexity levels and including learning outcomes and types of assessment
2.2 Maintain flexible curricula based on educational profiles	Several standard curricula based on educational profiles, designed in a modular, flexible way
2.3 Based on the curricula, showcase flexible learning programmes for a specific context	Several concrete learning programmes of those curricula for various target groups in different contexts
2.4 Provide, update and maintain learning resources	A set of relevant and ready-to use practical learning resources
Stakeholders involved	
Education and training providers, potential learners, businesses and other organisations that need digital sustainability skills	
Long-term milestones	
• A set of comprehensive, well-developed digital sustainability education profiles that are considered and used as an authoritative source in curriculum development • A set of comprehensive, well-developed digital sustainability curricula that are considered and used as an authoritative source in curriculum development • A set of ready-to use practical learning resources that have proven to be relevant and useful for learners and education and training providers alike	

Figure 9 -Strategic Objective 2: Actions and Milestones

7.2.1 Maintain educational profiles for digital sustainability roles

CEN Technical Committee 428, focusing on ICT professionalism, has designed a method of using educational profiles to translate market demands into learning programmes[44].

This method enables competence-based curriculum design and translates market needs like occupational profiles, competences, skills, and knowledge into educational terminology. An educational profile contains several elements: a set of programme learning outcomes (PLOs) with associated unit learning outcomes (ULOs) and their assessments. It also has a description with characteristics of the profile, such as its complexity. The educational profile serves as a blueprint, independent of the detailed design aspects of a concrete curriculum. It represents the market

[44] CEN/TC428 (2022) Guidelines for developing ICT Professional Curricula (TS 17699), https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0::::FSP_PROJECT,FSP_ORG_ID:72363,1218399&cs=169E9940F2911D404FAE0D4872E5D2630

demand in educational language and forms the basis for curriculum design and development. The main input for educational profiles is the market needs, represented by the digital sustainability role profiles. There are ten identified general digital sustainability role profiles. However, for the purpose of education and training, these roles need to be differentiated in terms of the complexity of these roles in practical applications. This is done by using the EQF. For example, a Software Developer for Sustainability can be trained at EQF levels 5, 6 and 7, resulting in 3 educational profiles for this role profile, with variations in the PLOs and ULOs as the degree of complexity of competences and skills also varies.

The competences of the role profiles are translated into PLOs at the corresponding complexity level, aligned with EQF. PLOs can be relevant to more than one educational profile, or even to all profiles at a given level. PLOs are further refined by defining ULOs. Achieving the ULOs automatically leads to achieving the PLO.

Educational profiles need to be updated regularly, for example, due to changes in the role profiles resulting from changes in market needs. There are also other possible changes to keep in mind, such as changes in the EQF or the e-CF. In most cases, the way learning outcomes are formulated will not need to be changed because of new technology or new methods and tools in the field, but sometimes this can also be a reason to make changes to the education profiles. Therefore, a regular check should be made, preferably annually, to ensure that the educational profiles are still up to date.

7.2.2 Maintain flexible curricula based on educational profiles

Skilling, upskilling, and reskilling people is essential to increase the number of digital sustainability professionals. This includes initial education programmes that skill new, young professionals, upskilling programmes that keep digital professionals up-to-date on sustainability, and reskilling programmes to reskill professionals from other fields to become digital sustainability professionals. Each of these target groups requires different curricula and consequently different learning programmes, so they can obtain the learning outcomes that suit their specific needs.

Initial learners are skilled in formal, initial education, sometimes starting from EQF4 level, but mostly at higher levels, given the complexity of the field. It is necessary to educate professionals who, on the one hand, can keep up with changes in the field of digital sustainability but also can operate within a business environment and have the (transversal/soft) skills to collaborate with other professionals within an organisation or project. It is therefore essential that these types of skills are part of initial education at all EQF levels. For this target group of initial learners, this results in curricula that cover all PLOs of a complete educational profile.

In most cases, **working professionals who need upskilling** will have more specific needs. For example, they may want to focus on specific technical learning outcomes, e.g. related to the use of new technologies for sustainability, or they may want to focus on specific learning outcomes related to sustainability. In addition, transversal/soft skills and competences should also be addressed, as these are needed given the interdisciplinary and multidisciplinary nature of the digital sustainability field. In general, working professionals have little time for upskilling, so they need flexible, highly efficient curricula.

Reskilling professionals from other, not ICT-related fields to become digital sustainability professionals creates professionals with expertise in multiple fields, such as 'm-shaped' or 'comb-shaped' professionals, who can bridge different fields. Curricula for this target group will focus mainly on the more technical, ICT-related learning outcomes.

7.2.3 Based on the curricula, showcase flexible learning programmes for a specific context

Learning providers have the flexibility to design their learning programmes to suit their specific needs. The key element is that it should be clear which learning outcomes of the educational profile are addressed by each learning unit, as this allows comparison between different learning providers. Often, a single learning unit addresses multiple learning outcomes. It is also possible that one learning outcome can be only fully achieved by multiple learning units. The latter situation is not ideal, as a learner must complete multiple units before receiving credentials for that learning outcome. Ultimately, the most important factor is that the relevant learning outcomes are covered by the set of learning units that make up the curriculum. It is also important to showcase these learning programmes, as they serve as practical illustrations of the implementation of the curricula, thus proving their applicability.

While each provider can design its own specific learning programme, this does not imply that they will be entirely different, as they are all focused on achieving the same learning outcomes. Each programme represents a curriculum that reflects a particular approach to reaching these outcomes.

Localisation

Besides different target groups, specific needs related to the local situation may also influence the need for training or education. For example, in one country, region or industry, a certain type of technology or tool may be predominant, while in another context a different type may prevail. It makes sense for a learning provider to include that dominant type in its learning offerings. In all cases, learners must achieve for example, a learning outcome related to programming, while in

specific learning programmes from different providers this will probably involve different types of programming languages. The learning outcomes in educational profiles are formulated in such a way that it is possible to meet these specific local requirements and still be in line with the profile. An educational profile and its learning outcomes can be translated into a general curriculum, but it will be the specific localised components of that curriculum that are implemented, as they are tailored to the target group, the local situation and perhaps other relevant factors.

Individual learning paths

Even when curricula are tailored to the target group and localised to specific situations, differences in individual learning needs can remain. For example, two experienced managers in need of upskilling can both have different learning needs due to differences in education, training, and experience in projects and organisations. To reach the same learning outcomes they need different training. In other words, they need ***individualised learning pathways*** to obtain the same learning outcomes.

Exemptions are one of the instruments to create individualised learning pathways. The prerequisite for this is assessing whether someone already achieved a certain learning outcome. Therefore, assessment criteria need to be developed to enable individualised pathways. Exemptions from parts of a curriculum are essential for efficient reskilling because the use of well-designed exemptions reduces needless and tedious repetition. They speed up programme completion and make it more attractive to learners and their employers.

Another perspective is to develop more than one way to achieve a learning outcome. For example, some learners learn better by listening, while others prefer reading or visual information. For some people, it is also easier to train a certain skill in their real work environment. The same learning outcome can be achieved with different learning methods.

Modularity

An important tool that enables flexible, individualised learning pathways is modular curriculum design. This allows learners to choose to do only those parts that are relevant to them. They can flexibly design the content of their education by combining different "small" modules ranging from a few hours to several hundreds of hours of learning.

A modular curriculum consists of small discrete modules or learning units that are virtually self-contained, independent, non-sequential, and typically short in duration. This means that a learner should be able to follow a learning unit without the need to follow preceding or subsequent units. Of course, there may be prerequisites for a learning unit, but these should be formulated in terms of learning outcomes a person must already have before they can participate in a particular

learning unit. It also means that each learning unit should be assessed independently of other learning units in terms of achieving the intended learning outcomes.

A modular curriculum also facilitates the possibilities of micro-credentialling or other kinds of credentialling. Each learning unit can be recognised with a credential showcasing the learning outcomes achieved. These credentials can be used independently or stacked to achieve an overarching credential or qualification.

It is also important to consider that people's workloads can change rapidly, leaving little time for learning outside of work. To increase learning opportunities, content should be accessible at a time, pace, and place that suits them, offering both self-paced (on-demand) and instructor-led learning. This flexibility enhances upskilling and reskilling and widens access to education for those with other commitments. Self-paced learning requires different materials, often with more context or explanation, while instructor-led learning relies on the teacher's expertise. A balance between both approaches ensures optimal flexibility and learning quality, with instructor-led learning used only when necessary

7.2.4 Provide, update and maintain learning resources

Providing up-to-date learning resources free of charge supports education and training. It facilitates the adoption of curricula because providers can immediately use the available materials. It also increases the quality of learning materials because providers can build on each other's work.

In an emerging field like digital sustainability, it is essential that learning materials are regularly updated. Collaboration between training providers and organizations seeking digital sustainability professionals will help ensure the continuous relevance and quality of learning resources. The stakeholder engagement described in Annex C will provide valuable insights in this regard.

The first step is ensuring that methods and materials are up-to-date, with new content developed to reflect the latest technologies and trends. The second, more challenging but crucial step, is maintaining the relevance of training materials over time. Due to the time and effort involved in creating training resources, trainers and providers may be inclined to keep methods and materials stable for several years. However, this can result in outdated content. Therefore, it is essential to establish mechanisms that identify emerging needs and facilitate the timely update of materials. This requires a system of continuous improvement to keep educational offerings aligned with evolving demands. A learning platform that serves as a repository for materials educators and trainers can use and update supports this approach. This repository encourages

greater usage, as learning resource providers have a solid foundation to work from, allowing them to either use the materials as is or adapt them to their specific needs. Furthermore, the ability to update and improve the materials continuously enhances their quality and ensures they remain current.

