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Twin Skills for the Twin Transition

DEFINING GREEN DIGITAL SKILLS AND JOBS

eit Digital

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TECH 4ALL

Seeds For The Future

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Contents

List of Abbreviations

Abbreviation	Description
AI	Artificial Intelligence
CBAM	Carbon Border Adjustment Mechanism
CEPR	Centre for Economic Policy Research
CEAP	Circular Economy Action Plan
CSRD	Corporate Sustainability Reporting Directive
CSDD	Corporate Sustainability Due Diligence Directive
CRM Act	Critical Raw Materials Act
CFRIDiL	Common Framework of Reference for Intercultural Digital Literacies
DESI	Digital Economy and Society Index
ETS	Emissions Trading System
EU	European Union
EGDC	European Green Digital Coalition
ESCO	European Skills, Competences, Qualifications and Occupations classification
HR	Human Resources
IRENA	International Renewable Energy Agency
IT	Information Technology
ICT	Information and Communication Technology
PRF	Recovery and Resilience Facility
R&D	Research and development
SMEs	Small and medium-sized enterprises
STEM	Science, technology, engineering, and mathematics

List of Definitions

Twin Transition	The approach that intertwines the green transition (sustainable and environmentally friendly economy) and digital transition (adoption and integration of digital technologies and innovations) and consider them equally important for the future of societies.
Green skills	The European Centre for the Development of Vocational Training (Cedefop) defines green skills as "the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society". Green skills are those skills needed to reduce environmental impacts and support economic restructuring with the purpose of attaining cleaner, more climate-resilient and efficient economies that preserve environmental sustainability and provide decent work conditions.
Green jobs	Green jobs can be defined as those impacting the environment in a positive way. Specifically, but not exclusively, this includes jobs that help to protect and restore ecosystems and biodiversity; reduce energy, materials, and water consumption through high-efficiency and avoidance strategies; decarbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution (UNEP, 2008).
Brown jobs	Brown jobs concern highly polluting activities, for example mining, manufacturing, agriculture.
White jobs	White jobs are the ones that are relatively neutral in their environmental impact.
Digital skills	Digital skills are defined as a range of abilities to use digital devices, communication applications, and networks to access and manage information. They enable people to create and share digital content, communicate, collaborate, and solve problems for effective and creative learning, work, and social activities at large (UNESCO, 2018). Entry-level digital skills, meaning basic functional skills required to make basic use of digital devices and online applications, are widely considered a critical component of a new set of literacy skills in the digital era, with traditional reading, writing, and numeracy skills. At the advanced spectrum of digital skills are the higher-level abilities that allow users to make use of digital technologies in empowering and transformative ways e.g., by using artificial intelligence (AI), machine learning, and big data analytics.
Underskilling	To lack the skills and abilities necessary to perform the current job to acceptable standards (CEDEFOP).
Skill shortage	Demand for a particular type of skill exceeds the supply of available people with that skill (CEDEFOP).
Skill gap	The level of skills of the person employed is less than that required to perform the job adequately or the type of skill does not match the requirements of the job (CEDEFOP).

Employee	An employee is an individual who works for someone else (a person or a company) in exchange for compensation.
ICT Specialist	Eurostat defines ICT specialists as "workers who have the ability to develop, operate and maintain ICT systems, and for whom ICT constitutes the main part of their job".
Fit for 55 Package	The “Fit for 55” is a set of proposals to revise and update EU legislation and to put in place new initiatives with the aim of ensuring that EU policies are into line with the climate goals agreed by the Council and the European Parliament. The package of proposals aims at providing a coherent and balanced framework for reaching the EU's climate objectives, which: ▪ ensures a just and socially fair transition ▪ maintains and strengthens innovation and competitiveness of EU industry while ensuring a level playing field vis-à-vis third country economic operators ▪ underpins the EU's position as leading the way in the global fight against climate change
Hard skills	Hard skills, or technical skills, are measurable abilities and knowledge that come through learning and can be job or task-specific (e.g., data analysis).
Soft skills	Soft skills are the behavioural, interpersonal attributes people need to succeed in the workplace. They refer to how someone works with and relates to others, efficiently (e.g., communication, teamwork).

Executive Summary

In an era of multiple crises, we witness a broad consensus that addressing primarily economic growth aspects without paying equal attention to environmental sustainability is short-sighted and does not produce the expected (successful) economic results. In parallel, the presence of digital technologies in almost all aspects of our life has exponentially increased the speed of changes and their impact on people and businesses. Societies must make the strategic move to prepare for a rapidly changing world and to address critical global challenges. In this respect, the recent pandemic revealed the readiness level that is required to handle global shocks.

Coping with all the above successfully is a laborious process that requires people capable of developing and deploying green digital solutions. In fact, two important and interlinked drivers are at the top of the EU's agenda: the digital and green transitions, also known as 'Twin Transition'. A transition underpinned by policy ambitions that wish for the EU to become climate neutral by 2050. Nevertheless, there is an ever-debated challenge in the EU and beyond, which is the development of the necessary skills to achieve the ambitions included in proposals and targets set under the European Green Deal.

This report focuses specifically on identifying the new set of *Green Digital Skills* that will define the present and future course of action required to skill and upskill people within the EU and beyond, in order to develop and deploy the net-zero technologies needed to achieve climate neutrality by 2050. Insights from this report further seek to provide recommendations for the education sector, to support the integration of the newly proposed taxonomy into existing and new curricula so as to meet the industry and labour market demand. An EU policy analysis under the sustainability and digital EU policy portfolio was conducted, as well as a review of the industrial sectors at the intersection of the Twin Transition (i.e. the ICT and Energy sectors). Next, the report elaborates on the driving role policymaking plays in supporting the industry to shift to environmentally friendly business models, and how new legislations can eventually shape the landscape for skills and jobs development.

A novel classification model to identify the most important Green and Digital skills, as well as knowledge concepts, is presented. The classification model utilizes the European Skills and Competences framework (ESCO). Subsequently, the report assessed the level of "Greenness and Digitalization" of Occupations (with a focus on the European labour market), highlighting the jobs requiring a high share of green and digital skills. The report provides data-based evidence on changes related to green and digital skills and occupations, showing that the portion of occupations that require both green and digital skills simultaneously has noticeably increased in the last decade.

The report highlights that the Agenda 2030, whereby global goals were formally agreed upon by 191 United Nations Member States in 2015 is no longer simply a declarative text. The 17 goals and 169 targets have been widely integrated into public policies and strategic guidelines that impact priorities and needs for future skills and occupations. The next challenge for a successful use of the Green Digital Skills taxonomy and integration into educational programs, is to involve Technical and Vocational Education and Training (TVET) systems, as well as universities. This will significantly increase the capacity to close current skills gaps in the digital and green fields at large, while enabling economies and societies to proactively respond to changing requirements and conditions, in a world where uncertainty has become the new reality.

1. Introduction

The Twin Transition raises the need to pay increased attention to intertwined skills and climate policies given the potential to **develop green and digital skills to drive both climate neutrality and a recovery full of job opportunities.**

Currently, more than three quarters of companies in the EU report difficulties in finding workers with the necessary skills to meet job requirements, and latest figures from Eurostat suggest that only 37% of adults undertake training on a regular basis[1]. Thus, having the **relevant skills** will undoubtedly empower people to successfully navigate labour market changes and to fully engage in society. Furthermore, a workforce with the skills that are in demand also contributes to sustainable growth, leading to more innovation, and improved industrial competitiveness. However, at the same time this constitutes a big challenge, as identifying the "right" skills for this new era demands a holistic approach; given the variety of occupations and the skills each one of them is associated with. It is important to note also, that for this to happen, focus should be placed mainly on soft skills, as they feature across different jobs (in contrast to the technical "hard" skills). In addition, it is necessary for a common understanding of green skills across occupations to be created.

When it comes specifically to the **changes in the labour market due to the Twin Transition,** these are less clear. Undoubtedly, the accelerated obsolescence of some technologies and products will have an impact on the labour market's structure, which can subsequently affect how certain jobs will be performed, or which roles will be in higher demand. This is also reflected in the linguistic evolution within the labour market: the terms "green", "brown", and "white" jobs are an increasingly common categorization for describing the environmental impact of jobs (Vandeplas et al,2022). The importance of focusing on skills and how those can be obtained by individuals is also confirmed by the European Commission's adopted proposal which declares the year **2023 the European Year of Skills,** following the announcement by President Ursula von der Leyen in her 2022 State of the Union address[2]. The European Year of Skills promotes lifelong learning, empowering people and companies to contribute to the green and digital transitions, supporting innovation and competitiveness.

Nonetheless, to tackle any existing skill gaps and understand the needs for upskilling and/or reskilling, it is crucial to firstly map the skills that are expected to be in high demand. Therefore, this **report aims to firstly define a new set of green digital skills**, **relying on well-defined competence frameworks**. Going beyond the skillset definition, it is necessary at a second stage to **link the green digital skills with occupations and employment, and highlights thereby relevant trends in the EU labour market**.

[1] https://eunec.eu/european-heartbeat-news-eu/2023-european-year-skills
[2] https://ec.europa.eu/commission/presscorner/detail/en/speech_22_5493

2. The need for Green & Digital Skills

The Twin Transition is paving the way for the European Union to become climate neutral by 2050. By proposing policies fit for the development of clean technologies manufactured by abiding to the highest sustainability standards, the EU may be ready for the next industrial revolution.

The Twin Transition is currently at the top of the EU's agenda with the understanding that this is and will continue to have a substantial impact on several life aspects in the short, medium, and long term. While a green transition differs from the digital transition, with each one being subject to specific dynamics, their twinning – i.e., their capacity to reinforce each other – deserves closer attention. It is recognized by the global community at large that digital technologies play a key enabling role to achieve climate neutrality, reduce pollution, and restore biodiversity by monitoring pollution exposure and accessing environmental data. Moreover, Wuppertal Institute (2021a, 2021b) and Ramesohl et al (2022a, 2022b) focus on the impact digital solutions have on changing behavioural patterns of stakeholders, incentive systems, market structures and business models as prerequisites for transformative changes towards sustainability and climate protection. This enabling role is further supported by the need of multiple economic operators to achieve climate neutrality and energy efficiency by 2030, e.g. in data centres and cloud infrastructures, which will support the greening of other technologies, such as big data analytics, blockchain, or the internet of things.

2.1 A Political Twin Transition: The Policy Context

The first alarming warnings on the impact current economic and industrial policies have on the environment have been published as early as 1972 (Meadows et al, 1972). However, it took several years for humanity to fully grasp the meaning of these warnings and start reacting on a global level. Precisely until 2015, which represents a milestone year in the development of climate policies. This is the year of the Paris Agreement, adopted by 196 Parties, and the agreement of the 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs), to be achieved by 2030.

Since then, policy efforts targeting sustainable development have been intensified in the European region, as summarized in Figure 1. The second report published by the SDSN Europe Senior Working Group provides a comprehensive summary of the efforts undertaken by the EU to integrate the Agenda 2030 into the strategic guidelines on various policy areas and the European Semester (the central process for coordinating national economic and employment policies in the EU) through the implementation of the European Green Deal. "The European Green Deal, introduced in December 2019 by the European Commission, serves as Europe's growth plan aiming to make it a climate-

neutral, resource-efficient, innovative, and socially inclusive continent. It includes several goals spanning many different policy areas, such as Clean Energy, Sustainable industry, Buildings and Renovation, Sustainable Agriculture Farm to Fork, Eliminating Pollution, Sustainable mobility, Biodiversity and Sustainable Finance. Moreover, as a response to the health, environmental, and economic consequences of the COVID-19 pandemic, the European Commission introduced 2021, the "Next Generation EU", a generous package of funds to mobilize policies supporting economic recovery while pursuing Europe's green and digital transition"[3].

