



THE FUTURE OF JOBS IS

GREEN

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THE FUTURE OF JOBS IS GREEN

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Key findings

The European Green Deal will trigger a deep transformation of the way we live, work and produce, the so-called green transition¹. This will require substantial investments in greening the economy, which could also lead to job growth if supported by the right policy mix.

The policy mix could include reliable political long-term targets for a green transition, financial incentives and support for greening of industry, investment in ecosystem restoration, incentives and awareness raising for greener consumption, funding programmes to create jobs, skills training, and others.

EXPECTED DEVELOPMENTS

Overall, the green transition is expected to trigger the following 4 key developments in the labour market.²

SECTORAL & REGIONAL IMPACTS



The green transition could have substantial implications for different economic sectors and regions

- Policies delivering a 55 % reduction in greenhouse gas emissions in the EU by 2030 could lead to a moderately positive effect on the total number of jobs in the EU: a net increase of up to 884 000 jobs by 2030, compared to a business-as-usual scenario. >> **PAGE 2**
- Policies delivering a 55 % reduction in greenhouse gas emissions in the EU by 2030 could have substantial impacts on the different economic sectors. Additional jobs can be expected in sectors such as electric goods (up to 3.8 %), energy-intensive transforming sectors (up to 2.4 %), equipment goods (up to 2.4 %), agriculture and forestry (up to 2.2 %), and the electricity (up to 2.0 %). >> **PAGE 3**
- Regionally, the job impact is spread out throughout the EU but with variant effects. An example is the positive job potential in the renewable energy sectors. >> **PAGE 4**
- Only few regions in the EU are significantly exposed to job declines in fossil fuel-based sectors (e.g. coal mining, fossil fuel extraction, fossil fuel processing, fossil fuel supply chains). >> **PAGE 4**

¹ The European Green Deal is the EU's sustainable growth strategy. It aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy, with net zero emission of greenhouse gases in 2050, and economic growth decoupled from resource use. (European Commission 2019a)

² EU 27, if not otherwise stated

TRANSFORMATION OF ENERGY-INTENSIVE SECTORS



The green transition can bring employment benefits in energy-intensive transforming sectors

- Energy-intensive transforming sectors such as steel, cement or chemicals production, can benefit from the green transition if there is a global effort to decarbonise. Policies delivering a 55 % reduction in greenhouse gas emissions in the EU by 2030 could lead to employment gains; particularly in the ferrous metals sector is expected to increase by up to 7 % compared to a business-as-usual scenario. >> **PAGE 6**

UP & RESKILLING



The green transition will lead to job growth across skills categories but reskilling will be important for labour to work in new or changing sectors

- In the energy sector, the green transition is expected to continue generating demand for low- and medium-skilled roles, with 75 % of employees being manual workers and technicians in 2050.³ >> **PAGE 7**
- The digital transition and technological advancement increase requirements for technological skills across the economy. >> **PAGE 7**
- Science, Technology, Engineering and Mathematics (STEM) skills are in high demand. Continuing education and dedicated retraining programmes in diverse fields are crucial to ensure successful job migration between high greenhouse gas emitting economic activities and growing 'green' sectors. >> **PAGE 8**

GENDER-BALANCED GREEN TRANSITION



Women's increased participation in technical education is a prerequisite of a successful transition towards green jobs.

- Transforming job roles and task compositions may contribute to an increase in labour supply by attracting more women and improve gender balance in the process. Attracting more women in STEM education would contribute to higher labour supply in these highly demanded fields. >> **PAGE 8**

³ Figures for EU28

DRIVERS OF CHANGE

Based on trends and developments that are already visible today, various **drivers of change are expected to shape the green transition and green jobs**. Some of them (e.g. purpose-driven work – see below) will occur without specific policy interventions, while the appearance of others (e.g. clean electrification – see below) will require dedicated action.

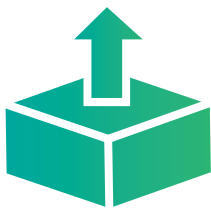
Drivers related to the green transition

These drivers cover the areas in which green jobs are already growing and new ones will emerge.