SO2 - Policy recommendations:

- **Encourage the integration of digital sustainability learning programmes in higher education, vocational education, and lifelong learning curricula, aligned with the EU policies and in particular with the EU Skills Agenda and Green Deal objectives.**

  This is relevant because it would provide learners with the opportunity to develop competencies across various domains related to digital sustainability. As a result, institutions can prepare a workforce ready to contribute to a more sustainable digital economy. Additionally, collaboration between governments, educational providers, and industry stakeholders is essential to create relevant learning opportunities that meet the needs of this evolving field.

- **Increasing funding for education institutions to support sustainability-focused digital training.**

  Increasing funding for education and training providers is crucial to enabling them to deliver high-quality, sustainability-focused digital training.
  To achieve this, both resources within already existing national and European funding programmes, such as Erasmus+ and Horizon Europe, as well as new funding opportunities, should be allocated to projects that integrate digital and sustainability skill-building.
  By enhancing financial support for these institutions, we can ensure that they are equipped to develop and deliver training programmes that align with EU digital and sustainability goals, preparing individuals for the rapidly evolving job market. Dedicated funding streams will allow education and training providers to create innovative curricula, invest in cutting-edge technologies, and collaborate with industry partners, ensuring learners acquire the relevant skills. Furthermore, this funding will support the research and development of new educational approaches, ensuring the workforce is well-prepared for future challenges in digital sustainability.

- **Implement targeted tax incentives to promote investment in digital and sustainable training.**

  To foster the transition towards a sustainable and digitally advanced economy, governments could introduce targeted tax incentives to encourage businesses to invest in trainings focused on digital sustainability skills.
  These incentives could either reduce the tax base through tax allowances or lower the tax due via tax credits, depending on national contexts. Additionally, governments could

consider enhanced tax benefits for training programmes directly aligned with sustainable digital practices, such as green technologies, energy-efficient solutions, and sustainable IT infrastructure.

In countries where training costs are typically treated as operational expenses, governments could introduce extra deductions or credits for training that directly contributes to more sustainable digital economies. This approach would ensure businesses are encouraged to invest in training that strengthens their competitiveness while meeting sustainability goals.

- **Prioritising digital sustainability skills in EU funding and public procurement.**

  EU funding and public procurement at both the national and European levels shall prioritise those projects that are led by teams with experts possessing digital sustainability skills. By directing financial support towards these teams, we can ensure that projects are not only innovative but also aligned with the EU's sustainability and digitalisation goals. This approach would incentivise the development of digital solutions that integrate sustainability, while also encouraging the upskilling of professionals in this critical area. As digital sustainability expertise becomes increasingly important, prioritising these skills in funding and procurement processes would create a strong incentive for companies and institutions to invest in building the necessary competencies. Additionally, it would foster collaboration across sectors, ensuring that the solutions developed are both environmentally responsible and technologically advanced, contributing to a more sustainable and resilient economy.

- **Provide businesses with vouchers to access training, advisory services, and technology adoption support for integrating sustainable practices.**

  Providing businesses, and in particular SMEs, which can experience issues in financing training activities, with vouchers to access training, advisory services, and technology adoption support for integrating sustainable practices is a highly effective way to foster their digital transition towards sustainability. These vouchers can support companies' investment in tailored training programmes that equip their employees with the skills needed in the labour market. Additionally, vouchers can help SMEs access expert advisory services, guiding them through the process of implementing sustainable practices and identifying opportunities for improvement.

- **Promoting sustainable digital tools to drive skill development and innovation.**

  Promoting the development of sustainable digital tools is crucial for accelerating the transition towards a more sustainable digital economy. By fostering the creation of digital solutions that prioritise environmental impact, we can drive an increase in the demand for relevant digital sustainability skills.

  This can be achieved through various initiatives, such as providing innovation grants for the development of sustainable digital solutions, including sustainability requirements in

public procurement processes, and supporting collaborative R&D projects focused on sustainable technologies. These actions would not only encourage the creation of innovative tools that align with environmental goals but also help to cultivate a workforce capable of building and maintaining these solutions. Ultimately, this will foster a more sustainable and resilient digital economy while creating new opportunities for skill development in the growing field of digital sustainability.

7.3 Develop, maintain and promote a validation framework for learning outcomes

It is important that learning is validated to determine whether someone is an up-to-date professional and that professionals can showcase their competences and skills. This encourages mobility of professionals, enhances the credibility of the digital sustainability field and supports lifelong learning. It is also important that learning providers deliver good quality programmes so that learners can be confident that a learning programme leads to the relevant learning outcomes.

Assessments are the way to validate whether someone has achieved a learning outcome. The fact that the achievement of learning outcomes is assessed according to agreed standards, such as those of a quality label, means that it is possible to recognise learning outcomes which promotes mobility.

SO3 Develop, maintain and promote a validation framework for learning outcomes	
Actions	**Short-term milestones**
3.1 Develop, maintain and promote a certification framework, including micro-credentials	A first version of a certification framework aligned with learning outcomes of the educational profiles and certificates is promoted
3.2 Design, maintain and promote a quality label for digital sustainability learning programmes	A first version of a quality label is delivered and promoted
Stakeholders involved	
Education and training providers, certification organisations, accreditation bodies, industry associations and networks	
Long-term milestones	
• A certification framework, accepted among education and training providers as well as certification institutes and companies, is widely recognised at both national and European level • The quality label is broadly recognised	

Figure 10 - Strategic Objective 3: Actions and Milestones

7.3.1 Develop, maintain and promote a certification framework, including micro-credentials

Certificates provide professionals with a valuable way to demonstrate the skills and knowledge they have, as proven by assessment. Certificates can be designed to be stackable, potentially leading to a full qualification. A multi-level certification framework that links directly to unit learning outcomes, programme learning outcomes and even complete roles helps to recognise the competences and skills of digital sustainability professionals.

People who successfully complete the assessment of a training or course can be certified for achieving the related learning outcomes. Training or courses can stand alone or be part of a larger programme and there must be an assessment that proves whether the intended learning outcomes have been achieved. This excludes the well-known participation certificates, as they do not prove that the learning outcomes have been achieved.

Traditionally, qualifications and certifications involved extensive knowledge and skills that were validated in a single step. This has changed in the digital age. It is now possible, using tools such as micro credentialling and digital badges, to recognise small parts of skills and knowledge. These may even be linked to just 10 minutes of learning material (microlearning), but usually relate to a larger unit of learning, such as 1 ECTS or 25-30 hours of learning.

Certifications for digital sustainability skills are important for gaining recognition, which enables mobility. The certifications can be displayed through digital badges, providing a clear and verifiable record of competencies. An effective certification framework should be structured across multiple levels, so that a collection of lower-level badges can lead to a higher-level certification, eventually culminating in a badge that signifies mastery of the competencies required for a complete role profile, equivalent to a traditional qualification.

This approach ensures flexibility, transparency, and accessibility in skills recognition and career progression. A system of digital badges also prevents issues such as the authentication of paper certificates. Professionals can learn a skill, prove the learning outcomes through assessment, and add this achievement to their digital CV in the form of a digital badge. The framework should also be linked to the **European Digital Credentials for Learning** tool from Europass[45].

The certifications can be awarded in two ways: the first is the recognition of professional certifications, and the second is the recognition of micro-credentials.

The recognition of these professional certifications results in the awarding of digital badges. These certifications will be acknowledged within the certification framework, provided they meet specific quality criteria, such as assessments conducted under exam conditions. The second path is through the recognition of micro-credentials issued by accredited partners. These are learning providers who have proven their quality, especially with regard to the assessment of achieving learning outcomes. They define learning units that lead to micro-certificates upon successful completion, which are mapped against the certification framework in the same way as

[45] European Union, EUROPASS. https://europass.europa.eu/it/strumenti-europass/european-digital-credentials-learning

professional certifications. The recognition of these micro-credentials again leads to the awarding of credentials in the form of digital badges.

Promoting a certification framework, including micro-credentials, ensures the recognition and validation of digital sustainability skills across industries. Micro-credentials provide flexible, modular learning pathways, enabling professionals to upskill and reskill effectively. To maximise impact, recognition of these certifications should first be established at the national level before being expanded across Europe through the promotion and standardisation of sectoral qualifications. This approach facilitates cross-border certification, enhances employability, supports lifelong learning, and aligns training with evolving labour market needs, helping to develop a workforce equipped to address digital and sustainability challenges.

7.3.2 Design, maintain and promote a quality label for digital sustainability learning programmes

A quality label can ensure that assessments, education and training are of good quality. Establishing a quality label for education and training providers for professionals in the field of digital sustainability will therefore increase recognition.

A system that focuses on learning outcomes rather than on the learning itself will automatically focus on the quality of the assessment that verifies whether learning outcomes are obtained. A quality label ensures that both the issuers of professional certifications and the learning providers issuing micro-credentials can guarantee the quality of their assessment of learning outcomes.

The quality of the issuers of professional certification can be assessed by the application of the ISO/IEC 17024 standard for 'bodies operating schemes for the certification of persons'[46] as a starting point. The learning providers that issue micro-credentials can be assessed by using European Quality Assurance in VET (EQAVET) and European Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) as a starting point with the limitation that they are still focused on the learning process itself rather than on the assessment of learning outcomes.