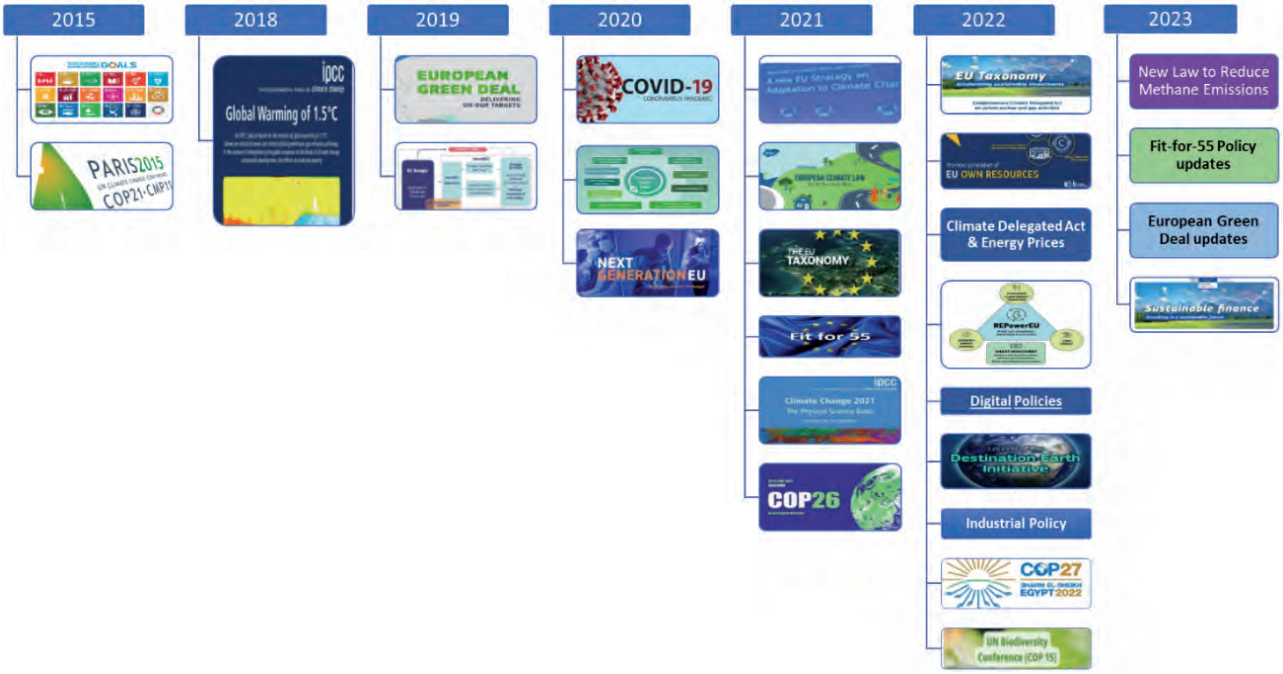

Figure 1 Summary of the policy framework for the transition to sustainability

Koundouri et al (2021) provides a framework to map the policies to 17 SDGs. Figure 2 depicts how the SDGs are mainstreamed into the policies of the European Green Deal. The results indicate that overall, the policies resulting from the European Green Deal affect all SDGs, some to a greater extent (E.G., EU Strategy on Adaptation to Climate Change, New Industrial Strategy, Fit for 55) and others to a lesser extent (e.g., EU Commission Recommendation on Energy Poverty). The most significant impact is found in goals 7,8,9, 12 and 13.

[3] https://egd-report.unsdsn.org/

	SDG 1	SDG 2	SDG 3	SDG 4	SDG 5	SDG 6	SDG 7	SDG 8	SDG 9	SDG 10	SDG 11	SDG 12	SDG 13	SDG 14	SDG 15	SDG 16	SDG 17	Total Score
A New Industrial Strategy for Europe	1	2	1	2	0	0	3	2	3	0	1	2	2	1	2	2	2	26
Circular Economy Action Plan	0	2	1	0	0	2	2	2	3	2	0	3	2	2	2	0	0	23
EU Biodiversity Strategy for 2030	0	2	2	1	1	0	2	2	1	1	0	2	2	3	3	0	2	24
Farm to Fork Strategy	2	3	2	0	0	0	2	2	1	2	0	3	2	2	2	0	1	24
EU Hydrogen Strategy	1	0	0	2	0	0	3	2	3	1	2	2	3	0	0	2	1	22
7 technology flagship Areas, ASGS for 2021	0	0	2	1	1	0	2	3	3	3	3	2	2	0	1	2	1	26
Stepping up Europe's 2030 climate Ambition	0	0	2	1	0	0	3	2	3	3	2	3	3	1	2	0	0	25
Chemicals strategy for Sustainability	0	1	3	0	0	0	1	0	3	0	1	2	3	3	3	1	0	21
EU Strategy to reduce methane emissions	1	3	1	1	0	0	2	1	2	0	1	2	1	1	1	1	1	19
A Renovation Wave for Europe	1	0	0	1	0	0	3	1	2	0	3	2	3	1	1	1	1	20
EU Commission Recommendation on Energy Poverty	3	0	0	0	0	0	2	2	0	3	1	1	2	0	0	0	0	14
EU Strategy to harness the potential of offshore renewable energy for a climate neutral future	0	0	0	1	0	0	3	2	3	0	2	1	3	2	0	2	2	21
European Climate Pact	0	2	1	2	1	0	0	1	2	1	2	2	3	2	2	0	0	21
Smart Mobility Strategy	0	1	2	0	0	0	3	0	3	2	2	2	3	2	0	0	1	21
The European economic and financial system: fostering openness, strength and resilience	0	0	1	0	0	0	2	2	2	1	0	1	1	0	1	3	3	17
EU Strategy on Adaptation to Climate Change	2	2	2	1	1	3	2	3	3	2	3	1	3	2	2	2	2	36
Directing finance towards the European Green Deal	0	0	0	0	0	0	0	2	0	2	0	2	3	1	1	0	0	11
Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery	1	2	1	2	0	0	3	2	3	0	1	2	2	1	2	2	2	26
The EU's Blue Economy for a Sustainable Future	0	2	0	1	1	2	2	1	1	0	2	2	2	3	0	0	1	20
European Climate Law	0	2	2	0	0	2	2	2	2	2	0	2	3	2	2	0	2	25
Strategy for Financing the Transition to a Sustainable Economy	0	0	0	0	0	1	1	3	3	3	1	1	2	1	2	3	2	23
Fit for 55	0	0	1	1	0	1	3	2	3	3	3	3	3	0	2	0	2	27
Total Score	12	24	24	17	5	11	46	39	49	31	30	43	53	30	31	21	26	

Figure 2 Connection of the European Green Deal to the 17 SDGs

The **"European Green Deal" (EGD)** builds on three main policy domains: Sustainable Finance and Corporate Sustainability Reporting (ESGs), Environment and Energy requirements and Industry. Considering that these domains cover a broad range of businesses and economic activities, it is easily understood that any ESG related policies have a great impact on the current job market and any future trends. We can with high probability assume that new green jobs will be created as the result of the implementation of policies focusing on environmental sustainability and the reduction of carbon emissions, not only in sectors where this is expected, such as renewable energy, energy efficiency, sustainable agriculture, and environmental management, but also in more "traditional" business sectors. Sustainability managers, environmental consultants, renewable energy specialists, sustainability analysts, are only few examples of recently introduced occupations. In parallel, traditional sectors and occupations are "enhanced" through the addition of sustainability dimensions: for example, the Sustainable Supply Chain Manager, the Sustainable Architect/Designer, the Sustainability Auditor, the Sustainable Finance Specialist.

The digital pillar of the Twin Transition also addresses numerous policy initiatives. Among those, it is worth noting the increased attention the EU Institutions attached to the definition and development of digital skills. Indeed, the European Commission has set targets in the **European skills agenda and the digital education action plan** to ensure that 80% of adults will have basic digital skills and 20 million Information and Communication Technology (ICT) Specialists -with equitable participation of men and women- will have been trained, by the end of this decade.

The **Digital Economy and Society Index (DESI)** which summarizes indicators on Europe's digital performance and tracks the progress of EU countries helps towards that effort, as the European Commission has been monitoring Member States' digital progress through the DESI reports since 2014.

While continuously monitoring skills-related data, the **EU has invested significant resources** to support digital transformation. 127 billion Euros has been dedicated to digital reforms and investments in the national Recovery and Resilience Plans. Moreover, Member States dedicated on average 26% of their Recovery and Resilience Facility (RRF) allocation to the digital transformation, above the compulsory 20% threshold. Member States that chose to invest more than 30% of their RRF allocation to digital are Austria, Germany, Luxembourg, Ireland, and Lithuania.

Finally, the **Digital Skills and Jobs Coalition** has been set up to successfully address the digital skills gap. This is an indicative EU initiative that brings together Member States, companies, and non-profit organizations aiming to tackle this gap. It offers organizations that work towards the increase of digital skills across Europe to learn from peers and showcase their actions and impact, while the actions done under the Coalition umbrella are key to reaching the "Digital Decade" targets.

With 2023 being the **European Year of Skills**, it is evident that skills are now centre-stage. Not only are skills-related initiatives highlighted across the EU, but skills become active chapters to be embedded into legislative proposals. This also applies to the **Net-Zero Industry Act**, the latest proposal for a regulation that aims to re-industrialize the European Union, attract investments and create better conditions and market access for clean tech in the EU. Supporting people to get the right skills (green and digital) and helping companies, in particular small and medium enterprises, to address skills shortages in the EU is what this Year is all about. This happens by showcasing skills development opportunities and activities across Europe, by fostering easier recognition of qualifications across borders, by bringing organizations and people together to share their experiences and insights, setting out how EU initiatives and funding possibilities can help.

It is understood from the above that focusing on enhancing green and digital skills through suitable training programmes is deemed crucial. For that to happen though, it is vital to have a good understanding and clarity of what exactly "green and digital skills" entail. In the next sections we provide data-based evidence on changes related to green and digital skills and occupations, and also link them to concrete policies (presented in Section 3).

Global Outlook I *Frameworks that reflect each region's priorities and strategies for addressing both sustainability and digitalization highlighting the interconnectedness of these two policy domains*	
United States	*In the heart of the Sustainability Transition Framework in US stands the **Infrastructure Investments**, that is proposed infrastructure plans, such as the **American Jobs Plan,** which include significant investments in green infrastructure, renewable energy and electric vehicle charging networks.* ***Clean Energy:** Federal and state incentives for renewable energy adoption, as well as efforts to reduce carbon emissions from the Power Sector. Furthermore, **Environmental Regulations**: Federal agencies like the Environmental Protection*

	Agency (EPA) enforce environmental regulations to reduce pollution and promote sustainability. ***Digital Transition** Framework consists of **Digital Infrastructure** (Investments in digital infrastructure, 5G, and broadband expansion to support the digital transition and bridge the digital divide) and **Innovation** (Promotion of innovation in digital technologies, including AI, advanced manufacturing, and quantum computing).*
China	***Green Growth**: Ambitious targets for reducing carbon emissions and increasing the use of renewable energy sources as part of China's commitment to sustainability.* ***Belt and Road Initiative (BRI):** The BRI includes green development principles, emphasizing sustainability in infrastructure projects across Asia and beyond.* ***Digital Infrastructure:** China is a leader in 5G deployment and invests heavily in technologies like AI and the Internet of Things (IoT).* ***E-commerce and Digital Platforms:** Thriving e-commerce sector and digital platforms, including Alibaba and Tencent, with global expansion.*
Japan	***Energy Transition:** Transitioning away from nuclear energy and investing in renewable energy sources, such as solar and wind.* ***Resource Efficiency:** Promoting a circular economy and resource efficiency to reduce waste and conserve resources.* ***Digital Innovation:** Known for innovation in digital technologies and robotics, with applications in healthcare, manufacturing, and disaster response.* ***Cybersecurity**: Prioritizing cybersecurity to protect digital assets and critical infrastructure*

2.2 The Industrial Twin Transition: the examples of the ICT & Energy

Considering the overall policy framework, it is useful to look into two specific industrial sectors that may be both driving the twin transition, as well as experience an important shift in labour demand and competition: the ICT and Energy sectors.

There are many factors responsible for the expected increase in demand for green and digital skills within these sectors in the European Market. An important role is played by ***External factors*** such as the accelerated phasing out of fossil fuels at a global scale. The implementation of the Paris Agreement inevitably refers to the development of new technologies and greener sources of energy. Moreover, countermeasures against foreign policies such as the IRA in the United States requires Union to completing the

Single Market, improving education and training, spurring R&D, streamlining and accelerating permitting processes for green investment, reaching trade agreements, as well as pursuing broader aims, including competitiveness in general, speedy decarbonization and formulating broad foreign policy and development policy goals, while also reviewing the State-Aid framework in a targeted way.

Other important factors relate to the ***Business environment***. As trade and commercial value happens along the value chain there is an increased demand for more and better accountability and traceability of sustainability practices, which is expected to increase the demand for green and digital skills, and dictates companies to focus on the identification of more green talents.

Finally, following the framework for the transition to sustainability, there is a gradual shift in ***Consumer behaviour*** with an increasing demand for environmentally friendly technologies and energy efficient products.

When it comes specifically to the **ICT sector,** it is certain that the sector plays a pivotal role in the acceleration of the green and digital transition. In general, **the number of ICT specialists in the EU grew by 50,5% from 2012 to 2021[4],** almost eight (8) times as high as the increase (6.3%) for total employment. However, according to DESI 2022, **the EU's 9 million ICT specialists** (representing 4.5% of the total EU workforce) **fall well short of the EU aim of 20 million specialists by 2030** and are not enough to address the skills shortages that businesses, SMEs and organizations are now experiencing, despite the fact that 500.000 ICT specialists entered the labour market between 2020 and 2021.