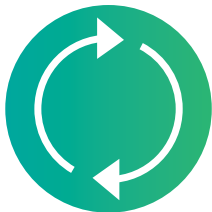
Clean electrification

Electrification will allow the substitution of carbon-intensive processes, for example by replacing combustion engines in cars by electrical engines. Such substitutions will lead to substantial emission reductions, if the electricity for these purposes comes from decarbonised energy sources. >> [PAGE 11](#)



Resource efficiency

Resource efficiency helps to reduce the energy and material consumption. The circular economy and the substitution of polluting or carbon-intensive products and materials will play an important role in this context. It supports decoupling of human well-being from resource use. >> [PAGE 11](#)



Responsible behaviour

Our current lifestyles are out of touch with planetary boundaries. There is an urge within consumers, business, as well as governments and public institutions to fundamentally change their behaviour and choices to enable the green transition. >> [PAGE 12](#)



Healthy and resilient planet

The protection of natural ecosystems, adaptation to climate change and increasing resilience will become more important to reduce the negative effects of environmental degradation, for both nature and humans. The restoration of already damaged ecosystems also plays an increasingly more important role.

>> [PAGE 13](#)

Drivers related to changes in the job market

These general work-related drivers particularly affect green jobs.



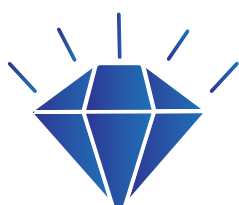
Digital transformation

The digital transition will affect the way we work. For instance, Artificial Intelligence will reduce the amount of repetitive and digital oriented tasks, and instead will allow people to focus on more varied tasks. The digital transition will also create new jobs, for example in cloud computing or big data analysis. These occupations rely more on non-routine interactive tasks, which are out of reach for computers. Digital is also a key enabler for the green transition, such as smart process optimising resource use or Internet of Things for environmental monitoring. >> [PAGE 13](#)



New organisation of work

New information and communication technologies will also enable a reorganisation of work. Flexible working arrangements allow that collaborators conduct projects regardless of their location, in addition to improved work-life balance reconciling work schedules with personal ones. New technologies will incentivise work-related innovations, for instance in business structure, human resources management, relationships with clients and suppliers, or in the work environment itself. Many green jobs are and will be shaped by new organisational patterns, such as ecosystem restoration or environmental monitoring that require spatial and temporal flexibility. >> [PAGE 14](#)



New forms of value creation

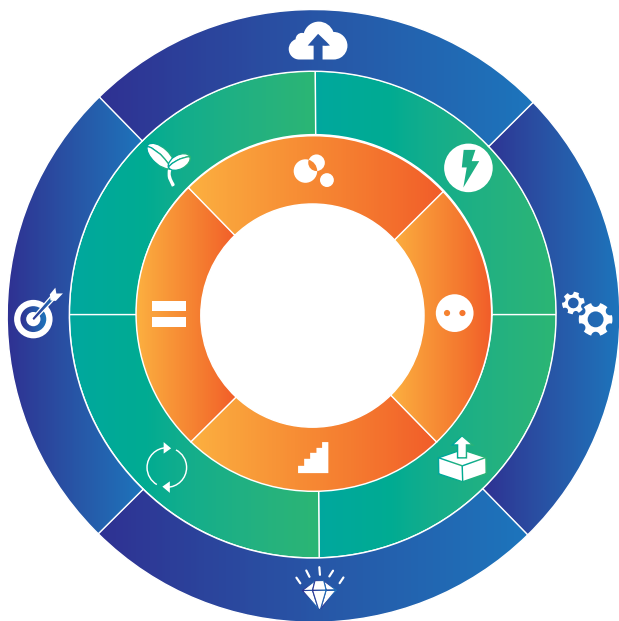
The transformation towards a fairer society will involve new business models with sustainability at their core and a re-design of how production chains work. More local and sustainable production chains arise, and there is a bigger involvement of the end user in product design and production. Green jobs are driving innovation in value chains, such as product sharing, and can profit from taking over of such innovations from other sectors, such as remote maintenance to enhance the use cycle of products. >> [PAGE 15](#)



Purpose-driven work

More people, and especially young talent, increasingly want a job where they feel engaged and are enabled to contribute to a future that is in line with their values and attitudes and helps ensure the workers' wellbeing. Green transition is part of the values and purpose of many and will profit of it. >> [PAGE 15](#)

SNAPSHOTS OF FUTURE JOBS



Expected developments

- Sectoral & regional impacts
- Transformation of energy-intensive sectors
- Up & reskilling
- Gender-balanced green transition

Green - Drivers of change

- Clean electrification
- Resource efficiency
- Responsible behaviours
- Healthy and resilient planet

Jobs - Drivers of change

- Digital transformation
- New organisation of work
- New forms of value creation
- Purpose-driven work

Snapshots of future jobs are based on the expected developments and the drivers of change. They provide examples of how the labour market will change in a green transition. This study presents three types of future jobs:

EXISTING JOBS

Jobs that have new green elements and/or there is an increased demand for these roles. Snapshots cover jobs in the areas from steel production, PV installation, inclusive landscape architecture, to sustainable finance.