These inputs are used to develop a procedure that awards a quality label to issuers of professional certification and learning providers, ensuring that they issue professional certifications and micro-credentials correctly.

[46] ISO/IEC 17024:2012 Conformity assessment — General requirements for bodies operating certification of persons. https://www.iso.org/standard/52993.html

In this case as well, to maximise impact, the recognition of a quality label for digital sustainability learning programmes should initially be established at the national level and then extended across Europe.

SO3 – Policy recommendations:

- **Develop a common European certification framework.**
  To maximise the impact of certificates and ensure effective skills portability across the EU, all Member States shall recognise and enforce the usage, including public tenders, of a common European certification framework. By implementing and reinforcing such a framework, the EU could streamline workforce mobility, making it easier for businesses to recruit talent while providing individuals with clear career pathways, and streamline hiring processes for companies and public administrations.

7.4 Raise awareness

Raising awareness is a crucial factor in fostering engagement and collaboration among key stakeholders, increasing recognition of digital sustainability challenges, and attracting the necessary support, resources, and expertise to drive meaningful change.

This strategic objective aims to ensure that stakeholders fully understand evolving labour market demands, professional skill requirements, and the opportunities available to bridge existing gaps effectively.

To achieve this, two key actions have been identified. The first focuses on sharing existing resources and best practices to address skill gaps in digital sustainability, enhancing awareness and facilitating meaningful knowledge exchange. The second involves organising targeted awareness-raising initiatives and campaigns to generate interest in digital sustainability topics and learning opportunities.

These initiatives will utilise a combination of communication strategies, engagement efforts and educational programmes to inspire action and support the development of a skilled workforce.

SO4 Raise awareness	
Actions	**Short-term milestones**
4.1 Establish pathways to share resources and best practices for digital sustainability challenges	Organise workshops or webinars to facilitate initial sharing of resources and encourage stakeholder collaboration
4.2 Organise awareness raising initiatives and campaigns to steer interest in digital sustainability topics and learning opportunities	Develop an awareness campaign strategy targeting key sectors and audiences
Stakeholders involved	
Policymakers, education and training providers, industry representatives	
Long-term milestones	
Achieve cross-border collaboration and long-term commitment from stakeholders on sharing digital sustainability solutions and knowledge	

Figure 11 - Strategic Objective 4: Actions and Milestones

7.4.1 Establish pathways to share resources and best practices for digital sustainability challenges

Establishing clear pathways for sharing resources and good practices is essential to effectively addressing skill gaps and challenges in digital sustainability.

- One of the primary activities that can support this goal is the **establishment of knowledge-sharing platforms**. These platforms can serve as centralised repositories where both organisations and individuals can upload and access valuable resources related to digital sustainability. This could include case studies, research papers, toolkits, and best practices that offer insight into effective strategies for tackling sustainability challenges in the digital sector. Such platforms would foster the exchange of ideas and allow stakeholders to build upon each other's experiences, ultimately driving progress towards common goals. By highlighting success stories, in particular, the platforms would provide concrete examples that others can learn from and replicate. Such platforms can also benefit from already that exist already and be developed as a one-stop-shop, focusing on a vast amplitude of all skills and resources in the areas of digital and sustainability skills (such as the EU Digital Skills and Jobs Platform).
- In addition to providing access to these resources, these platforms could host **collaborative forums** where stakeholders from various sectors such as technology, sustainability, academia, government can share challenges, discuss emerging technologies, and ideally collaborate on shaping the development of innovative solutions and ensuring that no sector is left behind in the quest for sustainability.
- To support organisations in evaluating and improving their digital sustainability practices, a comprehensive **resource toolkit** can be developed. This toolkit would provide guidance on assessing current practices, identifying areas for improvement, and implementing effective sustainability strategies. A key component of the toolkit would be self-assessment tools to help organisations evaluate their existing digital sustainability status and identify strengths, weaknesses, and potential areas for development, ensuring a structured approach to both digital and sustainability. In addition to self-assessment, the toolkit should include clear, actionable steps that organisations can follow to bridge sustainability gaps, enhance digital practices, and integrate sustainability into their operations and strategies. To facilitate implementation, the toolkit should also offer best practice templates, including checklists, policy frameworks, and case study examples that organisations can adapt to suit their specific needs.
- The promotion of **innovative** and **engaging approaches** to education and training is also essential, as these methods can enhance the quality of learning and attract individuals who may not be drawn to traditional knowledge transfer. Modern learning strategies shift the focus from the teacher or trainer to the learner, replacing passive instruction with interactive activities that encourage learners to build their own knowledge and develop skills and competences. This requires a shift in mindset, where educators take on a

coaching role, working collaboratively with learners rather than simply delivering information. Consequently, learning materials play a different and more dynamic role in this learner-centred approach. Traditionally, textbooks and slide decks have been the primary resources, but modern approaches call for a more diverse range of materials, including instructional videos, case-based assignments, guidelines for task execution, and educational games. These evolving needs must be considered in curriculum design.

- Case studies and other relevant materials could be featured on **websites, newsletters, and social media channels**, engaging all relevant stakeholders to highlight successful digital sustainability initiatives. Featuring these examples across various platforms ensures wide visibility and encourages collaboration, allowing stakeholders from different sectors to learn from each other and further advance digital sustainability efforts

By fostering these activities, a collaborative ecosystem can be created where resources, knowledge, and best practices are easily shared. This collaborative approach will not only help tackle the challenges of digital sustainability but will also accelerate the widespread adoption of solutions that contribute to a more sustainable and equitable digital future.

7.4.2 Organise awareness raising initiatives and campaigns to steer interest in digital sustainability topics and learning opportunities

Organising awareness-raising initiatives and campaigns is essential to stimulate interest in digital sustainability topics and highlight the learning opportunities available. These initiatives should target a wide audience, including all stakeholders, emphasising the importance of digital sustainability in today's economy.

- Hosting **webinars, workshops, other online events and the above-mentioned shared platforms** provide a valuable opportunity to share insights, discuss emerging trends, and present successful practices for addressing digital sustainability challenges. These events can be led by experts in the field, offering participants the chance to gain actionable knowledge on how to tackle challenges within their own organisations or sectors. Workshops can be tailored to specific industries such as energy, agriculture, or manufacturing, where digital sustainability practices require sector-specific solutions. By focusing on the unique challenges and opportunities within each sector, these sessions can provide more targeted guidance and practical strategies that align with industry needs. To enhance engagement and ensure that participants gain the most from these events, interactive discussions and Q&A sessions should be incorporated.
- Creating opportunities for **networking** further strengthens collaboration, enabling participants to build connections that can lead to long-term partnerships and shared

initiatives. **Roundtable discussions** and **panels** could be held, bringing together thought leaders from various sectors to share insights on integrating sustainability into digital innovation.

- In addition to these professional events, dedicated awareness-raising **initiatives and campaigns for learners** can help increase engagement with digital sustainability topics from an early stage. Education and training providers could introduce themed awareness weeks, interactive online challenges, and social media campaigns to promote the importance of digital sustainability skills. Competitions, hackathons, and gamified learning experiences can help learners develop innovative solutions to sustainability challenges, fostering both awareness and practical skills.

SO4 - Policy recommendations:

- **Develop accessible and centralised online Platforms offering modular trainings and learning materials related to digital sustainability skills.**

  Centralised platforms can play a crucial role in providing easy access to training materials, particularly in emerging areas such as digital sustainability. By consolidating resources in one place, these platforms, at both national and European levels, can ensure that individuals and organisations can efficiently access high-quality, up-to-date educational content. This approach not only enhances accessibility but also promotes consistency and coherence in the delivery of sustainability-focused digital skills, helping to equip a workforce ready to contribute to a more sustainable and digitally resilient future. Existing platforms can already be leveraged, particularly the Digital Skills and Jobs Platform, which collects and analyses data at the national level. To maximise its impact, the platform should be expanded to include dedicated resources for training and capacity-building. This enhancement would enable the platform to serve as a comprehensive hub for individuals, businesses, and policymakers, offering accessible learning opportunities that align with EU digital and sustainability goals.

7.5 Promote a supporting regulatory framework

A robust regulatory framework is essential for ensuring a structured and coordinated approach to integrating digital sustainability skills into education and training systems, fostering alignment among key stakeholders. A well-defined framework not only enhances coherence but also encourages long-term investment by establishing financial and regulatory mechanisms that support skills development. This includes dedicated funding programmes, public-private partnerships, and targeted incentives to help businesses upskill their workforce.

By setting a clear roadmap and advocating for strong financial and regulatory support, these efforts will build a resilient and future-proof skills ecosystem. This will equip individuals and organisations with the expertise needed to drive sustainable innovation and play a key role in Europe's transition towards a more sustainable and digitally advanced economy.

SO5 Promote a supporting regulatory framework	
Actions	**Short-term milestones**
5.1 Develop a roadmap for integrating digital sustainability skills into existing education policies and frameworks at national and European levels	Engage key policymakers, education providers, and industry representatives in consultations and workshops
5.2 Advocate for financial and regulatory frameworks supporting skills development for digital sustainability	Propose initial recommendations to policy makers
Stakeholders involved	
Policymakers, education and training providers, industry representatives	
Long-term milestones	
More EU and national policies focused on digital sustainability	

Figure 12 - Strategic Objective 5: Actions and Milestones

7.5.1 Develop a roadmap for integrating digital sustainability skills into existing education policies and frameworks at national and European levels.