The second sector that is directly connected with the green transition is, without a doubt**,** the **energy sector.** According to projections, the direct employment in the sector could go up by more than 66%.[5] **Focusing on the renewables in the EU,** direct employment in the production of energy from renewable sources reached nearly 660.000 jobs in 2016 in the EU.[6] However, despite the ever-growing share of renewable energy, a downward trend in related jobs occurred from 2011 onwards, turning to stagnation in the following years. Factors behind this development include the aftermath of the 2008 financial crisis, the relocation of some renewables manufacturing capacities outside of Europe, and changes in subsidy schemes for renewables within the EU. The solid biomass and wind sectors each supported nearly a quarter of total EU renewable-energy jobs, with liquid biofuels, heat pumps, photovoltaics and hydropower following.

When it comes to the **solar industry** alone, it is expected to require one million skilled workers by 2030, twice as many as today. An analysis by the International Renewable Energy Agency (IRENA)[7] further confirms a steady increase in job opportunities in the field of solar energy technology, which dominates the renewable energy jobs market. These jobs demand more technician level skilled workforce to perform jobs-tasks along

[4]https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220505-1#:~:text=The%20number%20of%20ICT%20specialists,6.3%20%25)%20for%20total%20employment.&text=Despite%20a%20slight%20increase%20over,specialists%20(19.1%25)%20in%202021

[5] https://www.euractiv.com/section/energy-environment/opinion/why-europe-must-reskill-workers-to-reach-its-climate-goals/

[6] https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/employment-energy-sector-2020-07-09_en

[7] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_RE_Jobs_Annual_Review_2018.pdf

the solar energy value chain (manufacturing, construction and installation, operation and maintenance).

Global Outlook II *The ICT and Energy sectors in the United States and China have also experienced growth from 2015 to today, with China being a global leader in these sectors. Key factors are summarized below*	
United States	***ICT Sector***
	Digital Economy Growth: *The digital economy has continued to expand significantly in the United States. This growth encompasses various segments, including software development, IT services, e-commerce, and digital content creation. Tech companies like Apple, Amazon, Google (Alphabet), and Microsoft have continued to thrive, contributing to job creation and economic growth.* ***Cloud Computing and Data Centers:*** *The adoption of cloud computing services has grown substantially. Leading cloud providers, including Amazon Web Services (AWS), Microsoft Azure, and Google Cloud, have expanded their data center infrastructure to meet increasing demand.* ***Telecommunications:*** *The telecommunications sector has evolved with the deployment of 4G and the ongoing rollout of 5G networks. These developments have led to increased connectivity and faster data speeds.* ***Cybersecurity:*** *The need for cybersecurity solutions has grown due to the increasing frequency and sophistication of cyber threats. This has led to growth in the cybersecurity industry, including companies specializing in threat detection, identity protection, and data security.*
	Energy Sector
	Renewable Energy Expansion: *The U.S. has seen significant growth in renewable energy capacity, particularly in solar and wind power. Falling renewable energy costs, government incentives, and corporate sustainability goals have driven this expansion.* ***Natural Gas Production:*** *The United States has become a major producer of natural gas due to advancements in hydraulic fracturing (fracking) technology. Natural gas has played a significant role in the country's energy mix.* ***Energy Efficiency:*** *The focus on energy efficiency has grown, with businesses and households adopting energy-saving technologies and practices. Energy-efficient appliances, lighting, and building designs have become more common.*

	Electric Vehicles (EVs): *The adoption of electric vehicles has increased, with a growing number of automakers offering EV models. This shift is driven by both consumer interest in cleaner transportation options and government incentives.* ***Grid Modernization:*** *Investments in grid modernization and smart grid technologies have aimed to enhance the reliability and efficiency of the energy infrastructure.*
China	***ICT Sector***
	Digital Economy Growth: *China's digital economy continued to expand rapidly, encompassing various segments such as e-commerce, mobile payments, social media, and digital services. Companies like Alibaba, Tencent, and JD.com played pivotal roles in this growth.* ***Mobile Internet:*** *The widespread adoption of smartphones and mobile internet access contributed to the growth of online services, mobile apps, and digital entertainment.* ***5G Development:*** *China was actively investing in and deploying 5G technology, with the aim of becoming a leader in 5G infrastructure and services.* ***Artificial Intelligence (AI):*** *China made significant strides in AI research, development, and application across industries, including healthcare, finance, and manufacturing.* ***E-commerce and Retail:*** *China's e-commerce market continued to thrive, with platforms like Alibaba's Taobao and Tmall expanding both domestically and internationally.*
	Energy Sector
	Renewable Energy Expansion: *China increased its investment in renewable energy sources, particularly solar and wind power. It became one of the largest producers of solar panels and wind turbines in the world.* ***Energy Efficiency:*** *China implemented energy efficiency measures and standards across various sectors, including manufacturing and construction, to reduce energy consumption and emissions.* ***Electric Vehicles (EVs):*** *The Chinese government promoted the adoption of electric vehicles (EVs) and set ambitious targets for EV production and sales. Several domestic EV manufacturers, like BYD and NIO, gained prominence.* ***Coal-to-Gas Conversion:*** *Efforts to reduce air pollution led to the conversion of coal-fired heating systems to natural gas and the implementation of cleaner technologies in power generation.*

3.The New Set of Green Digital Skills

The 'Twin Skills for the Twin Transition' are presented: first, the policy context is listed under the three major pillars of our analysis that is Corporate Sustainability Reporting, Environment and Energy and Industry; second, the underlying sectors of economic activity. For the classification of sectors, we use the NACE rev.2 (Nomenclature of Economic Activities in the European Community) Level 2 classification[8]. Third, the relevant skills and occupations are presented.

The aim of this report is to identify a new set of Green Digital Skills that will support the attainment of the targets and goals of the Twin Transition. As discussed in previous sections, this refers to the EU's commitment to pursuing two major transitions simultaneously: the transition to a green economy (achieving climate neutrality and addressing environmental challenges) and the transition to a digital economy (embracing digital technologies and ensuring digitalization across various sectors). These transitions are definitely seen as a way to drive economic growth, create jobs, and make the EU more competitive globally.

Through the use of the European Skills and Competences framework (ESCO), we develop a novel classification model to identify the most important Green and Digital skills and knowledge concepts. Focusing on the EU labour market, we also assess the level of "Greenness and Digitalization" of Occupations (jobs), highlighting the jobs requesting a high share of green and digital skills. Table 1 presents an overview of such 'Twin Skills for the Twin Transition'.

Focusing on the Policy mapping, the corporate sustainability framework is expected to horizontally affect companies, irrespective of their sector of incorporation. On the other hand, specific sectors such as Energy Supply, Manufacturing, Construction, ICT, Transport and storage, Water and Wastewater Treatment and Agriculture, Forestry and Fishing are primarily influenced by the European Policies in relation to the Environment and Energy. The European Green Deal has a profound impact on the energy sector, particularly in promoting renewable energy sources, enhancing energy efficiency, and reducing greenhouse gas emissions. This affects electricity and heat production from renewable sources, as well as the fossil fuel energy sector.

Moreover, the Green Deal aims to decarbonize the transportation sector, which includes road and rail transport, aviation, and shipping. Policies focus on electric and sustainable mobility, reducing emissions, and shifting to cleaner fuels. Manufacturing sector is also impacted by encouraging energy-efficient and sustainable production processes and the adoption of circular economy principles. This includes many industries related to automotive, chemicals, and machinery. Policies promote energy-efficient and

[8] https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

sustainable building practices, having a direct impact on the construction and real estate sectors. Waste Management and recycling businesses are also directly impacted by the policies supporting a transition to a circular economy by promoting recycling and reducing waste. Agriculture and Forestry is also influenced by efforts to combat deforestation and promote afforestation. Finally, the European Green Deal encourages innovation in green technologies and sustainable practices, which affects companies involved in research, development, and production of clean technologies.

In the same vein, the European Industrial Policy aims to support and promote the growth and competitiveness of various industries within the EU. The manufacturing sector encompasses a wide range of industries, from automotive and aerospace to pharmaceuticals and machinery. The ICT sector includes the development and manufacturing of computer hardware, software, telecommunications equipment, and services, which is directly affected by policies to boost innovation and digitalization in this sector.

The EU Industrial Policy places a strong focus on the development and growth of renewable energy sources such as wind, solar, and hydropower (Energy Supply). Moreover, the EU Industrial Policies include measures to support the development of electric and autonomous vehicles and to enhance the competitiveness of European car manufacturers (Manufacturing). Also, initiatives related to circular economy and eco-friendly production greatly affect the Textiles and other Manufacturing sectors.

Along these lines, and supported by the frameworks and empirical results presented in the next session, our work is highly important in identifying the 'soft' and 'hard' skills needed to support the twin transition of all sectors. Moving one step forward, and to further connect results with the European Labour market, we also identify, the top "Green and Digital" occupations[9]; these are the jobs which require the greatest share of jointly Green and Digital Skills and knowledge concepts. Having said that, the fourth column of Table 1 presents a set of "Soft" Skills, e.g. competences, required for the transition. Critical Thinking, Judgement and decision making, Complex Problem Solving, Monitoring, Writing and Coordination are the top six "Soft" Skills jointly classified as Green and Digital which are very important in the most occupations under all pillars. Focusing on the Skills and Competences, for the ESG (Corporate Sustainability) Pillar, we can identify several skills such as advising on environmental issues, environmental sciences, complying with environmental protection laws and standards, computer use, analysing and evaluating information and data as the top jointly green and digital skills. Focusing on Labour market and specific occupations environmental education officer, environmental expert, green ICT consultant, natural resources consultant and sustainability officer are among the top "Twin" Occupations, expected to be of high need on the way to the implementation of the ESG related policies.

Equivalently, for the Environmental and Energy pillar, top skills include analysing and evaluating information and data, complying with environmental protection laws and standards, computer use, database and network design and administration, designing electrical or electronic systems or equipment, disposing of non-hazardous waste or debris, electricity and energy environmental protection technology, handling and

[9] As explained in the next session, each occupation is related to of a set of skills and competences which are required.

disposing of hazardous materials, maintaining electrical, electronic and precision equipment, monitoring environmental conditions operating agricultural or forestry equipment and using precision measuring equipment. In addition, the top jobs in terms of their level of Greenness and Digitalization include electric meter technician, electrical, transmission system operator, electricity distribution technician, energy assessor, energy systems engineer, environmental education officer, geothermal technician, green ICT consultant, hazardous waste inspector, irrigation technician, recycling specialist, smart home engineer and smart home installer are considered.

Finally, in relation to the Industrial Pillar, the results overlap partly with the Environmental and Energy pillar, while electronics and automation and analysing scientific and medical data are also among the top skills and acoustical engineer, botanist and ecologist among the top occupations.

Table 1 Top Green Digital Skills and Occupations (Jobs)

EU Policy[10]	Industrial Sector *(NACE Rev. 2)*	Green Digital Skills	Green Digital Occupations
Corporate Sustainability Reporting (ESG) EU Taxonomy Regulation EU Sustainable Finance Disclosure Regulation (SFDR) EU Sustainable Investment Plan Corporate Sustainability Reporting Directive (CSRD) EU Action Plan on Financing Sustainable Growth	All sectors	advising on environmental issues analysing and evaluating information and data complying with environmental protection laws and standards computer use database and network design and administration environmental sciences	environmental education officer environmental expert green ICT consultant natural resources consultant nature conservation officer sustainability manager
Environmental and Energy Policies European Green Deal EU Biodiversity strategy for 2030 Circular Economy Action Plan Waste Framework Directive Air Quality Directive Water Framework Directive Renewable Energy Directive Energy Efficiency Directive EU Emission Trading System (EU ETS) Just Transition Fund Connecting Europe Facility (CEF) Fit for 55	Agriculture, Forestry and Fishing Construction Energy Supply ICT Manufacturing Transport and Storage Water and Wastewater Treatment	analysing and evaluating information and data complying with environmental protection laws and standards computer use database and network design and administration designing electrical or electronic systems or equipment disposing of non-hazardous waste or debris electricity and energy environmental protection technology handling and disposing of hazardous materials maintaining electrical, electronic and precision equipment monitoring environmental conditions operating agricultural or forestry equipment using precision measuring equipment	electric meter technician electrical transmission system operator electricity distribution technician energy assessor energy systems engineer environmental education officer geothermal technician green ICT consultant hazardous waste inspector irrigation technician recycling specialist smart home engineer smart home installer
Industry Policies EU Industrial Policy Green Deal Industrial Plan EcoDesign Critical Raw Materials Act Chips Act	Construction Energy Supply Health and Social Care ICT Manufacturing Mining and Quarrying	analysing and evaluating information and data analysing scientific and medical data complying with environmental protection laws and standards computer use database and network design and administration designing electrical or electronic systems or equipment electronics and automation maintaining electrical, electronic and precision equipment using precision measuring equipment	acoustical engineer botanist ecologist energy assessor energy systems engineer environmental education officer green ICT consultant smart home engineer smart home installer

[10] Note: at the time of publication of this report, several policy proposals in examine, are still undergoing interinstitutional negotiations

4. A New Framework for Green & Digital Occupations in the EU

A data-driven framework is developed to classify Skills, Knowledges and Occupations in the EU Labour Market

The demand for Occupations with a high "Green and Digital" Score has significantly increased from 2015 for all sectors.

The Skills classified as the "most" Digital" or jointly "Digital and Green" are among the most demanded skills for all occupations.

Filling the gap in the need for Green and Digital skills will accelerate the transition

This section describes the methodologies used to derive the results presented in the following section. In this direction, the report develops and presents a data-driven framework to assess the level of "Greenness", "Digitalization" and its combination (Greenness and Digitalization), of the EU labour market occupations, and subsequently explore shifts in the demand for Green and Digital Skills during the last 5 years, as well as its trend and projections to 2035.

4.1 The ESCO Framework

The ESCO framework[11] is the multilingual classification of European Skills, Competences and Occupations. ESCO is part of the Europe 2020 strategy[12], the European strategy for smart, sustainable and inclusive growth. The ESCO classification[13] identifies and categorizes skills, competences, and occupations relevant for the EU labour market and education and training. ESCO identifies 3008 occupations (Level 0) and is built on the International Standard Classification of Occupations ISCO-08[14] which serves as the hierarchical structure for ESCO's occupations pillar. The Occupations are classified in Groups on 4 Levels (Level 1, 2, 3 and 4 corresponds to 10, 42, 126 and 426 groups of occupations respectively[15]). Similarly, ESCO's skills pillar provides a comprehensive list of knowledge, skills and competences relevant to the European labour market. It contains 13, 895 concepts (Level 0 – 10831

[11] https://esco.ec.europa.eu/en

[12] https://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

[13] We use the most recent version v1.1.1

[14] The International Standard Classification of Occupations (ISCO) is a four-level classification of occupation groups managed by the International Labour Organisation (ILO). Its structure follows a grouping by education level. The two latest versions of ISCO are ISCO-88 (dating from 1988) and ISCO-08 (dating from 2008).

[15] Level 1 Skills refer to broader level sets of skills, grouping the granular

skills/competences and 3059 Knowledge concepts) structured in a hierarchy which contains four sub-classifications:

- Knowledge
- Language skills and knowledge
- Skills
- Transversal skills

The Skills pillar distinguishes between i) skill/competence concepts and ii) knowledge concepts by indicating the skill type. There is however no distinction between skills and competences. Similar to Occupations the Skills and Knowledge concepts are organized to 3 levels (Level 1, 2 and 3 refer to 8, 74 and 296 groups of skills and 11, 29 and 86 groups of Knowledge Concepts respectively)

The ESCO system also identifies skills which are labelled as green[16], to support the transition the green transition of the EU labour market. As workers need a skill set that can respond to the need of reducing emissions in working practices, the Skills/Competences pillar has been enriched with the additional information at skill level to distinguish green skills and knowledge concepts. The labelling of skills and knowledge concepts as green follows a methodology based on a 3-step process, which combines human labelling and validation, and the use of Machine Learning (ML) algorithms.

Figures 3 and 4 show the distribution of the green concepts in the skills and knowledge skills hierarchies. A total of 571 ESCO skills and knowledge concepts are labelled as green. This includes: 386 skills and 185 knowledge concepts.

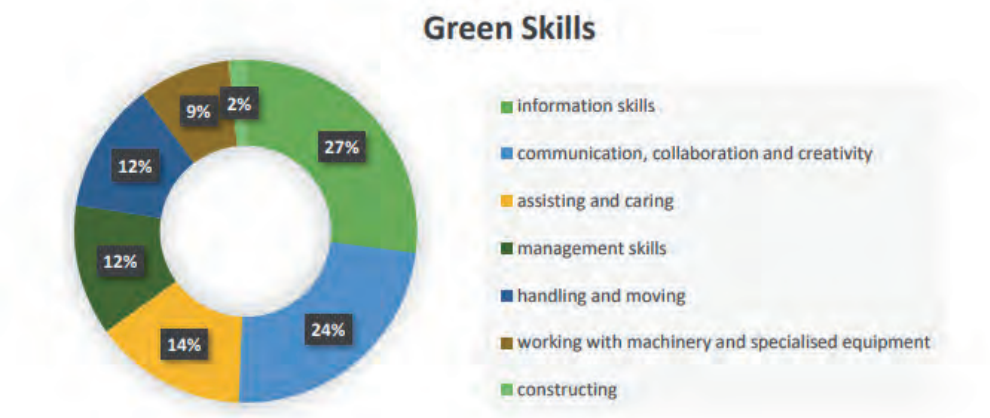

Figure 3 Green Skills – Source: ESCO Publications - Green Skills and Knowledge Concepts: Labelling the ESCO classification

[16] https://esco.ec.europa.eu/en/about-esco/publications/publication/green-skills-and-knowledge-concepts-labelling-esco#:~:text=The%20European%20Classification%20of%20Occupations,are%20now%20labelled%20as%20green.

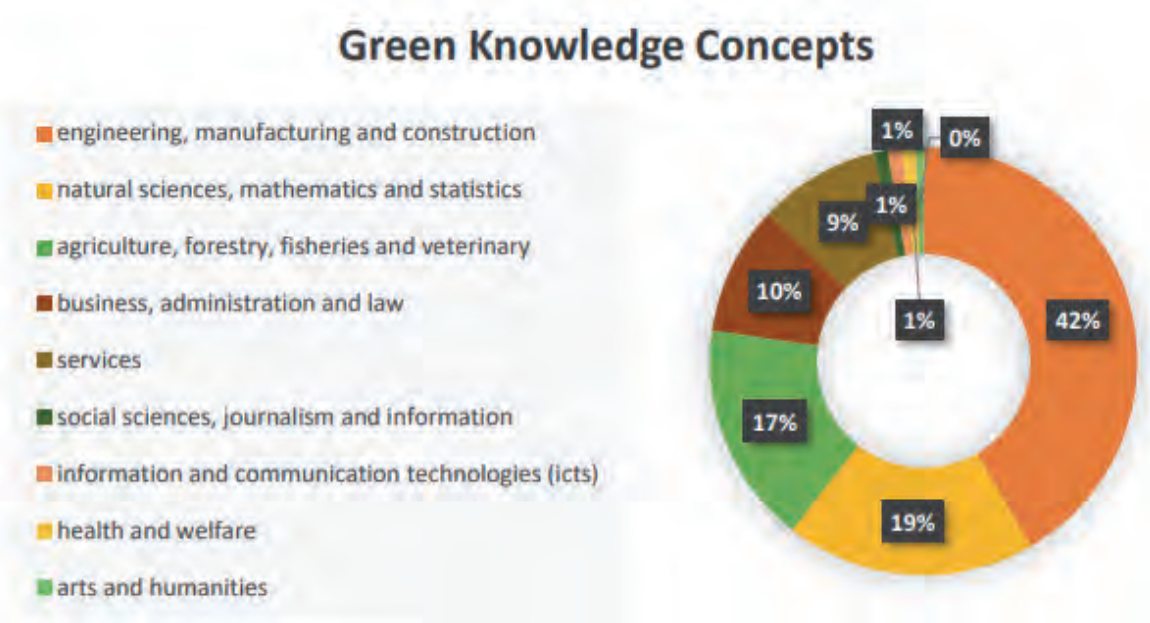

Figure 4 Green Knowledge Concepts – Source: ESCO Publications - Green Skills and Knowledge Concepts: Labelling the ESCO classification

Similarly, ESCO provides a classification of 725 Skills/ Competences and 475 Knowledge Concepts as Digital, following the Digital Competence Framework as presented in Section 4.1.

Finally, the ESCO framework provides the relations between the Occupations and the Skills and Knowledges, e.g. which skills and Knowledge concepts are relevant for the each of the occupations.

4.2 Classification of Green and Digital Occupations and Groups of Occupations

Using the above setup and the classifications and hierarchies provided by the ESCO API, we develop a framework to classify Occupations based on their level of "Greenness", "Digitalization" and "Greenness and Digitalization". Our data driven methodology is presented in Technical Appendix 1, and consist of the calculation of a score, ranging from 0 to 100, which is defined as the share of green, of digital and jointly green and digital skills and knowledge concepts in each occupation or occupation Group.

Following our methodology, Table 2 presents the ranking of the top 15 occupations, at Level 0 (the most granular level), based on their scores on "Greenness", "Digitalization" and "Greenness and Digitalization" respectively[17].

[17] Appendix 2 Tables A2.1, A2.2 and A2.3 presents the ranking of the Occupations at Level 1 ,2 and 0 based on their level of Greenness, digitalization and Greenness and Digitalization respectively. For All levels except 1, only the top 15 of occupations (for Level 0) or occupation groups (Levels 1 and 2) are displayed.

Table 2 Top 15 Green, Digital and Green and Digital Occupations

Green Occupations	Score
energy assessor	90.909
natural resources consultant	78.788
energy conservation officer	75.000
environmental policy officer	75.000
energy analyst	70.833
environmental expert	70.588
hazardous waste inspector	69.697
recycling specialist	67.568
sustainability manager	65.278
environmental geologist	64.706
environmental protection manager	64.583
environmental education officer	64.000
forestry adviser	62.857
nature conservation officer	60.345
liquid waste treatment plant operator	60.000
Digital Occupations	
webmaster	98.837
software tester	96.154
user interface developer	93.878
ICT network administrator	93.684
database integrator	93.548
system configurator	93.478
database designer	93.069
mobile application developer	92.941
ICT network engineer	92.784
data warehouse designer	92.593
knowledge engineer	91.954
embedded systems software developer	91.892
integration engineer	91.860
web developer	91.837
ICT integration tester	91.667
Green and Digital Occupations	
smart home engineer	6.818
smart home installer	6.667
geothermal technician	4.878
green ICT consultant	4.762
irrigation technician	4.348
environmental education officer	4.000
acoustical engineer	3.846
electricity distribution technician	3.571
electric meter technician	3.571
energy systems engineer	3.448
ecologist	3.448
interior planner	3.333
electrical transmission system operator	3.333
pastry chef	3.226
botanist	3.125

Equivalently, Table 3 presents the ranking of the Skills/Knowledge Groups at Level 3 (the more detailed group of skills and Knowledges)[18].

Table 3 Top 15 Green, Digital and Green and Digital Skills/ Knowledge Groups (Level 3)

Green Skills	Score
handling and disposing of waste and hazardous materials	100.000
environmental sciences	90.000
environmental protection technology	86.667
complying with environmental protection laws and standards	84.444
natural environments and wildlife	80.000
advising on environmental issues	65.517
forestry	62.500
disposing of non-hazardous waste or debris	47.619
monitoring environmental conditions	47.619
electricity and energy	36.905
designing electrical or electronic systems or equipment	35.000
social and behavioural sciences not elsewhere classified	33.333
crop and livestock production	32.143
community sanitation	30.435
handling and disposing of hazardous materials	29.730
Digital Skills	
browsing, searching and filtering digital data	100.000
resolving computer problems	100.000
setting up computer systems	100.000
using word processing, publishing and presentation software	100.000
using computer aided design and drawing tools	100.000
using digital tools for collaboration, content creation and problem solving	100.000
programming computer systems	100.000
working with computers	100.000
computer use	100.000
information and communication technologies not elsewhere classified	100.000
managing, gathering and storing digital data	98.413
software and applications development and analysis	97.436
protecting ict devices	95.833
using digital tools for processing sound and images	93.750
designing ict systems or applications	93.548
Green and Digital Skills	
environmental protection technology	6.667
complying with environmental protection laws and standards	4.444
operating agricultural or forestry equipment	3.846
using precision measuring equipment	3.333
designing electrical or electronic systems or equipment	2.500
monitoring environmental conditions	2.381
computer use	2.381
electricity and energy	2.381
analysing scientific and medical data	1.724
maintaining electrical, electronic and precision equipment	1.563
electronics and automation	1.333
analysing and evaluating information and data	1.220
database and network design and administration	0.935
disposing of non-hazardous waste or debris	0.000
handling and disposing of hazardous materials	0.000

[18] Appendix 2 Tables A2.4, A2.5 and A2.6 presents the ranking of the Skills/Knowledge Groups at Level 1 and 2 based on their level of Greenness, digitalization and Greenness and Digitalization respectively. For All levels except Level 1, only the top 15 of skills/ knowledge concepts groups are displayed (Levels 2 and 3).