To advance the actions described in this Skills Strategy, it is necessary to develop a roadmap for integrating digital sustainability skills into existing education policies and frameworks at both national and European levels. This roadmap should provide clear guidance on how digital sustainability competencies can be embedded into formal education and lifelong learning initiatives.

It should also include an assessment of existing policies to identify gaps and opportunities for enhancement, ensuring that sustainability-driven digital skills are recognised as fundamental to future workforce needs.

Defining key learning outcomes that align with technological advancements and sustainability goals will be a crucial step in this process. Collaboration between educational institutions, industry stakeholders, and policymakers must be encouraged to ensure that curricula remain relevant and adaptable to the evolving demands of the digital and green transition.

Additionally, a roadmap should outline specific implementation strategies that support education and training providers in incorporating digital sustainability skills into their programmes, ultimately ensuring a structured and harmonised approach across Europe. The development of a roadmap relies on the successful implementation of all other strategic objectives, as it represents the culmination of the actions and policy recommendations outlined within them.

7.5.2 Advocate for financial and regulatory frameworks supporting skills development for digital sustainability

Alongside the above-mentioned action, advocating for financial and regulatory frameworks to support skills development in digital sustainability is imperative.

Sustained investment is required to scale up efforts and make digital sustainability skills accessible to a wide range of learners. This can be achieved through dedicated funding programmes at both the European and national levels, enabling educational institutions, businesses, and training providers to develop and deliver high-quality courses in this field. Public-private partnerships should be actively promoted to facilitate collaboration between governments, industries, and academic institutions, ensuring that skills development initiatives are aligned with real-world needs. Furthermore, financial incentives, such as tax benefits or subsidies, should be introduced to encourage businesses to invest in upskilling their workforce in digital sustainability. Regulatory alignment is equally important, ensuring that digital sustainability skills are embedded within broader policies on education, employment, and environmental sustainability.

In this context, engagement with all stakeholders, particularly policymakers, becomes especially important to ensure that market needs are acknowledged and receive the necessary financial support.

7.6 Strengthen cooperation

Strengthening cooperation in the sector is essential to accelerate the development and adoption of digital sustainability skills. Collaboration between industry leaders, educational institutions, policymakers, and civil society fosters a more integrated approach to addressing skills gaps and aligning training programmes with real-world needs. By creating multi-stakeholder partnerships, organisations can share knowledge, resources, and best practices, ensuring that digital sustainability remains a strategic priority. Joint initiatives, such as industry-led training schemes, research collaborations, and knowledge-sharing platforms, can enhance the effectiveness of education and workforce development efforts. Additionally, fostering cross-sector cooperation at national and European levels ensures consistency in policy implementation and promotes the exchange of innovative solutions, ultimately driving a more sustainable and resilient digital economy.

SO6 Strengthen cooperation	
Actions	**Short-term milestones**
6.1 Build and maintain a community of digital sustainability stakeholders	Establish an initial network of key stakeholders
6.2 Facilitate collaboration between education and training providers and industry to develop, promote, and deliver digital sustainability training programmes	Identify and engage key industry partners and training providers
6.3 Encourage cross-border and cross-sectoral mobility	Facilitate cross-border exchange or internship programme
Stakeholders involved	
Organisations, education and training providers, policymakers, learners and potential learners	
Long-term milestones	
• Develop a knowledge hub that provides continuous updates on digital sustainability trends, policies, and skill development • Expand partnerships across different sectors in Europe • Facilitate mobility exchanges or cross-sector placements in Europe	

Figure 13 - Strategic Objective 6: Actions and Milestones

7.6.1 Build and maintain a community of digital sustainability stakeholders

As mentioned, raising awareness about digital sustainability is a fundamental pillar for the Skills Strategy, to ensure that all stakeholders recognise the importance of integrating sustainability into digital transformation efforts.

To achieve this main goal, it is essential to build and maintain a strong community including industry leaders, companies, policymakers, educators, and professionals. This network will facilitate the exchange of knowledge, best practices, and emerging trends, fostering a collaborative environment that drives skill development in sustainable digital solutions.

To achieve these objectives, several initiatives linked to all the strategic objectives can be implemented, including:

- Regularly **hosting discussions** with stakeholders representing the industry, education and training providers and public sectors to explore emerging trends, challenges, and best practices in digital sustainability.
- Encouraging collaboration among the identified stakeholders to further develop joint initiatives on digital sustainability skills is essential. In particular, fostering closer cooperation between learning providers and organisations will enable learners to gain real-life experiences that enhance their ability to achieve learning outcomes. These experiences can range from full internships to shorter, hands-on assignments lasting one or two days or even completing specific tasks within an organisation. The emphasis is on practical engagement, where learning is driven by experience rather than predefined instructional materials.
- Organising **events** that bring together stakeholders to discuss innovations, policies, and industry advancements.
- Running **targeted campaigns, newsletters, and educational webinars** to inform professionals about the importance of sustainability in digital transformation and inspire continuous learning.

Engagement with the **Digital LSP** [47] is important, with members having identified learning programmes as a crucial resource to support their activities and objectives. Notably, the Skills Strategy has been recognised as a significant output, with the potential to greatly benefit the Digital LSP community, uniting a broad spectrum of stakeholders[48] committed to equipping the European workforce with the digital skills essential for success in an increasingly interconnected economy.

[47] European Commission, Digital ecosystem and LSP(s) https://pact-for-skills.ec.europa.eu/about/industrial-ecosystems-and-partnerships/digital_en

[48] These include a wide range of entities, such as businesses of all sizes, higher education institutions, VET providers, academic organisations, employment agencies, social partners, public authorities, and umbrella organisations. It also encompasses local partnerships formed through programmes like Erasmus+ Blueprints and other EU-funded projects, as well as membership organisations and alliances focused on skills development.

7.6.2 Facilitate collaboration between education and training providers and industry to develop, promote, and deliver digital sustainability training programmes.

Strengthening collaboration between education and training providers and industry is crucial to developing, promoting, and delivering effective digital sustainability training programmes. By fostering partnerships, training initiatives can be aligned with real-world industry needs, ensuring that learners acquire relevant and practical skills. Industry involvement can provide valuable insights into emerging trends, technological advancements, and sector-specific sustainability challenges, allowing training providers to design targeted and up-to-date curricula. Moreover, businesses can play an active role by offering hands-on learning opportunities such as apprenticeships, mentorship schemes, and workplace training sessions. This cooperation not only enhances the quality and impact of training but also ensures a skilled workforce capable of driving sustainable digital transformation across various sectors.

7.6.3 Encourage cross-border and cross-sectoral mobility

Encouraging cross-border and cross-sectoral mobility is essential for fostering knowledge exchange, innovation, and skills development in digital sustainability. By enabling professionals, researchers, and learners to gain experience in different countries and industries, mobility initiatives can help bridge skill gaps, promote best practices, and facilitate the transfer of expertise across sectors. European funding programmes, such as Erasmus+ [49] and Horizon Europe[50], can play a key role in supporting mobility schemes, internships, and collaborative projects that enhance digital and sustainability skills.

Additionally, fostering partnerships between educational institutions, businesses, and policymakers can create more structured mobility pathways, ensuring that individuals gain practical, hands-on experience in diverse environments. Strengthening mobility opportunities will not only improve workforce adaptability but also accelerate the development and implementation of innovative digital sustainability solutions across Europe.

[49] European Commission, Erasmus+ EU programme for education, training, youth and sport. https://erasmus-plus.ec.europa.eu/

[50] European Commission, Horizon Europe, https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/horizon-europe_en

SO 6- Policy recommendations:

- **Encourage the development of EU-funded apprenticeship schemes for digital sustainability skills.**

  Encouraging the development of relevant apprenticeship programmes will provide hands-on training opportunities that bridge the gap between theoretical knowledge and practical industry needs. By collaborating with all relevant stakeholders, these apprenticeships can be tailored to emerging labour market demands, ensuring that learners acquire the necessary skills to contribute to EU policies and priorities. Moreover, fostering inclusivity within these initiatives will help expand access to sustainable digital careers, ensuring that a diverse workforce is equipped to drive innovation in a resource-efficient and environmentally responsible manner.

- **Promoting diversity and accessibility in digital sustainability careers through targeted educational policies.**

  It is essential that policies and action plans at both European and national levels actively encourage the inclusion of underrepresented groups in digital sustainability careers. By prioritising diversity and accessibility, these policies can help bridge the skills gap and create equal opportunities for all individuals, regardless of background. To achieve this, policies and financial incentives should support targeted educational initiatives, such as scholarships, apprenticeship programmes, and training schemes, that focus on promoting the participation of underrepresented groups in the digital and sustainability sectors. These measures will not only empower individuals from diverse backgrounds to pursue careers in digital sustainability but will also contribute to a more inclusive, innovative, and equitable workforce, driving progress towards a greener and more digitally resilient future.

- **Strengthening public-private-academic partnerships for digital sustainability skill development.**

  Strengthening Public-Private-Academic Partnerships is essential for addressing the growing demand for digital sustainability skills. One effective approach could be the establishment of Digital Sustainability Skill Alliances, potentially under the Pact for Skills initiative. These Alliances would bring together education and training providers, industry leaders, and policymakers to collaborate in co-creating training programmes that align with the needs of the labour market. By pooling expertise and resources, Alliances can ensure that training initiatives are relevant, up-to-date, and tailored to emerging challenges and market requests. This collaborative approach not only helps develop a

skilled workforce equipped with the knowledge and expertise needed to drive the green digital transition but also fosters long-term partnerships that can adapt to evolving industry demands. Through such partnerships, the public and private sectors can work together to create impactful learning opportunities and bridge the gap between education and employment in the digital sustainability field.

- **Establishment of skills networks for digital sustainability through regional and sector-specific collaboration.**

  Establishing Skills Networks focused on digital sustainability is crucial for fostering collaboration and knowledge-sharing across regions and sectors. By funding the creation of regional or sector-specific networks, it would be possible to facilitate the exchange of best practices, resources, and training materials, enabling stakeholders to learn from each other and adopt successful strategies. These networks can bring together different stakeholders, ensuring that training initiatives are tailored to the specific needs of communities and industries.

- **Include digital sustainability skills in the newly established European Skills Intelligence Observatory.**

  Creating a Skills Observatory for Digital Sustainability at the European level has been foreseen in the latest announcement of the Union of skills. However, it is also crucial to effectively monitor and forecast the demand for skills specifically related to digital sustainability. It would be desirable for the planned Observatory to harness data analytics and labour market trends provided by national institutions to identify emerging skill needs, track shifts in job requirements, and anticipate future workforce demands. By collecting and analysing this data, the Observatory would offer valuable insights to help policymakers, as well as education and training providers, align their efforts with evolving market trends. This proactive approach ensures that initiatives remain responsive to the latest developments, equipping individuals with the skills necessary to drive sustainable innovation and contribute to Europe's long-term digital and sustainability goals. Furthermore, it shall be considered to establish strategic partnerships with existing initiatives—such as the Geneva Internet Platform Digital Watch Observatory[51], the World Environment Situation Room, and the Coalition for Digital Environmental Sustainability (CODES)[52]—to extend the Observatory's outreach and enhance its impact.

[51] Geneva Internet Platform, https://dig.watch/topics/sustainable-development
[52] UNEP, Digitalization for Sustainability, https://www.unep.org/topics/digital-transformations/digitalization-sustainability

- **Leveraging the EDIH network to promote sustainable digital skills development.**

  Expanding partnerships under the European Digital Innovation Hubs (EDIHs) initiative to co-finance training programs that support businesses' skill development in sustainable practices is essential for fostering the green and digital transitions across the EU.

  By leveraging the EDIH network, stakeholders such as public authorities, industry leaders, and educational and training providers can collaborate to provide businesses with the necessary tools and knowledge to integrate sustainable practices into their operations. These partnerships can co-finance tailored training initiatives, focusing on areas such as energy efficiency, sustainable digital technologies, and green business strategies. This approach not only promotes the adoption of sustainable practices but also strengthens the digital capabilities of businesses, enabling them to remain competitive and aligned with EU sustainability goals. Through co-financed programs, EDIHs can enhance the reach and impact of these initiatives, ensuring that businesses can access the resources they need to thrive in a more sustainable digital economy.

  These suggestions could be taken into consideration and implemented as part of the next EDIHs' next funding period, starting in late 2025.

8. Conclusions

The conclusions are organised by highlighting the key elements of the six Strategic Objectives and actions that are part of this Skills Strategy.

Each section emphasises the most crucial aspects, focusing on the core goals and the specific actions necessary to achieve them. This approach ensures a clear understanding of the strategic framework, and the steps needed to drive its successful implementation.

- Skills and roles are the foundation of this Skills Strategy, serving as the bridge between digital expertise and sustainability knowledge. As digital technologies play an increasingly crucial role in addressing global sustainability challenges, ensuring that professionals possess the right competencies is essential. This Strategy has focused on **identifying, monitoring, and mapping both existing and emerging digital sustainability skills and roles** to meet evolving labour market needs.

  A key aspect of this effort is recognising the interplay between digital and sustainability-related skills. Digital sustainability professionals must possess a unique combination of expertise—technical proficiency in digital solutions, a strong understanding of sustainability principles, and sector-specific knowledge.

  However, the dynamic nature of both digitalisation and sustainability requires continuous monitoring. As new technologies emerge and policy frameworks evolve, the demand for specific skills and roles will also change. Regular consultations with industry experts, stakeholders, and educational institutions will be crucial to ensuring that this strategy remains aligned with future market needs. The current landscape of training and education offerings presents both opportunities and challenges. While some programmes address digital sustainability, many focus primarily on either digital skills or sustainability knowledge, with limited integration of both fields. This gap highlights the need for targeted upskilling and reskilling efforts, particularly to develop "M-shaped" and "comb-shaped" professionals, those who combine expertise in digital technologies, sustainability and sector-specific applications.

  To address these challenges, the Strategy emphasises the importance of **mapping existing training opportunities**, **assessing skill gaps** and **fostering collaboration between educational institutions, industry, and policymakers**. This will not only ensure that professionals are equipped with relevant competencies but also support long-term sustainability in workforce development.

- **Maintaining educational profiles for digital sustainability roles** is essential to translating evolving market demands into effective learning programmes. The structured use of educational profiles ensures alignment between occupational needs and curriculum design, providing a clear framework for training professionals at different levels of expertise. Regular updates to these profiles are crucial to keeping pace with changes in role complexity, technologies and industry standards.

  To meet the diverse needs of learners, flexible curricula must be developed for initial education, upskilling, and reskilling. These curricula should support personalised learning pathways, allowing professionals to acquire relevant skills efficiently. Modularity plays a key role in this adaptability, enabling learners to engage with discrete learning units that lead to recognised credentials.
- Additionally, **maintaining and continuously updating learning resources** is vital for ensuring the relevance and accessibility of training. Collaboration among stakeholders, including education providers, industry experts, and policymakers, facilitates the timely revision of learning materials, keeping educational offerings aligned with the rapidly evolving landscape of digital sustainability. By embracing these strategies, digital sustainability education can remain responsive, inclusive, and effective in developing the skilled workforce needed for a sustainable digital future**.** It is essential to **validate learning** to ensure professionals remain up-to-date and can effectively showcase their competencies and skills. This process encourages the mobility of professionals, enhances the credibility of the digital sustainability field, and supports lifelong learning. Additionally, it is important for learning providers to deliver high-quality programmes, allowing learners to trust that a programme will lead to the desired learning outcomes.
- **Raising awareness** is essential for driving engagement and collaboration among key stakeholders, highlighting digital sustainability challenges, and attracting the necessary resources and expertise to create meaningful change. It is crucial to ensure stakeholders understand evolving labour market demands, skill requirements, and the opportunities available to bridge existing gaps effectively.
- A **robust regulatory framework** is crucial for integrating digital sustainability skills into education and training systems, ensuring coordination among key stakeholders. It promotes long-term investment by establishing financial and regulatory mechanisms, including funding programmes, public-private partnerships, and incentives for businesses to upskill their workforce. By developing a clear roadmap and advocating for strong financial support, these efforts can create a resilient skills ecosystem, equipping

individuals and organisations to drive sustainable innovation and contribute to Europe's transition to a digitally advanced and sustainable economy.

- **Strengthening cooperation** across sectors is key to accelerating the development of digital sustainability skills. Collaboration between industry leaders, educational institutions, policymakers, and civil society ensures that training programmes address skills gaps and align with real-world needs. Multi-stakeholder partnerships and joint initiatives, such as training schemes and research collaborations, enhance workforce development efforts.

9. Glossary

Term	Definition/ Description
Accreditation of an education or training programme	Process of quality assurance through which a programme of education or training is officially recognised and approved by the relevant legislative or professional authorities following assessment against predetermined standards. *(Cedefop, 2024)*
Accreditation of an education or training provider	Process of quality assurance through which an education or training provider is officially recognised and approved by the relevant legislative or professional authorities following assessment against predetermined standards. *(Cedefop, 2024)*
Assessment (of learning outcomes)	Process of appraising knowledge, know-how, information, values, skills and competences – acquired in formal, non-formal or informal settings – against relevant standards (learning outcomes, validation) . Assessment of learning outcomes typically leads to certification. *(Cedefop, 2024)*
Bachelor's degree EQF level 6	Qualification awarded after successful completion of the first cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a minimum of 180 and a maximum of 240 ECTS. *(European Consortium for Accreditation, 2021)*
Certification (of learning outcomes)	Process of issuing a certificate, diploma or title formally attesting that a set of learning outcomes (knowledge, knowhow, information, values, skills and/or competences) acquired by an individual have been assessed by a competent body against a predefined standard. Certification may validate the outcomes of learning acquired in formal, non-formal or informal settings. *(Cedefop, 2024)*
Comb-shaped professionals	Professionals who have a depth of knowledge and skills in many specific domains of expertise or fields (all the vertical bars of the comb-shape) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the comb-shape). This allows them to cross-collaborate and effectively leverage someone else's expertise in that area. *(Adapted from Friedlein, 2013; Grupman, J., 2021)*
Competence	Demonstrated ability to apply knowledge, skills, and attitudes for achieving observable results. *(CEN/TC 428, EN 16234-1 (2019)*
Curriculum	Inventory of activities related to the design, organisation and planning of an education or training action, including definition of learning objectives, content of programmes, methods (including assessment of learners and evaluation of programmes) and material, as well as arrangements for training teachers and trainers. The term 'curriculum' refers to the design, organisation and planning of learning activities; the term 'programme' refers to the implementation ofthese activities. *(Cedefop, 2024)*
Digital badge	Validated graphical visualisation of a learning experience – e.g. participation in a course, seminar or workshop, or acquisition of knowledge, skills and competences – with or without certification. Digital badges are issued in a variety of formal or nonformal settings. *(Cedefop, 2024)*
Digital credential	In education and training, electronic, secured and verifiable statement issued by a competent authority (education or training provider, awarding body, professional organisation) describing a learning action. *(Cedefop, 2024)*
Digital sector	Combination of manufacturing and service industries whose primary purpose is to both create and sell digital technology products, services or solutions. *(CODES, 2022)*
Digital sustainability	The design, development, deployment and regulation of digital technologies to secure sustainable economic, environmental and social development. In the CODES Action Plan, this refers to an overarching aim, embodying all three shifts of the Action Plan. *(CODES, 2022)*