4.3 Green and Digital Skills, Occupations and Employment

In this section, the report explores the relationship between green and digital skills and knowledge concepts and employment growth in the European Markets, based on the scoring system we developed in the previous subsection.

Employment data by Occupation Groups are downloaded from Eurostat's Labour Force Survey (LFS)[19]. For all Level 1 Occupation groups, we performed cross-sectional regressions of the average, over years 2012 to 2022, annual employment growth on their Green, Digital and Green & Digital Scores[20].

Results indicate a strong and steady increase in the annual employment growth rates of Occupations with a high Digital and Jointly Green and Digital Scores. As the digital / green & digital score increases by 1%, the average annual growth rate of occupations over the years 2012 to 2022, increases by 0.28%/28.89% respectively. On the other hand, the negative and significant estimate for Green Occupations (-0.22%) is mainly due to the fact that Agriculture related occupations have a high green score, while on the same time the Agriculture sector employment suffered a significant reduce during the last decade.

As such, it is important to study the employment of green, digital and jointly green and digital occupations after controlling for the NACE sector. Focusing on the most recent data (year 2022), we performed cross sectional regressions of the occupations (Level 2) employment rates by NACE sector (NACE Level 2) to the Green, Digital and Green and Digital Scores[21].

Interestingly results reveal a positive and significant relation of highly "Green" Level 2 Occupations and employment, for the Agriculture Forestry and Fishing, the Energy and the Water and Waste Management treatment sectors. That is Level 2 Occupations with a higher "Green" Score, tend to have higher employment rates for 2022. Focusing on Digital Scores, as expected a highly significant positive relationship, is estimated for the ICT sector that is 2022 employment is higher for occupations with a high Digital Score while a negative relationship is estimated for Health and Social Care and Mining and Quarrying Sectors. Finally, we estimate a highly significant positive relation between the employment rate for occupations with a high green and digital score for ICT, Construction and Energy sectors, while a negative relationship is estimated for Wholesale and Retail Trade and Mining and Quarrying Sectors.

In order to measure, how the above results have also evolved through the period 2016 to 2022 that is from the year the Paris Agreement took effect we perform the following cross-sectional regression:

$$y_{i,j} = a + \beta x_i + \varepsilon_{i,j}$$

Where $y_{i,j}$ is the employment rate growth (2016 to 2022) of the ith occupations Group (Level 2) for the jth Level 2 NACE sector and x_i the Green/Digital/Green & Digital Scores

[19] https://ec.europa.eu/eurostat/web/lfs/database. Data refer to Levels 1 and 2.
[20] Regression results are presented in Appendix 1, Table A1.1.
[21] Results are included in Appendix 1, Table A1.2.

of the i^{th} occupations Group (Level 2). The Newey-West p values are also reported in parenthesis, while bold denotes significance at 5% level. The number of observations (n) as well as the R squared is included in Table 4.

Table 4 Employment Growth (2016-2022) Occupations Level 2 of NACE sectors Level 2 vs Green, Digital and Green and Digital Scores

NACE Level 2	Green Score				Digital Score				Green and Digital Score			
	b	*p value*	*n*	*R2*	*b*	*p value*	*n*	*R2*	*b*	*p value*	*n*	*R2*
1.1 Administrative Services	**0.06**	0.04	9	0.31	0.05	0.34	9	0.07	-0.02	0.78	9	0.02
1.2 Arts and Recreation and other services	-0.03	0.23	9	0.09	**0.05**	0.03	9	0.28	**0.07**	0.04	9	0.67
1.3 Finance and Insurance	0.08	0.51	6	0.04	**0.10**	0.03	6	0.45	**0.13**	0.02	6	0.56
1.4 ICT	-0.07	0.69	7	0.02	**0.11**	0.00	7	0.57	**0.10**	0.03	7	0.46
1.5 Professional Services	-0.05	0.42	8	0.02	**0.09**	0.00	8	0.56	**0.10**	0.01	8	0.57
2.1 Construction	0.11	0.61	8	0.01	0.10	0.29	8	0.40	0.03	0.83	8	0.01
3.1 Accommodation and Food	0.11	0.18	8	0.10	**0.07**	0.02	8	0.43	0.05	0.12	8	0.17
3.2 Transport and Storage	**0.11**	0.00	9	0.51	0.02	0.63	9	0.02	-0.06	0.41	9	0.13
3.3 Wholesale and Retail Trade	-0.05	0.12	9	0.12	**0.08**	0.00	9	0.35	0.00	0.97	9	0.00
4.1 Manufacturing	**-0.11**	0.00	9	0.41	**0.14**	0.00	9	0.75	**0.09**	0.04	9	0.45
5.1 Education	-0.21	0.06	8	0.24	0.03	0.43	8	0.04	0.00	0.96	8	0.00
5.2 Health and Social Care	**-0.09**	0.00	9	0.43	**0.09**	0.00	9	0.52	0.04	0.20	9	0.08
5.3 Public Sector and Defence	-0.04	0.38	9	0.04	**0.12**	0.01	9	0.31	0.00	0.98	9	0.00
6.1 Agriculture, Forestry and Fishing	**-0.14**	0.00	8	0.64	**0.11**	0.00	8	0.46	0.08	0.19	8	0.18
6.2 Energy Supply Services	-0.04	0.51	9	0.01	**0.09**	0.03	9	0.55	**0.10**	0.01	9	0.51
6.3 Mining and Quarrying	-0.03	0.15	5	0.06	-0.07	0.21	5	0.14	-0.05	0.13	5	0.11
6.4 Water and Wastewater treatment	0.01	0.91	8	0.00	**0.11**	0.01	8	0.62	-0.01	0.82	8	0.00

It is interesting to note that the employment growth of "Green" occupations mainly occurs within the Administrative Services and the Transportation and Storage Sectors; while within the Manufacturing, Health and Social Care and Agriculture, Forestry and Fishing Sectors the employment growth of "Greener" occupations is lower than the employment growth of less green occupations. On the contrary, the results for Digital Occupations are striking, with almost all sectors having shifted employment to occupations with a higher level of digitalization. The same is true for the jointly Green and Digital occupations with the most significant positive relationships to be reported for ICT, Energy, Professional Services, Manufacturing and Finance and Insurance Sectors.

4.4 Green and Digital Skills and Occupations, Future Demand

All the above results, indicate a clear positive and statistically significant trend between the development of occupations and their level of Greenness and Digitalization. Moreover, the demand for green and digital skills are experiencing a considerable growth over the years 2016 to 2022. CEDEFOP Skills Intelligence, the online tool of the European Centre for the development of Vocational Training[22], utilizes the analysis of labour market data to provide estimates for the Future job prospects of Level 1 and Level 2 Occupations in EU27 for the years 2022-2035. The CEDEFOP estimates refer to a score from 0 to 100, in relation to how much the demand for the specific occupations is expected to grow. Table 5 presents the relevant estimates.

Table 5 Future job prospects for Level 1 Occupations

Occupations	*Value*
Professionals	100
Managers	78
Technicians and associate professionals	75
Elementary occupations	75
Plant and machine operators and assemblers	64
Service and sales workers	60
Craft and related trades workers	43
Clerical support workers	41
Skilled agricultural, forestry and fishery workers	0

Comparing the entries of this table with Tables 1, 2 and 3, it is clear that the Top Occupations (Professionals, Managers and Technicians and associate professionals) also correspond to the top "Green and Digital" occupations, where their demand is expected to continue to growth until 2035.

Focusing on skills, it is also important to know which are the most requested skills in the job market by occupation. For each Level 2 ESCO occupation, Appendix 2, Table A2.7 reports the share of all the skills (level 1) requested in online job ads in 2022 in EU27[23]. Table 6 below focuses on the shares for information and communication technologies

[22] https://www.cedefop.europa.eu/en/tools/skills-intelligence/
[23] Appendix Table 5.7 presents the results in a greater detail.

(ICTs) and engineering which are, as shown in previous sections, the top Green and Digital Skills in Level 1.

The first two columns of Table 6 report the Level 2 occupation group, and the ESCO Level 1 Skills and Knowledge Groups respectively. The 3rd column contains the frequency that the underlying skill/ Knowledge appears in the online job adds. Focusing on the level 1 skills with the highest Green and Digital Score (information and communication technologies (ICT) and engineering), it is striking that those are among the top skills requested in all of the occupations[24].

[24] Appendix Tables 5.4 -5.6 present the ranking of Level 1 skills.

Table 6 Most Requested Skills (Level 1) by Occupation

Occupations (Level 2)	Skills and Knowledge Concepts (Level 1)	Share In online Adds
	information and communication technologies (icts)	9.5
health associate professionals	engineering and engineering trades	5.6
	information and communication technologies (icts)	49.4
Information and communications technicians	engineering and engineering trades	13.8
Legal, social, cultural and related associate professionals	information and communication technologies (icts)	10.8
business and administration associate professionals	information and communication technologies (icts)	19.3
	engineering and engineering trades	30.1
Science and engineering and engineering trades associate professionals	information and communication technologies (icts)	19.5
Numerical and material recording clerks	information and communication technologies (icts)	14.7
Customer services clerks	information and communication technologies (icts)	12.5
General and keyboard clerks	information and communication technologies (icts)	19.5
	information and communication technologies (icts)	15.4
Other clerical support workers	engineering and engineering trades	6.3
	engineering and engineering trades	3.2
Agricultural, forestry and fishery labourers	information and communication technologies (icts)	1.1
Cleaners and helpers	engineering and engineering trades	1.0
Food preparation assistants	engineering and engineering trades	1.6
	engineering and engineering trades	4.4
Refuse workers and other elementary workers	information and communication technologies (icts)	1.4
	information and communication technologies (icts)	16.3
Street and related sales and service workers	engineering and engineering trades	6.0
Food processing, wood working, garment and other craft and related trades workers	engineering and engineering trades	3.1
	information and communication technologies (icts)	10.1
Market-oriented skilled agricultural workers	engineering and engineering trades	9.9
Market-oriented skilled forestry, fishery and hunting workers	information and communication technologies (icts)	11.5
Administrative and commercial managers	information and communication technologies (icts)	26.6
Chief executives, senior officials and legislators	information and communication technologies (icts)	29.5
Hospitality, retail and other services managers	information and communication technologies (icts)	44.1
Production and specialized services managers	information and communication technologies (icts)	28.8
Assemblers	engineering and engineering trades	52.1
	engineering and engineering trades	4.0
Drivers and mobile plant operators	information and communication technologies (icts)	2.5
Machine & plant operators	engineering and engineering trades	18.4
	information and communication technologies (icts)	5.1
health professionals	engineering and engineering trades	2.8
Information and communications technology professionals	information and communication technologies (icts)	64.3
Legal, social and cultural professionals	information and communication technologies (icts)	11.6
business and administration professionals	information and communication technologies (icts)	29.7

Table 6 Most Requested Skills (Level 1) by Occupation (Continued)

	information and communication technologies (icts)	40.1
Science and engineering and engineering trades professionals	engineering and engineering trades	37.5
	information and communication technologies (icts)	16.5
Teaching professionals	engineering and engineering trades	5.6
Protective services workers	information and communication technologies (icts)	4.7
Sales workers	information and communication technologies (icts)	15.1
	engineering and engineering trades	12.4
Labourers in mining, construction, manufacturing and transport	engineering and engineering trades	2.9
	engineering and engineering trades	46.9
	engineering and engineering trades	10.1
Electrical and electronic trades workers	information and communication technologies (icts)	3.7
	engineering and engineering trades	14.1
Handicraft & printing workers	information and communication technologies (icts)	7.1
	engineering and engineering trades	37.7
Metal, machinery and related trades workers	engineering and engineering trades	8.3
	engineering and engineering trades	7.3
Building and related trades workers, excluding electricians	information and communication technologies (icts)	4.2

5. Recommendations

The report provides a thorough assessment of the EU policy context, the classification of skills and knowledges, as well as trends in the EU labour market in relation to the demand for skills and occupations based on their level of *Greenness* and *Digitalization*. One of the main objectives of this report is to further translate the empirical results in a set of recommendations for universities and TVET to integrate and/or develop green digital skills in existing and future curricula.

Evidence presented in this study shows that following the introduction of the Paris Agreement and the Agenda 2030, there is a statistically significant and gradual increase in the demand for the skills classified as of high level of greenness and digitalization. So, it is of crucial importance these skills to be mainstreamed in TVET and University Curriculums.