Digital sustainability roles	The roles in an organisation that require substantial digital sustainability skills, meaning these skills are central to the job. These are people with at least partial responsibility for digital innovation that seeks to proactively enable, accelerate and scale environmentally and socially sustainable development: digitalisation for sustainability. *(D4S Consortium, 2024; based on CODES, 2022)*
Digital sustainability skills	Skills related to designing, developing, deploying and regulating digital technologies to secure sustainable economic, environmental and social development. *(D4S Consortium, 2024; based on CODES, 2022)*
Digital transformation	Systems-level economic, societal and environmental transformations triggered as a result of digitalisation. *(CODES, 2022)*
Digitalisation	Use of digital technologies to turn products and services into a digital format to drive efficiency and innovation. *(CODES, 2022)*
Digitalisation for sustainability	Digital innovation that seeks to proactively enable, accelerate and scale environmentally and socially sustainable development. In the CODES Action Plan, this refers to shift three and the six related strategic priorities. *(CODES, 2022)*
Doctorate degree	Qualification awarded after successful completion of the third cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires three to four years of study, mostly as a period of research. *(European Consortium for Accreditation, 2021)*
e-Competence Framework (e-CF)	Standard established as a tool to support mutual understanding and provide transparency of language through the articulation of competences, skills, knowledge and proficiency levels as required and deployed by Information and Communication Technology (ICT) professionals. *(CEN/TC 428, EN 16234, 2019)*
Educational credential	Documented statement that acknowledges a person's learning outcomes. *(European Micro-Credential Terminology, 2022)*
Educational profile	Structure that enables a competence-oriented learning programme design and development, thus providing a link between competences needed in a professional environment and learning outcomes of education and training. It assists planning education and professional accomplishment at individual and institutional levels. *(CEN/TC 428, TS 17699, 2021)*
E-shaped professionals	Professionals with deep expertise in a specific field, combined with broad knowledge across multiple areas, which enables them to collaborate across disciplines with experts in other areas. Besides expertise and experience these professionals also possess knowledge and skills related to the tangible (execution) and intangible (exploration), implying having both a big-picture outlook and an attention to detail from being a practitioner. *(Adapted from DaVanzo, 2010)*
European Qualification Framework (EQF)	Overarching framework that makes transparent the relationship between European national (higher) education frameworks of qualifications and the qualifications they contain. It is an articulation mechanism between national frameworks. *(Bologna Working Group on Qualifications Frameworks, 2005)*
European Skills, Competences, Qualifications and Occupations (ESCO)	The multilingual ESCO classification identifies and categorises skills, competences, qualifications, and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. *(ESCO, 2022)*
Formal education	Education that is institutionalised, intentional and planned through public organizations and recognised private bodies [...] Formal education programmes are thus recognised as such by the relevant national education or equivalent authorities Institutionalised education occurs when an organization provides

	structured educational arrangements, such as student-teacher relationships and/or interactions, that are specially designed for education and learning. […] Formal education consists mostly of initial education. Vocational education, special needs education and some parts of adult education are often recognised as being part of the formal education system. […] Programmes that take place partly in the workplace may also be considered formal education if they lead to a qualification that is recognised by national education authorities (or equivalent). These programmes are often provided in cooperation between educational institutions and employers (e.g. apprenticeships). (UNESCO, 2011)
Formal learning	Acquisition of knowledge, know-how, information, values, skills and competences in an organised and structured environment in terms of learning objectives, time or resources (e.g. an education or training institution or a company). Formal learning is intentional from the learner's point of view. It typically leads to certification. *(Cedefop, 2024)*
Formal recognition (of learning outcomes)	Process of granting official status to learning outcomes knowledge, skills and competences either through: • validation of non-formal and informal learning; • grant of equivalence, credit units or waivers; • award of qualifications (certificates, diploma or titles). *(Cedefop, 2014)*
Higher or upper VET	Composed of: a) post-secondary level VET, offered outside higher education; b) higher-level continuing VET (CVET) offered within or outside the formal education system (usually after entry into working life); qualification here often gives access to nationally recognised qualifications but the target is adult learners; qualifications are often based on professional experience and examinations (competence tests); c) higher-level CVET provided outside the formal education system (by adult education centres, public employment services or private companies), which do not fall into the above categories. Higher VET relates to EQF levels 5 to 8. *(Cedefop, 2019)*
ICT Professional Role Profiles	A generic set of typical roles performed by ICT Professionals in any organisation, covering the full range of ICT business processes, and using the European e-Competence Framework (e-CF) as the basis for competence identification. The 30 ICT Profiles give a sound basis and starting point for any organisation to develop more context-specific ICT profiles according to specific needs. The profiles can be used from multiple perspectives and for a broad range of purposes. These include HR planning, recruitment, digital transformation process support, curriculum design and qualification promotion. *(CWA 16458 ICT Profiles, 2018)*
ICT sector	Combination of manufacturing and services industries whose products primarily fulfil or enable the function of information processing and communication by electronic means, including transmission and display. *(OECD, 2022)*
Informal learning	Acquisition of knowledge, know-how, information, values, skills and competences in the framework of daily activities – work, family or leisure – which are not explicitly designated as learning activities in terms of objectives, time or learning support. Informal learning may be unintentional from the learner's perspective; its outcomes may be validated and certified. *(Cedefop, 2024)*
Information and Communication Technology (ICT)	Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. *(UNESCO, 2009)*. From a technical point of view ICT relates to digital computers/ devices and internet (communication) systems, including software, hardware and networks. From an economic and political standpoint, ICT relates to a cross sector of enterprises, including manufacturers, product suppliers or service providers relating to the ICT field. *(EN16234-1 e-CF)*

Initial education	Formal education of individuals before their first entrance to the labour market, i.e., when they will normally be in full-time education. It thus targets individuals who are regarded as children, youth, and young adults by the society to which they belong. It is typically provided by educational institutions in a continuous educational pathway. *(UNESCO, 2012)*
Job profile	A context-specific and detailed description of what an employee does to assure that the job holder has no doubts about their tasks, duties, responsibilities and often those to whom they report. It usually contains precise information about the competences, skills and knowledge required and practical information about health and safety and remuneration. *(ECSF, 2022 / CEN CWA16458, 2018)*
Knowledge	Theoretical or practical understanding and awareness of phenomena such as facts, terminology, concepts, models, or theories that are related to a field of work or study. Knowledge is the outcome of the assimilation of information through learning and is theoretical and/or factual. *(CEN/TC 428 EN 17748-1, 2022; Council of the European Union, 2017)*
Learning	Process by which an individual assimilates information, ideas and values and thus acquires knowledge, know-how, skills and competences. Learning occurs through personal reflection, reconstruction and social interaction. It may take place in formal, non-formal or informal settings. *(Cedefop, 2024)*
Learning environment	Any environment that allows a person to learn in providing certain conditions or procedures to do so; this can be an educational institute, a training facility or a workplace, as well as a face-to-face, hybrid or a virtual environment. *(CEN/TC 428, TS 17699, 2022)*
Learning outcome	Statements of what a learner knows, understands and is able to do on completion of learning process, which are defined in terms of knowledge, skills and competence. *(Cedefop, 2014)*
Learning programme	Inventory of activities, content and/or methods implemented to education or training achieve education or training objectives (acquiring knowledge, skills and/or competences), organised in a logical sequence over a specified period of time. *(Cedefop, 2014)*
Learning path	Specific route that reflects a person's subsequent learning activities undertaken in a specific learning environment throughout their life, career or study. *(CEN/TC 428, TS 17699, 2022)*
Lifelong learning	All learning activity undertaken throughout life, with the aim of improving knowledge, skills/competences and/or qualifications for personal, social and/or professional reasons. *(Cedefop, 2014)*
Master's degree	Qualification awarded after successful completion of the second cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a minimum of 90 ECTS, of which at least 60 ECTS at master's level. (European Consortium for Accreditation, 2021)
Micro-credential	The record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity. *(Council of the European Union, 2022)*
Modular programmes	Programmes that are composed of small discrete modules or learning units that are virtually self-contained, independent, non-sequential, and typically short in duration. Modular programmes allow