Technical and vocational education and training (TVET) systems play an important role in equipping youth and adults with the skills required for employment, decent work, entrepreneurship and lifelong learning. In the present development context, TVET can equip youth with the skills required to access the world of work, including skills for self-employment.

Greening TVET and University Curriculum is an essential and cross-cutting theme for sustainable development. It refers to the efforts to reorient and reinforce existing TVET institutions and policies in order to reinforce achievement of sustainable development.

Good practice I: Turning university-industry collaboration into an ICT Academy that serves the future

To date, over 170 countries have released digital strategies and over 50 countries have their own AI strategies. ICT talent development strategies are thus necessary to meet growing requirements set by countries around the world. University-enterprise collaboration thus becomes ever more necessary to serve the emerging digital industries such as cloud, big data, IoT. Huawei understands the challenge and built a talent development ecosystem with universities and colleges worldwide to deliver training that offer a fair and high-quality education. The Company has so far opened more than 2,600 ICT Academies, with more than 200 in Europe alone. The ICT Academy can count on more than 11,000 teachers who trained more than 200,000 students per year and supported ICT competitions that convened 580,000 students from 85 countries and regions to boost innovation. The ICT Academy builds upon a strong combination of theoretical and practical courses spanning from connectivity (cybersecurity, WLAN technologies and application, 5G, and AI) to cloud and computing (deep learning, ML, big data, data storage), and application and development, focusing on vocational certifications. The success of such educational programs is

also reflected on the ambition to scale the number of partnerships to more than 7,000 globally to serve 1 million ICT Academy students by 2026.

Good practice II: the (d) Academy

(d)Academy will be a unique pan-European effort to upskill and reskill key workers across the continent, using an AI-based platform and aiming at leading the "Reskilling Revolution" in Europe. It will automatically suggest, match and deliver challenge-driven programs based on real-world scenarios to close the skills gap. The (d) Digital Academy will be executed in close collaboration with key European Partners, including the **AI Data Robotics Association** (ADRA), the **European Cybersecurity Organization** (ECSO), **the Association for European Nanoelectronics Activities** (Aeneas), the **Big Data Value Association**, the **Software and Data Association** (NESSI), the **Robotics Association** (euRobotics). (d)Digital Academy ecosystem will provide unparalleled access to **industry-proven learning content, training programs, experts, educational technology and certification**, relying on EIT-Digital's education services track record.

Good practice III: Fostering STEM talent for the Twin Transition

The green and digital twin transition brings about an array of opportunities to the industrial sector. Nevertheless, the industry won't succeed in this new industrial era if technological transfer and know-how does not happen across sectors and people.

Tech-savvy and change-resilient young talents available worldwide deserve every opportunity to succeed in the future of technology. Huawei's global CSR flagship program 'Seeds for the Future' seeks to develop local STEM talent to boost innovation and a deeper understanding of the ICT industry. Through this platform, top university students can tap into various learning opportunities from field visits to Huawei campus and labs in China, online lectures, conferences participation, competitions, and more. It is an encompassing experience that exposes the participants to improve their ICT skills, while learning about the impact of climate change and the need to sharpen digital skills for the green and energy transition.

Indeed, digital solutions play a key enabling role to push the green transition forward, as also demonstrated by Huawei's TECH4ALL initiatives deployed across natural ecosystems worldwide. Solutions that combine acoustic or visual technology with cloud and AI to protect biodiversity, restore nature, and improve the quality of research. The use of technological solutions to protect the environment is a collaborative effort on multiple levels. But most importantly, cross-sector talent must be harnessed. ICT experts developing and deploying Tech4Nature solutions need to be educated about ecological issues, while nature conservationists need to know the potential of technologies like AI in nature conservation. Talent unlocks potential and cultivating STEM talent that sees the green and digital transition as the way forward will upscale initiatives such as TECH4ALL

As discussed in the chapters of this report, the “information and communication technologies (ICTs)” skill and knowledge group is the top requested Green and Digital skill in online job markets and the Education sector is not an exception. ICT in education improves engagement and knowledge retention, it not only assumes the role of assisting teaching in the integration process of TVET, but also helps teachers improve technological self-confidence and teaching quality.

Following the global momentum in the commitment to SDGs and the climate change agreements, there is an evident momentum in the demand and the need of such skills from the ICT, Energy, Professional Services, Manufacturing and Finance and Insurance Sectors.

In this direction, disadvantaged groups in the labour market (young people, women, persons with disabilities, rural communities and other vulnerable groups) require targeted support to develop their potential knowledge and skills for green jobs. So investing in training to help the disadvantaged groups acquire specialized skills will enable their participation in activities linked to transitioning to green economies.

Finally, based on the results of section 4, greening of the TVET and university curriculums should be further reinforced on a sector-by-sector basis to the following directions:

Financial Sector:

- Mainstream ESGs
- Enhance skills in ESG and SDG metrics

Energy:

- technical knowledge for application of energy-efficiency measures
- technical knowledge for application of renewable energy technologies
- • upgraded skills for emergent energy markets

Manufacturing:

- raw material collection
- pre-processing
- production
- distribution
- trade (marketing)
- sustainable business and product development

Agricultural and Food:

- advanced wastewater treatment practices
- improved packaging
- improved sensors and process control (to reduce waste and improve productivity)
- food irradiation
- water and wastewater reduction using closed loop/zero emission systems
- use of information and communication technology (ICT) in agriculture
- technical knowledge for new practices like organic farming and agroforestry

Focusing more on the ICT and Energy sectors, the green and digital skills are increasingly important to foster the transition of the economies to sustainability. These skills are critical for addressing sustainability challenges, promoting the transition to clean energy sources, and harnessing digital technologies for efficient and eco-friendly operations. Below is an overview of the green and digital skills needed in these sectors:

Green Skills:

- Renewable Energy Expertise: Proficiency in designing, installing, and maintaining renewable energy systems, such as solar panels, wind turbines, and hydropower systems.
- Energy Efficiency: Skills related to improving energy efficiency in buildings, industries, and transportation, including energy auditing and retrofitting.
- Circular Economy Knowledge: Understanding of circular economy principles, sustainable materials management, and waste reduction strategies.
- Environmental Regulations: Knowledge of EU environmental regulations and compliance requirements, including emissions standards and waste management.

Digital Skills:

- Data Analytics: Proficiency in data analysis and interpretation for optimizing energy consumption, predicting equipment failures, and enhancing energy efficiency.
- Internet of Things (IoT): Skills related to IoT device deployment and management for monitoring and controlling energy systems remotely.
- Cybersecurity: Understanding of cybersecurity measures to protect critical energy infrastructure and data.
- AI and Machine Learning: Knowledge of AI and machine learning algorithms for optimizing energy production, consumption, and grid management.

To meet the evolving demands of these sectors, educational institutions, training programs, and industry collaborations play a crucial role in preparing a skilled workforce.

Global Outlook *Essential Green and Digital skills in the ICT and energy sectors across different regions and Countries, reflecting each region's priorities and strategies for addressing both sustainability and digitalization.*	
United States	*Green Skills*
	Renewable Energy Technology: Expertise in solar and wind energy systems, including installation, maintenance, and grid integration. Energy Management: Skills in energy-efficient building design, HVAC systems, and smart lighting technologies. Sustainable Construction: Knowledge of sustainable building practices and green building certifications like LEED.

	Environmental Policy: Understanding of federal and state environmental regulations and compliance.
	Digital Skills
	Big Data Analytics: Proficiency in analyzing large datasets to improve energy efficiency, grid management, and predictive maintenance. Cybersecurity: Expertise in protecting energy infrastructure from cyber threats and ensuring data security. Smart Grid Technologies: Knowledge of smart grid technologies, including advanced metering infrastructure (AMI) and grid automation. Blockchain: Understanding of blockchain technology for transparent and secure energy transactions and supply chain management.
China	*Green Skills*
	Renewable Energy Engineering: Expertise in solar and wind power systems, including manufacturing, installation, and grid integration. Environmental Engineering: Skills in managing air and water quality, pollution control, and waste management. Green Building Design: Knowledge of sustainable building materials and practices.
	Digital Skills
	5G and IoT: Proficiency in 5G and IoT technologies for energy grid monitoring and management. Digital Manufacturing: Skills related to digital manufacturing and industrial automation for energy-efficient production.
Japan	*Green Skills*
	Nuclear Energy Expertise: Despite transitioning away from nuclear energy, Japan maintains expertise in nuclear power generation and decommissioning. Renewable Energy Technology: Skills in solar, wind, and hydroelectric systems, along with energy storage solutions.
	Digital Skills
	Robotics and Automation: Expertise in robotics and automation for energy infrastructure maintenance and disaster response. AI and Robotics: Knowledge of AI and robotics for optimizing energy production and consumption

6. Conclusion

In the context of the EU policy framework to be implemented during the forthcoming years, the Twin Transition is set to accelerate and trigger significant structural changes in EU labour markets. Following the ONET and ESCO classification systems, in this paper we provide a thorough analysis for the classification of jobs (occupations) in the EU, distinguish them into Green, Digital and jointly Green and Digital.

Using Eurostat and CEDEFOP data, we show that the employment related to Jobs/ Occupations with a high level of Digitalization, and simultaneously a high level of Greenness and Digitalization have significantly increased over the period 2011 to 2022. Moreover, focusing on employment data by NACE sector in 2022, the positive relationship between employment and level of Greenness is mainly apparent in Agriculture, Energy and Water management sectors, for Digitalization in ICT sector; while for occupations which are jointly classified as Green and Digital in the ICT, Construction and Energy Sectors. Focusing on the growth of employment from 2016 to 2022, the result is striking for Digital and jointly Green and Digital Occupations where we demonstrate a significant positive and significant relation to almost all the sectors. On the other hand, the sectors which appear to be laggards in the integration and demand for Green and Digital skills are the Mining and Quarrying and Wholesale and Retail trade sectors.

Finally, focusing on data from online ads, groups of skills with a high level of Greenness, such as engineering and engineering trades, and Digitalization, such as information and communication technologies (ICTs) are included amongst the top requested skills for all occupations in the job market.

Following the forecasts, the demand for Green jobs (Elementary occupations), Digital jobs (Professionals and Managers) and jointly Green and Digital jobs (Technicians and associate professionals) is expected to further grow during the period 2022 to 2035. It is apparent that EU talent development will be geared towards more Green and Digital skills and occupations. This trend and the associated new job opportunities are expected to support the green and digital transformation of the EU job market and economies, towards the implementation of the 2030 and 2050 goals.

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Appendices

Appendix 1 - Technical

This Technical Appendix presents in greater detail our methodology to assess individual Occupations (Level 0) and groups of Occupations (Levels 1, 2 and 3), as well as Groups of Skills and Knowledge Concepts (Levels 1,2 and 3), as Green, Digital and jointly Green and Digital.

We define the following green dummy variables at the granular (Level 0) skills and knowledge concepts:

$$green\_skill_i = 1\ if\ i^{th}\ Skill\ is\ classified\ by\ ESCO\ as\ green\ and\ 0\ otherwise, i = 1, \dots, 10831.$$

$$green\_knowledge_j = 1\ if\ j^{th}\ Knowledge\ is\ classified\ by\ ESCO\ as\ green\ and\ 0\ otherwise, j = 1, \dots, 3059.$$

For all groups of skills or Knowledges (Levels 1, 2 and 3), the green skills and green knowledge indices for the underlying group takes the value of the number of Skills/ Knowledge Concepts in the group which are classified as Green, divided by the total number of Skills/Knowledge Concepts belonging in the underlying group.

Similarly, we define the following Digital Dummy variables:

$$digital\_skill_i = 1\ if\ i^{th}\ Skill\ is\ classified\ by\ ESCO\ as\ Digital\ and\ 0\ otherwise, i = 1, \dots, 10831.$$

$$digital\_knowledge_j = 1\ if\ j^{th}\ Knowledge\ is\ classified\ by\ ESCO\ as\ Digital\ and\ 0\ otherwise, j = 1, \dots, 3059.$$

Also, equivalently for all groups of skills or Knowledges (Levels 1, 2 and 3), the digital skills and digital knowledge indices for the underlying group takes the value of the number of Skills/ Knowledge Concepts in the group which are classified as Digital, divided by the total number of Skills/Knowledge Concepts belonging in the underlying group.

Finally, we define the following Green and Digital dummy variables:

$$green\&digital\_skill_i = 1\ if\ i^{th}\ Skill\ is\ classified\ by\ ESCO\ as\ green\ and\ digital\ and\ 0\ otherwise, i = 1, \dots, 10831.$$

$$green\&digital\_knowledge_j = 1\ if\ j^{th}\ Knowledge\ is\ classified\ by\ ESCO\ as\ green\ and\ digital\ and\ 0\ otherwise, j = 1, \dots, 3059.$$

Equivalently for all groups of skills or Knowledges (Levels 1, 2 and 3), the green & digital skills and green & digital knowledge indices for the underlying group takes the value of the number of Skills/ Knowledge Concepts in the group which are classified as Green and Digital, divided by the total number of Skills/Knowledge Concepts belonging in the underlying group.

The Dummy variables can be used in order to calculate the levels of Greenness, Digitalization and Greenness and Digitalization, for all occupations or groups of occupations.

The Green, Digital and Green & Digital Scores for Occupations (Level 0) or Groups of Occupations (Levels 1, 2, 3 and 4), or Groups of Skills (Level 1, 2 and 3) are defined as:

$$GreenScore_i = \frac{\sum_{j=1}^{S} green_{skill_j} + \sum_{j=1}^{k} green_{knowledge_j}}{S+k} x100 \ \ (eq1),$$

$$DigitalScore_i = \frac{\sum_{j=1}^{S} digital_j + \sum_{j=1}^{k} digital_{knowledge_j}}{S+k} x100 \ \ (eq\ 2),$$

$$Green\&DigitalScore_i = \frac{\sum_{j=1}^{S} green\&digital_j + \sum_{j=1}^{k} green\&digital_{knowledge_j}}{S+k} x100 \ (eq\ 3),$$

Where:

$S = number\ of\ Skills\ related\ to\ the\ ith\ Occupations\ or\ Skills\ group.$

and

$k = number\ of\ Knowledge\ Concepts\ related\ to\ the\ ith\ Occupations\ \ or\ Skills\ Group$.

Table A1.1 reports the cross-sectional OLS regression estimates of the following model

$$y_i = a + \beta x_i + \varepsilon_i$$

Where y_i is the average annual employment growth, from 2012 to 2022, of level 1 Occupations Group and x_i the Green/Digital/Green & Digital Scores. The Newey-West p values are also reported in parenthesis, while bold denotes significance at 5% level. The number of observations (n) as well as the R squared are reported in Table.

Table A1.1 Employment Growth vs Green – Digital – Green and Digital Scores -Occupations Level 1

a	b	n	R^2
Green			
0.01 (0.01)	**-0.22** (0.00)	**10**	**0.52**
Digital			
-0.02 (0.04)	**0.28** (0.00)	**10**	**0.55**
Green and Digital			
-0.01 (0.29)	**28.89** (0.02)	**10**	**0.62**

Table A1.2 presents the cross-sectional regressions of the 2022 employment rates of occupations (Level 2) by NACE sector (NACE Level 2) to their Green, Digital and Green and Digital Scores.

$$y_{i,j} = a + \beta x_i + \varepsilon_{i,j}$$

Where $y_{i,j}$ is the 2022 employment rates of occupations Group (Level 2) of the jth Level 2 NACE sector and x_i the Green/Digital/Green & Digital Scores. The Newey-West p values, the number of observations (n) and the R squared are also reported in table, while bold denotes significance at 5% level.

Table A1.2 Employment Occupations Level 2 vs NACE sectors Level 2

Level 2	Green Scores				Digital Scores				Green and Digital Scores			
	b	*p value*	R^2	*n*	*b*	*p value*	R^2	*n*	*b*	*p value*	R^2	*n*
1.1 Administrative Services	0.504	0.062	0.01	31	-0.695	0.093	0.03	32	-0.426	0.063	0.08	16
1.2 Arts and Recreation and other Services	**-0.622**	0.012	0.02	34	-0.588	0.082	0.02	35	0.008	0.979	0.00	17
1.3 Finance and Insurance	-3.504	0.134	0.07	16	-0.252	0.642	0.00	17	-11.359	0.064	0.26	8
1.4 ICT	1.768	0.900	0.07	18	**4.971**	0.000	0.76	19	**11.28**	0.048	0.05	9
1.5 Professional Services	0.719	0.683	0.01	30	0.255	0.576	0.00	31	-0.148	0.892	0.00	17
2.1 Construction	0.590	0.636	0.00	25	-0.702	0.223	0.01	26	**1.501**	0.000	0.28	14
3.1 Accommodation and Food	-1.452	0.207	0.01	20	-2.630	0.181	0.03	20	13.007	0.157	0.10	10
3.2 Transport and Storage	-0.480	0.357	0.00	26	-0.643	0.201	0.01	27	-1.343	0.132	0.02	14
3.3 Wholesale and Retail Trade	-1.423	0.122	0.04	35	-0.416	0.179	0.00	36	**-0.744**	0.038	0.12	16
4. Manufacturing	-0.052	0.918	0.00	35	-0.190	0.443	0.00	35	-0.209	0.727	0.00	17
5.1 Education	-3.610	0.224	0.04	25	-0.626	0.214	0.00	25	-12.874	0.151	0.10	11
5.2 Health and Social Care	-0.733	0.094	0.01	32	**-0.886**	0.030	0.03	32	-0.975	0.216	0.04	16
5.3 Public Sector and Defence	-0.512	0.117	0.02	31	0.225	0.677	0.00	31	-1.047	0.071	0.08	13
6.1 Agriculture, Forestry and Fishing	**10.190**	0.002	0.68	17	-4.480	0.205	0.03	18	0.305	0.128	0.02	9
6.2 Energy Supply Services	**5.026**	0.001	0.44	14	0.099	0.883	0.00	15	**2.269**	0.003	0.33	9
6.3 Mining and Quarrying	-3.336	0.147	0.12	6	**-14.13**	0.010	0.67	6	**-3.569**	0.017	0.57	5
6.4 Water and Wastewater treatment	**4.750**	0.049	0.35	12	-1.998	0.338	0.05	13	-0.761	0.058	0.04	8

Appendix 2 - Additional Results

This Appendix contains additional results not included in detail in section 4. Tables A2.1, A2.2 and A2.3 presents the ranking of the Occupations at Level 1 ,2 and 0 based on their level of Greenness, digitalization and Greenness and Digitalization respectively. For All levels except 1, only the top 15 of occupations (for Level 0) or occupation groups (Levels 1 and 2) are displayed.

Table A2.1 –Top 15 Green Occupations (Level 0,1 and 2)

Green Occupations	Score
Level 1	
Skilled agricultural, forestry and fishery workers	18.875
Elementary occupations	8.175
Technicians and associate professionals	4.603
Professionals	4.507
Plant and machine operators and assemblers	3.739
Craft and related trades workers	3.701
Managers	3.681
Clerical support workers	2.493
Service and sales workers	2.487
Armed forces occupations	0.278
Level 2	
Market-oriented skilled agricultural workers	23.800
Agricultural, forestry and fishery labourers	14.106
Refuse workers and other elementary workers	13.581
Science and engineering professionals	11.332
Market-oriented skilled forestry, fishery and hunting workers	11.052
Building and related trades workers, excluding electricians	9.934
Science and engineering associate professionals	8.251
Food preparation assistants	6.928
Health associate professionals	5.696
Cleaners and helpers	5.385
Administrative and commercial managers	5.239
Electrical and electronic trades workers	5.213
Protective services workers	4.602
Health professionals	3.994
Food processing, wood working, garment and other craft and related trades workers	3.938
Level 0	
energy assessor	90.909
natural resources consultant	78.788
energy conservation officer	75.000
environmental policy officer	75.000
energy analyst	70.833
environmental expert	70.588
hazardous waste inspector	69.697
recycling specialist	67.568
sustainability manager	65.278
environmental geologist	64.706
environmental protection manager	64.583
environmental education officer	64.000
forestry adviser	62.857
nature conservation officer	60.345
liquid waste treatment plant operator	60.000

Table A2.2 Top 15 Digital Occupations (Level 0,1 and 2)

Digital Occupations	Score
Level 1	
Professionals	15.615
Clerical support workers	10.362
Armed forces occupations	8.069
Technicians and associate professionals	7.924
Craft and related trades workers	6.693
Managers	6.118
Plant and machine operators and assemblers	3.818
Service and sales workers	2.892
Skilled agricultural, forestry and fishery workers	2.448
Elementary occupations	1.748
Level 2	
Information and communications technology professionals	78.662
Information and communications technicians	44.517
General and keyboard clerks	37.081
Electrical and electronic trades workers	17.730
Science and engineering professionals	15.800
Other clerical support workers	14.693
Armed forces occupations, other ranks	11.671
Non-commissioned armed forces officers	10.414
Customer services clerks	9.876
Science and engineering associate professionals	9.276
Legal, social and cultural professionals	8.695
Production and specialized services managers	7.851
Metal, machinery and related trades workers	7.483
Teaching professionals	7.463
Assemblers	7.103
Level 0	
webmaster	98.837
software tester	96.154
user interface developer	93.878
ICT network administrator	93.684
database integrator	93.548
system configurator	93.478
database designer	93.069
mobile application developer	92.941
ICT network engineer	92.784
data warehouse designer	92.593
knowledge engineer	91.954
embedded systems software developer	91.892
integration engineer	91.860
web developer	91.837
ICT integration tester	91.667

Table A2.3 Top 15 Green and Digital Occupations (Level 0,1 and 2)

Green and Digital Occupations	Score
Level 1	
Professionals	0.077
Craft and related trades workers	0.067
Technicians and associate professionals	0.063
Managers	0.051
Service and sales workers	0.041
Plant and machine operators and assemblers	0.013
Armed forces occupations	0.000
Clerical support workers	0.000
Skilled agricultural, forestry and fishery workers	0.000
Elementary occupations	0.000
Level 2	
Electrical and electronic trades workers	0.508
Science and engineering professionals	0.201
Legal, social, cultural and related associate professionals	0.116
Personal service workers	0.096
Science and engineering associate professionals	0.092
Building and related trades workers, excluding electricians	0.082
Administrative and commercial managers	0.079
Information and communications technology professionals	0.069
Drivers and mobile plant operators	0.059
Hospitality, retail and other services managers	0.057
Production and specialized services managers	0.046
Health associate professionals	0.023
Business and administration professionals	0.021
Food processing, wood working, garment and other craft and related trades workers	0.018
Teaching professionals	0.014
Level 0	
smart home engineer	6.818
smart home installer	6.667
geothermal technician	4.878
green ICT consultant	4.762
irrigation technician	4.348
environmental education officer	4.000
acoustical engineer	3.846
electricity distribution technician	3.571
electric meter technician	3.571
energy systems engineer	3.448
ecologist	3.448
interior planner	3.333
electrical transmission system operator	3.333
pastry chef	3.226
botanist	3.125

Tables A2.4, A2.5 and A2.6 present the ranking of the Skills/Knowledge Groups at Level 1 and 2 based on their level of Greenness, digitalization and Greenness and Digitalization respectively. For All levels except Level 1, only the top 15 of skills/ knowledge concepts groups are displayed (Levels 2 and 3). Table A2.7 reports in detail the share of all skills (level 1) requested in Linked in and online job markets by Occupation (Level 2).

Table A2.4 Top 15 Green Skills Groups (Level 1, 2 and 3)

Green Skills	Score
Level 1	
agriculture, forestry, fisheries and veterinary	27.635
natural sciences, mathematics and statistics	27.136
engineering, manufacturing and construction	14.112
constructing	6.682
services	6.507
handling and moving	6.270
business, administration and law	5.232
information skills	2.940
communication, collaboration and creativity	2.694
social sciences, journalism and information	2.525
working with machinery and specialized equipment	2.309
assisting and caring	2.295
management skills	1.776
health and welfare	1.147
information and communication technologies (icts)	0.829
Level 2	
environment	85.000
forestry	62.500
handling and disposing of waste and hazardous materials	59.116
agriculture	29.708
architecture and construction	20.316
hygiene and occupational health services	18.967
engineering and engineering trades	17.110
constructing	16.667
biological and related sciences	14.315
protecting and enforcing	13.497
fisheries	13.333
designing systems and products	11.423
tending plants and crops	10.833
installing interior or exterior infrastructure	9.722
analysing and evaluating information and data	9.476
Level 3	
handling and disposing of waste and hazardous materials	100.000
environmental sciences	90.000
environmental protection technology	86.667
complying with environmental protection laws and standards	84.444
natural environments and wildlife	80.000
advising on environmental issues	65.517
forestry	62.500
disposing of non-hazardous waste or debris	47.619
monitoring environmental conditions	47.619
electricity and energy	36.905
designing electrical or electronic systems or equipment	35.000
social and behavioural sciences not elsewhere classified	33.333
crop and livestock production	32.143
community sanitation	30.435
handling and disposing of hazardous materials	29.730

Table A2.5 Top 15Digital Skills Groups (Levels 1, 2 and 3)