	students to compose the content of their education in a flexible way by combining different courses or modules. *(French, 2015; UNESCO, 2011)*
M-shaped professionals	Professionals who have a depth of knowledge and skills in three specific domains of expertise or fields (the vertical bars of the M) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the M-shape). This allows them to cross-collaborate and effectively leverage someone else's expertise in that area. *(Adapted from Friedlein, 2013; Grupman, J., 2021)*
Non-formal education	Education that is institutionalised, intentional and planned by an education provider. [...] It is an addition, alternative and/or complement to formal education within the process of lifelong learning of individuals. [...] It caters to people of all ages but does not necessarily apply a continuous pathway structure; it may be short in duration and/or low-intensity; and it is typically provided in the form of short courses, workshops or seminars. Non-formal education mostly leads to qualifications that are not recognised as formal or equivalent to formal qualifications by the relevant national or sub-national education authorities or to no qualifications at all. Nevertheless, formal, recognised qualifications may be obtained through exclusive participation in specific non-formal education programmes; this often happens when the non-formal programme completes the competences obtained in another context. *(UNESCO, 2011)*
Non-formal learning	Learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contain an important learning element. Non-formal learning is intentional from the learner's point of view. It typically does not lead to certification. *(Cedefop, 2014)*
Professional development	Any action of education or training undertaken by an individual after entering working life, to update her/his skills and qualifications – or acquire new ones –, improve their performance and career progress. Professional development: • encompasses job-related and generic skills and competences (team or time management, negotiation skills, conflict management, communication, etc.); • may take the form of self-directed learning, formal training, certifications, consultation, conferences, coaching or mentoring, communities of practice and technical assistance. *(Cedefop, 2014)*
Proficiency level	Level indicating the degree of mastery that allows an ICT professional to meet requirements in the performance of a competence; proficiency levels in the e-CF are characterised by a combination of levels of influence within a community, context complexity, autonomy, and typical behaviour expressed by examples of action verbs; this standard incorporates proficiency levels e-1 through to e-5. *(EN16234-1 e-CF, 2019)*
Qualification	An official record (certificate, diploma) of achievement which recognises successful completion of education or training, or satisfactory performance in a test or examination; and/or the requirements for an individual to enter, or progress within an occupation. *(UNESCO, 1984)*
Qualification system	All activities related to the recognition of learning outcomes and other mechanisms that link education and training to the labour market and civil society. These activities include: • definition of qualification policy, training design and implementation, institutional arrangements, funding, quality assurance; • assessment and certification of learning outcomes. Comment: a national qualifications system may be composed of several subsystems and may include a national qualifications framework. *(Cedefop, 2014)*

Reskilling	Training enabling individuals to acquire new skills and knowledge giving access either to a new occupation or to new professional activities. *(Cedefop, 2014)*
Role Profile	An outline or general document that demonstrates the relationship between specific activities or tasks in a role and the individual skills, competences and knowledge required to undertake them. Unlike a particular job, a role derives from an organisational need to do something. Assigned employees can meet organisational requirements by carrying out all or part of the tasks required to ensure their role. *(ENISA, 2022 / CEN CWA16458 2018)*
Short cycle tertiary education	Programmes at this level are often designed to provide participants with professional knowledge, skills, and competences. Typically, they are practically based, occupational-specific and prepare students to enter the labour market. However, these programmes may also provide a pathway to other tertiary education. programmes. Short cycle tertiary education relates to EQF level 5 and ISCED level 5. *(UNESCO, 2011)*.
Skilling	Training enabling individuals to acquire new skills and knowledge giving access either to an occupation or to professional activities. *(Cedefop, 2014)*.
Skills	Ability to apply knowledge and use know-how to complete tasks and solve problems. Skills can be cognitive (involving the use of logical, intuitive, and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). *(Council of the European Union, 2017)*
Skill gap	Situation where an individual does not have the kind and/or level of skills required to perform their job adequately. *(Cedefop, 2014)*.
Skill mismatch	Situation of imbalance in which the level or type of skills available does not correspond to labour market needs. *(Cedefop, 2014)*.
Skill needs	Demand for particular types of knowledge and skills on the labour market (total demand within a country or region, economic sector, etc.). *(Cedefop, 2014)*.
Skill shortage	Situation where skills supply (type of abilities and number of people available on the labour market) is not sufficient to meet labour market demand. *(Cedefop, 2014)*.
Soft skills	Patterns of thought, feelings and behaviours that are socially determined and can be developed throughout the lifetime to produce value. These are cross-cutting skills across jobs roles and sectors that relate to personal competences (confidence, discipline, self-management) and social competences (teamwork, communication, emotional intelligence). *(Borghans, 2008; Dall'Amico, E. & Verona, S., 2015)*
Software	Computer programs, procedures, and possibly associated documentation and data pertaining to the operation of a computer system *(IEEE 828, 2012)*.
Sustainability	Meeting the needs of the present whilst ensuring future generations can meet their own needs. It has three pillars: economic, environmental and social. To achieve sustainable development, policies in these three areas have to work together and support each other. *(European Commission, 2024; based on UN, 1987)*.
Sustainability competence	Empowers learners to embody sustainability values, and embrace complex systems, in order to take or request action that restores and maintains ecosystem health and enhances justice, generating visions for sustainable futures. *(Bianchi e.a., 2022)*.

Sustainability education	Education that aims to provide learners with sustainability competences in order to reflect and embrace sustainability in their daily lives as students, consumers, producers, professionals, activists, policymakers, neighbours, employees, teachers and trainers, organisations, communities, and society at large. *(Bianchi e.a., 2022)*.
Sustainable Development Goals	The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The Goals were adopted by all United Nations Member States in September 2015 as part of the 2030 Agenda for Sustainable Development which sets out a 15-year plan to achieve the Goals and their related targets. (UN, 2015)
Sustainable digitalisation	Digital infrastructures, software and applications that are socially responsible, ethical and environmentally sustainable throughout their life cycle. In the CODES Action Plan, this refers to shift three and the six related strategic priorities. (CODES, 2022)
T-shaped professionals	Professionals who have a depth of knowledge and skills in a specific domain or field (the vertical bar on the letter T) and also have broad knowledge and skills across multiple fields or disciplines (the horizontal bar on the letter T), which enables them to collaborate across disciplines with experts in other areas. *(Adapted from Gardner, 2017; Brown, 2009)*.
Tertiary education	Third level education that encompasses bachelor, master's and doctorates or equivalents. Vocationally-oriented education and training at tertiary qualifications level means education and training that can contain aspects of both academic and vocational areas typically with the majority of vocational aspects (e.g., Universities of applied sciences, Polytechnic institutes). It is usually located at levels equivalent to EQF levels 6 to 8 and ISCED levels 6 to 8. *(Cedefop, 2011)*
Transversal skills and competences	Learned and proven abilities which are commonly seen as necessary or valuable for effective action in virtually any kind of work, learning or life activity. They are "transversal" because they are not exclusively related to any particular context (job, occupation, academic discipline, civic or community engagement, occupational sector, group of occupational sectors, etc.). *(ESCO/EQF expert group., 2021)*
Upper-secondary education	Encompasses educational institutions that focus on general or vocational education. Programmes at this level are typically designed to complete secondary education in preparation for tertiary education, or to provide skills relevant to employment, or both. Pupils enter this level typically between ages 14 and 16. Upper secondary education relates to EQF levels 3 to 5 and ISCED level 3. *(Cedefop, 2014;2020)*.
Upskilling	Short-term targeted training typically provided following initial education or training, and aimed at supplementing, improving or updating knowledge, skills and/or competences acquired during previous training. *(Cedefop, 2014)*
Validation (of learning outcomes)	Confirmation by a competent body that learning outcomes (knowledge, skills and/or competences) acquired by an individual in a formal, non-formal or informal setting have been assessed against predefined criteria and are compliant with the requirements of a validation standard. Validation typically leads to certification. *(Cedefop, 2014)*.
Vocational Education and Training (VET)	Education and training which aims to equip people with knowledge, know-hows, skills and/or competences required in particular occupations or more broadly on the labour market. Vocational Education and Training covers upper-secondary, post-secondary, non-tertiary, and tertiary levels of education. *(Cedefop, 2008; Erasmus+ Programme Guide, 2019)*.
Work-based learning	Learning that takes place through some combination of observing, undertaking, and reflecting on productive work in real workplaces. It may be paid or unpaid and includes a diversity of arrangements

	like apprenticeships, dual programmes, traineeships, internships, job shadowing, and other work placements used as part of school-based VET programmes. *(OECD, 2016; UNESCO, 2015)*.
π-shaped professionals	Professionals who have a depth of knowledge and skills in two specific domains or fields (the two vertical bars of the π-shape) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the π-shape), which enables them to bridge the gap between the two domains or fields and also to collaborate with experts in other areas. *(Adapted from Friedlein, 2013)*.

10. Annexes

10.1 A. Methodology for the Skills Strategy Development

The development of the Skills Strategy followed a collaborative and structured approach, engaging a wide range of stakeholders to ensure its relevance and effectiveness.

The process began with a thorough Skills Needs Analysis, which served as the foundation for defining the Strategy. Through this Analysis, key gaps and emerging trends were identified, allowing for the development of a clear mission, vision, and strategic objectives. These elements were shaped through a collaborative process bringing together consortium members to ensure that the Skills Strategy is both relevant and adaptable to the needs of all involved.

To do so, the development of the Strategy involved the engagement of the consortium members through two co-creation workshops.

Consortium members were also consulted at different stages of the development and drafting of the Strategy.

Considering its pivotal role, also the Advisory Board in was involved by offering feedback and input on the Skills Strategy.

The European Digital Sustainability Skills Strategy aims to support the Digital Large-scale Partnership (Digital LSP) ecosystem under the Pact for Skills (PfS) in achieving its objectives.

The Skills Strategy serves as a blueprint to guide Digital LSPs members in developing their own approaches to equipping the workforce with the skills needed at the intersection of digital technology and sustainability, ensuring the sector has professionals capable of leveraging digital technologies for the benefit of the environment, economy, and society, while also driving digital innovation. To ensure the strategy was aligned with the ecosystem's needs and could contribute to its overarching goals, the Digital LSP community was actively involved throughout its development.