Digital Skills	Score
Level 1	
information and communication technologies (icts)	97.723
working with computers	93.729
education	22.679
information skills	8.482
social sciences, journalism and information	7.576
arts and humanities	7.098
engineering, manufacturing and construction	5.979
working with machinery and specialized equipment	5.323
business, administration and law	4.520
communication, collaboration and creativity	3.882
services	3.538
natural sciences, mathematics and statistics	3.166
health and welfare	2.587
management skills	2.185
agriculture, forestry, fisheries and veterinary	1.280
Level 2	
programming computer systems	100.000
working with computers	100.000
setting up and protecting computer systems	98.611
information and communication technologies (icts)	97.723
using digital tools for collaboration, content creation and problem solving	96.875
accessing and analysing digital data	93.915
using digital tools to control machinery	72.973
managing information	40.984
inter-disciplinary programmes and qualifications involving education	40.000
designing systems and products	28.404
using precision instrumentation and equipment	26.719
journalism and information	22.727
processing information	17.306
engineering and engineering trades	15.025
installing, maintaining and repairing electrical, electronic and precision equipment	14.063
Level 3	
browsing, searching and filtering digital data	100.000
resolving computer problems	100.000
setting up computer systems	100.000
using word processing, publishing and presentation software	100.000
using computer aided design and drawing tools	100.000
using digital tools for collaboration, content creation and problem solving	100.000
programming computer systems	100.000
working with computers	100.000
computer use	100.000
information and communication technologies not elsewhere classified	100.000
managing, gathering and storing digital data	98.413
software and applications development and analysis	97.436
protecting ICT devices	95.833
using digital tools for processing sound and images	93.750
designing ICT systems or applications	93.548

Table A2.6 Top 15 Green and Digital Skills Groups (Level 1, 2 and 3)

Green and Digital Skills	Score
Level 1	
information and communication technologies (ICTs)	0.829
engineering, manufacturing and construction	0.433
working with machinery and specialized equipment	0.228
assisting and caring	0.079
information skills	0.064
communication, collaboration and creativity	0.028
handling and moving	0.000
working with computers	0.000
constructing	0.000
management skills	0.000
generic programmes and qualifications	0.000
education	0.000
arts and humanities	0.000
social sciences, journalism and information	0.000
business, administration and law	0.000
Level 2	
engineering and engineering trades	1.298
operating mobile plant	1.282
information and communication technologies (ICTs)	0.829
protecting and enforcing	0.556
installing, maintaining and repairing electrical, electronic and precision equipment	0.521
using precision instrumentation and equipment	0.476
analysing and evaluating information and data	0.421
designing systems and products	0.417
monitoring, inspecting and testing	0.216
handling and disposing of waste and hazardous materials	0.000
moving and lifting	0.000
making moulds, casts, models and patterns	0.000
tending plants and crops	0.000
transforming and blending materials	0.000
washing and maintaining textiles and clothing	0.000
Level 3	
environmental protection technology	6.667
complying with environmental protection laws and standards	4.444
operating agricultural or forestry equipment	3.846
using precision measuring equipment	3.333
designing electrical or electronic systems or equipment	2.500
monitoring environmental conditions	2.381
computer use	2.381
electricity and energy	2.381
analysing scientific and medical data	1.724
maintaining electrical, electronic and precision equipment	1.563
electronics and automation	1.333
analysing and evaluating information and data	1.220
database and network design and administration	0.935
disposing of non-hazardous waste or debris	0.000
handling and disposing of hazardous materials	0.000

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2)

Occupations (Level 2)	Skills and Knowledge Concepts (Level 1)	Share In online Adds
health associate professionals	business and administration	24.5
health associate professionals	health	18.0
health associate professionals	information and communication technologies (icts)	9.5
health associate professionals	engineering and engineering trades	5.6
Information and communications technicians	information and communication technologies (icts)	49.4
Information and communications technicians	business and administration	37.1
Information and communications technicians	engineering and engineering trades	13.8
Legal, social, cultural and related associate professionals	business and administration	23.7
Legal, social, cultural and related associate professionals	information and communication technologies (icts)	10.8
business and administration associate professionals	business and administration	48.8
business and administration associate professionals	information and communication technologies (icts)	19.3
business and administration associate professionals	social and behavioural sciences	8.5
Science and engineering and engineering trades associate professionals	business and administration	31.9
Science and engineering and engineering trades associate professionals	engineering and engineering trades	30.1
Science and engineering and engineering trades associate professionals	information and communication technologies (icts)	19.5
Science and engineering and engineering trades associate professionals	architecture and construction	19.3
Science and engineering and engineering trades associate professionals	manufacturing and processing	10.3
Numerical and material recording clerks	business and administration	42.2
Numerical and material recording clerks	information and communication technologies (icts)	14.7
Customer services clerks	business and administration	23.4
Customer services clerks	information and communication technologies (icts)	12.5
General and keyboard clerks	business and administration	40.2
General and keyboard clerks	information and communication technologies (icts)	19.5
Other clerical support workers	business and administration	40.7

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

Other clerical support workers	information and communication technologies (icts)	15.4
Other clerical support workers	engineering and engineering trades	6.3
Other clerical support workers	mathematics and statistics	4.6
Agricultural, forestry and fishery labourers	agriculture	5.1
Agricultural, forestry and fishery labourers	business and administration	4.0
Agricultural, forestry and fishery labourers	engineering and engineering trades	3.2
Agricultural, forestry and fishery labourers	physical sciences	1.4
Agricultural, forestry and fishery labourers	architecture and construction	1.3
Agricultural, forestry and fishery labourers	manufacturing and processing	1.3

Agricultural, forestry and fishery labourers	information and communication technologies (icts)	1.1
Cleaners and helpers	personal services	5.5
Cleaners and helpers	physical sciences	3.9
Cleaners and helpers	engineering and engineering trades	1.0
Cleaners and helpers	manufacturing and processing	0.6
Food preparation assistants	manufacturing and processing	2.5
Food preparation assistants	engineering and engineering trades	1.6
Food preparation assistants	business and administration	1.4
Food preparation assistants	welfare	1.2
Refuse workers and other elementary workers	business and administration	5.8
Refuse workers and other elementary workers	engineering and engineering trades	4.4
Refuse workers and other elementary workers	physical sciences	2.0
Refuse workers and other elementary workers	arts	1.9
Refuse workers and other elementary workers	agriculture	1.7
Refuse workers and other elementary workers	information and communication technologies (icts)	1.4
Street and related sales and service workers	information and communication technologies (icts)	16.3
Street and related sales and service workers	business and administration	11.0

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

Street and related sales and service workers	architecture and construction	7.5
Street and related sales and service workers	engineering and engineering trades	6.0
Street and related sales and service workers	physical sciences	4.3
Food processing, wood working, garment and other craft and related trades workers	engineering and engineering trades	3.1
Food processing, wood working, garment and other craft and related trades workers	transport services	1.2
Food processing, wood working, garment and other craft and related trades workers	manufacturing and processing	1.0
Market-oriented skilled agricultural workers	business and administration	11.9
Market-oriented skilled agricultural workers	information and communication technologies (icts)	10.1
Market-oriented skilled agricultural workers	engineering and engineering trades	9.9
Market-oriented skilled agricultural workers	architecture and construction	5.7
Market-oriented skilled agricultural workers	agriculture	3.4
Market-oriented skilled agricultural workers	physical sciences	2.1
Market-oriented skilled forestry, fishery and hunting workers	business and administration	15.8
Market-oriented skilled forestry, fishery and hunting workers	information and communication technologies (icts)	11.5
Market-oriented skilled forestry, fishery and hunting workers	welfare	9.4
Market-oriented skilled forestry, fishery and hunting workers	physical sciences	6.6
Market-oriented skilled forestry, fishery and hunting workers	manufacturing and processing	5.0
Administrative and commercial managers	business and administration	60.8
Administrative and commercial managers	information and communication technologies (icts)	26.6
Administrative and commercial managers	social and behavioural sciences	19.9

Chief executives, senior officials and legislators	business and administration	51.2
Chief executives, senior officials and legislators	information and communication technologies (icts)	29.5
Chief executives, senior officials and legislators	social and behavioural sciences	10.5
Hospitality, retail and other services managers	business and administration	64.3
Hospitality, retail and other services managers	information and communication technologies (icts)	44.1
Hospitality, retail and other services managers	social and behavioural sciences	16.1

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

Production and specialized services managers	business and administration	49.2
Production and specialized services managers	information and communication technologies (icts)	28.8
Assemblers	engineering and engineering trades	52.1
Assemblers	business and administration	11.8
Assemblers	manufacturing and processing	6.0
Assemblers	architecture and construction	4.7
Assemblers	physical sciences	1.5
Drivers and mobile plant operators	transport services	17.3
Drivers and mobile plant operators	business and administration	16.5
Drivers and mobile plant operators	engineering and engineering trades	4.0
Drivers and mobile plant operators	information and communication technologies (icts)	2.5
Machine & plant operators	manufacturing and processing	19.4
Machine & plant operators	business and administration	18.6
Machine & plant operators	engineering and engineering trades	18.4
Machine & plant operators	architecture and construction	3.3
health professionals	health	25.9
health professionals	business and administration	6.2
health professionals	information and communication technologies (icts)	5.1
health professionals	engineering and engineering trades	2.8
Information and communications technology professionals	information and communication technologies (icts)	64.3
Information and communications technology professionals	business and administration	49.0
Legal, social and cultural professionals	business and administration	24.9
Legal, social and cultural professionals	information and communication technologies (icts)	11.6
Legal, social and cultural professionals	welfare	8.2
business and administration professionals	business and administration	55.7
business and administration professionals	information and communication technologies (icts)	29.7

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

business and administration professionals	social and behavioural sciences	15.8
Science and engineering and engineering trades professionals	information and communication technologies (icts)	40.1
Science and engineering and engineering trades professionals	engineering and engineering trades	37.5
Science and engineering and engineering trades professionals	business and administration	36.1

Science and engineering and engineering trades professionals	architecture and construction	17.4
Teaching professionals	information and communication technologies (icts)	16.5
Teaching professionals	business and administration	12.7
Teaching professionals	mathematics and statistics	7.6
Teaching professionals	architecture and construction	6.5
Teaching professionals	engineering and engineering trades	5.6
Teaching professionals	welfare	5.1
Teaching professionals	education	4.7
Personal care workers	welfare	10.2
Personal care workers	health	5.9
Personal care workers	business and administration	5.9
Personal care workers	education	2.3
Personal service workers	business and administration	13.1
Personal service workers	personal services	6.5
Personal service workers	manufacturing and processing	4.1
Protective services workers	business and administration	11.1
Protective services workers	information and communication technologies (icts)	4.7
Protective services workers	architecture and construction	3.0
Sales workers	business and administration	39.2
Sales workers	information and communication technologies (icts)	15.1
Sales workers	manufacturing and processing	3.3
Labourers in mining, construction, manufacturing and transport	engineering and engineering trades	12.4

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

Labourers in mining, construction, manufacturing and transport	architecture and construction	9.9
Labourers in mining, construction, manufacturing and transport	business and administration	8.2
Labourers in mining, construction, manufacturing and transport	physical sciences	7.6
Labourers in mining, construction, manufacturing and transport	manufacturing and processing	3.5
Labourers in mining, construction, manufacturing and transport	engineering and engineering trades	2.9
Electrical and electronic trades workers	engineering and engineering trades	46.9
Electrical and electronic trades workers	architecture and construction	14.6
Electrical and electronic trades workers	business and administration	12.5
Electrical and electronic trades workers	engineering and engineering trades	10.1
Electrical and electronic trades workers	manufacturing and processing	3.8
Electrical and electronic trades workers	information and communication technologies (icts)	3.7
Electrical and electronic trades workers	physical sciences	3.0
Handicraft & printing workers	business and administration	14.1
Handicraft & printing workers	engineering and engineering trades	14.1
Handicraft & printing workers	information and communication technologies (icts)	7.1

Handicraft & printing workers	architecture and construction	5.5
Handicraft & printing workers	manufacturing and processing	4.9
Handicraft & printing workers	physical sciences	3.2
Handicraft & printing workers	arts	3.0
Metal, machinery and related trades workers	engineering and engineering trades	37.7
Metal, machinery and related trades workers	business and administration	9.8
Metal, machinery and related trades workers	architecture and construction	9.1
Metal, machinery and related trades workers	engineering and engineering trades	8.3
Metal, machinery and related trades workers	manufacturing and processing	7.5
Building and related trades workers, excluding electricians	business and administration	26.9
Building and related trades workers, excluding electricians	engineering and engineering trades	7.3

Table A2.7 Share of Skills (Level 1) Requested by Occupation (Level 2) Continued

Building and related trades workers, excluding electricians	manufacturing and processing	5.2
Building and related trades workers, excluding electricians	information and communication technologies (icts)	4.2
Building and related trades workers, excluding electricians	architecture and construction	4.1