Furthermore, to ensure the successful implementation of the Skills Strategy, efforts were focused on identifying and monitoring relevant policies and regulations to pinpoint potential enablers and obstacles. This approach aimed to create a supportive environment, ensuring that the Skills Strategy could be effectively applied and adapted across various contexts.

10.2 B. Review process

The Monitoring, evaluation, and continuous improvement process is a crucial element of any Sectoral Skills Strategy, ensuring its relevance, effectiveness, and adaptability over time. This process involves the tracking of the Skills Strategy's implementation, assessing the progress towards its objectives, and identifying areas for improvement. It will be also fundamental to the annual update of the Skills Strategy, ensuring that it remains relevant and responsive to changing needs while maintaining its effectiveness in addressing both current and future challenges.

This approach will allow for timely adjustments and improvements, ensuring that the Skills Strategy is continuously responsive to the changing context and requirements.

The monitoring process will focus on several key aspects to ensure the Strategy remains relevant, actionable, and aligned with the evolving needs of the target groups. A primary focus will be on assessing the demand for and supply of skills in the labour market and ensuring that learning programmes reflect market requirements. This will include continuous analysis of skill profiles, learning outcomes, and the overall relevance of training initiatives in response to technological advancements and market updates.

External dependencies, such as legislative changes and shifts in the frameworks within the European landscape, will be closely monitored to ensure alignment with evolving policies. Additionally, the Strategy's accessibility and usability for external stakeholders, beyond the project consortium, will be evaluated, with particular emphasis on fostering industry engagement and collaboration.

Evaluation will focus on periodic assessments to be performed with relevant stakeholders to determine the overall status of the Skills Strategy. This can involve both qualitative and quantitative analysis, looking at the extent to which strategic objectives have been achieved and identifying lessons learned. Through this evaluation process, the Skills Strategy can be adjusted, ensuring it remains aligned with evolving market needs. The insights gained will contribute to the annual update, allowing the Skills Strategy to adapt to emerging trends, new technologies, and changing labour market demands. This iterative process will be driven by stakeholder feedback, ensuring that the Strategy remains relevant, responsive, and effective in addressing the evolving landscape of digital sustainability skills.

Ensuring the long-term sustainability of the Strategy will be a priority as well, achieved by building collaborations with stakeholders. Moreover, strategies for raising awareness and improving engagement will be further developed, creating a dynamic and responsive framework for continuous improvement.

10.3 C. Digital Sustainability Role Profiles

1	**MANAGEMENT & CONSULTANCY**
1a	**Digital Sustainability Lead**
	Defines and implements a digital sustainability strategy, policy, and governance across the organisation. Provides leadership for the implementation and development of sustainability by the organisation's architecture and applications.
	Alternative names: ICT/ IT Sustainability Lead, Digital Sustainability General Manager, ICT/ IT Sustainability General Manager
1b	**Digital Sustainability Manager**
	Proposes, plans and manages the functional development of the information system, focusing upon sustainability. Ensures the continuous enhancement of sustainability by ICT.
	Alternative name: ICT/IT Sustainability Manager
1c	**Digital Sustainability Consultant**
	Advises organisations on their digital sustainability strategy and its implementation of applying digital technologies to reach sustainability goals and add value to a business in the most effective and efficient manner.
	Alternative names: Digital Sustainability Advisor, ICT/ IT Sustainability Advisor, ICT/ IT Sustainability Consultant, ICT/IT sustainability systems consultant
2	**DATA PROCESSING & ANALYSIS**
2a	**Sustainability Business Analyst**
	Analyses an organisation's processes and systems and optimises business performance with regard to sustainability through technology application. Provides possible ICT solutions compliant with the digital sustainability strategy.
	Alternative names: ICT/ IT Business Analyst Sustainability, Business Analyst Sustainability
2b	**Sustainability Data Scientist**
	Delivers insights from data by optimising the analytics process focusing on sustainability. Creates, identifies, selects and optimises the mathematical models, the algorithms and predictive models to deliver insights in sustainability aspects, applying advanced programming techniques.
2c	**Sustainability Data Analyst**
	Imports, inspects, cleans, transforms, validates, models and analyses collections of data with regard to sustainability. Ensures that the data sources and repositories provide consistent and reliable data. Prepares sustainability dashboards and management reports.
2d	**Sustainability Data Engineer**
	Builds and maintains systems that collect, manage, and convert raw data into usable information regarding sustainability for data scientists and analysts to interpret.

3	DEVELOPMENT & OPERATIONS
3a	**Sustainability Solution Designer**
	Proposes and designs solutions that support sustainability in line with technical architecture which fit business requirements and support change.
3b	**Software Developer for Sustainability**
	Designs and/ or codes components to meet sustainability specifications. Builds and implements ICT applications and components that support sustainability.
	Alternative name: Software Engineer in Sustainability
3c	**Sustainability Technical Specialist**
	Installs, maintains and repairs hardware, software and service applications that support sustainability. *Alternative name: Digital Sustainability Technician*

The Digital Sustainability Role Profiles are based on CEN Workshop Agreement - **CWA 16458 "European ICT professional role profiles - Part 1: 30 ICT profiles"**[53](2018). This document presents 30 ICT professional role profiles that provide a generic set of typical roles performed by ICT professionals in any organisation, covering the full ICT business process.

These profiles are a flexible tool for ICT professional development and profile construction. The role profiles were built as a foundation and inspiration, from an organisational viewpoint, for the flexible creation of more context-specific profiles in a broad variety of areas.

The Digital Sustainability Role Profiles are such a specific set of ICT profiles, so called "generation 3" profiles.

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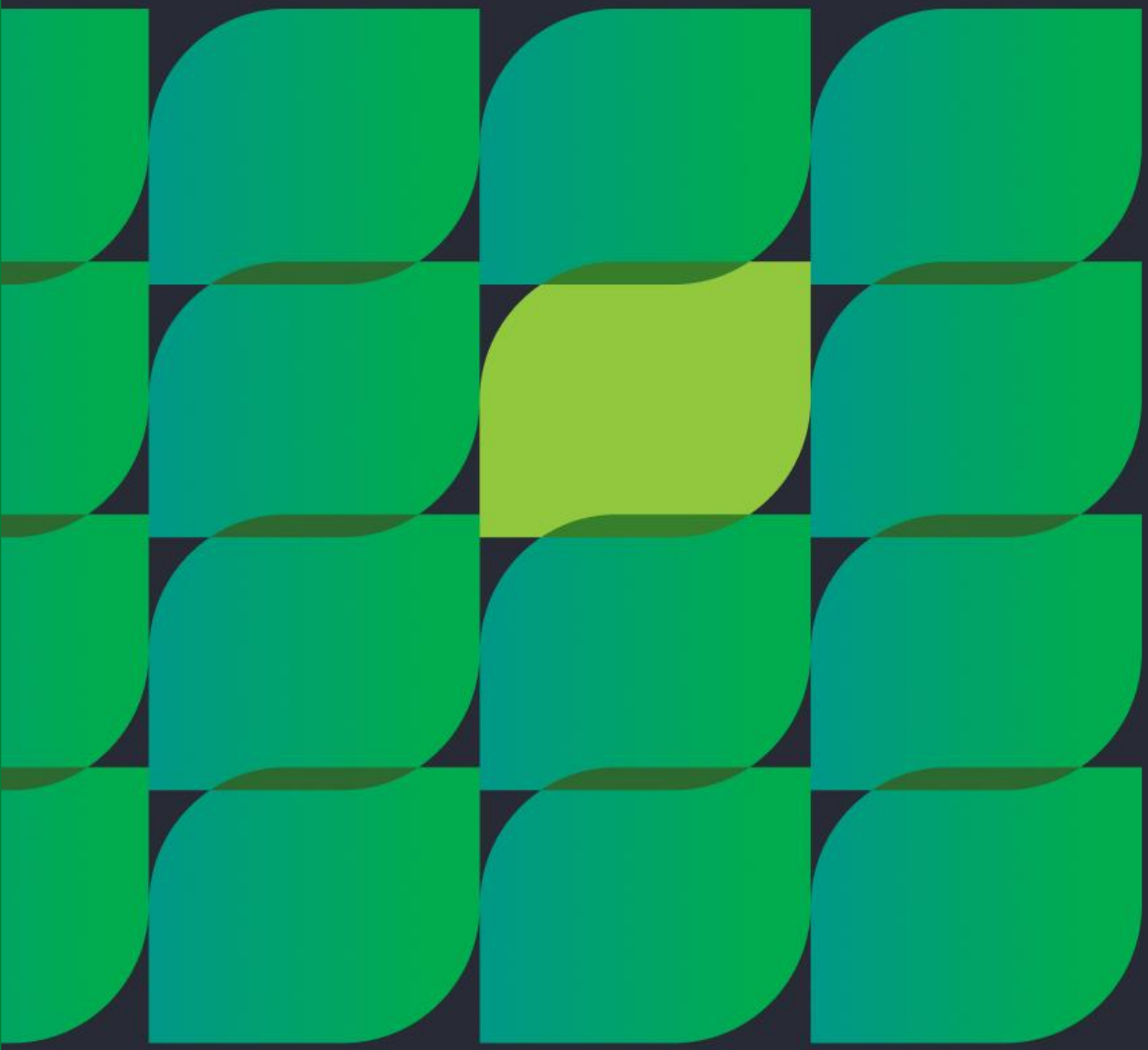

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