>> [PAGE 17](#)

EMERGING JOBS

Jobs that are currently popping up at a small scale. Snapshots range from farming, mobility assistance, material data management, to environmental data analyst. >> [PAGE 21](#)

FUTURE JOBS

Jobs that are currently not there yet, but could in the future become regular jobs. Snapshots include new forms of teaching, career advice, energy production, and matchmaking for sharing. >> [PAGE 25](#)

Green jobs grow and emerge across a wide area of sectors and with all kind of skills levels. The job stories help to get a tangible understanding of transformations in the job market. They break down the findings of macro-economic impacts of the green transformation and analytical drivers of change to exemplary careers and jobs.

Snapshots of future jobs give young people an idea about possible future professions. Education and training providers and policy makers can take the examples as a starting point for a reflection on needs to adjust the curricula.

POLICY IMPLICATIONS

By combining the insights gained from forecast (expected developments) and foresight (drivers of change), we derive the following **implications for policymakers, both national and supranational, regarding the future of jobs in the green transition** and the need for innovative actions to reinforce its positive impact on the labour market:

Support regions in transition with investments in economic diversification, local and regional long-lasting opportunities are created. Concretely, material infrastructure investments need to go beyond environmental restoration and renewable and alternative energy with investments in support sectors such as eco-tourism. Besides, a region-centric approach allows to identify comparative advantages and reform educational systems for a local supply of skilled workers. >> **PAGE 29**

Provide adequate training to workers in transition with specialised programmes, which are more adequate for green activities compared to more general and transversal training programmes (more suited for ICT). Consequently, vocational education and training is better suited to supplement the workforce with the specific skills needed in the emerging green occupations, especially in the case of transitioning occupations with closely related skill-sets. >> **PAGE 30**

Support sectors and companies in transition through dedicated financing instruments to implement largescale restructuring and renovation programmes, together with an adapted regulatory framework to ease the deployment of such a transformation. Support for upskilling to gain knowledge about the possibilities offered by new emerging technologies and how to apply them in practice could even lead to productivity gains. >> **PAGE 30**

Ensure that the green jobs are decent jobs that provide workers with conditions that are in line with their values without compromises on salary, health, safety or living standards. As workplaces are getting more dispersed and more difficult to reach, monitoring and enforcement of good working conditions and safe working practices are likely to become more important. This is the precondition for a fair green transition, leaving no one behind. >> **PAGE 31**

Perform active monitoring of greening labour markets in order to equip people with the right skill set. This includes anticipating skills needs through constant monitoring of the job market, appropriate frameworks and mechanisms for learning new skills, as well as dialogues and joint mechanisms with industry, social partners and educational institutions. The acquisition of skills that are useful in the long-term and would enable people to continue being part of the active work force. Supporting instruments exist at Member State and EU-level (e.g. the European Social Fund Plus or the Just Transition Fund). >> **PAGE 32**













Achieve a crucial shift in values and behaviour through sustainability awareness. Sustainability awareness is essential to ensure that individuals can evaluate the implications of their actions in terms of sustainability. This should be promoted within communities, beyond work and school. Initiatives, such as the sustainable product policy, supported by the European Parliament need to be more comprehensive and apply to the broadest possible range of products. A workforce that is aware of the need for the green transition could create bottom-up pressure in companies and organisations to increase sustainability performance. >> **PAGE 33**

Promote women's participation in green sectors. In order to alleviate the barriers for their participation in the green economy, women need to have the skills and resources to compete in the labour market. Supporting an increase in women's share in STEM education and participation in sectors such as renewable energy or construction could increase women's participation in growing sectors. >> **PAGE 33**

Setup a coherent incentive system to ensure that individuals with the relevant skill-set are interested in green jobs. Policymakers need to design a fiscal system that ensures a fair value for economic activities, internalizing negative environmental externalities and supporting those with positive ones. >> **PAGE 34**

Support willing and able learners from the earliest learning stages. Ensure that these learners have easier access to qualified instructors and revamped curricula. Learners, both in formal education institutions or informal social settings, require adequate access to mentors and eligible career guidance counsellors, and preferably from the earliest learning stages and not until they reach higher education levels or when they are in the labour market. >> **PAGE 34**

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**THE FUTURE
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The European Green Deal is the EU's sustainable growth strategy. It aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy, with net zero emission of greenhouse gases in 2050, and economic growth decoupled from resource use.¹

This short foresight study aims to leap forward to 2040 and beyond, envisioning plausible medium- and long-term futures for the European labour markets in view of the green transition. Drivers of future developments are highlighted. These in turn inform policy action today to achieve the most favourable future labour market outcomes.

This study aims to shed light on how jobs will change in the green transition. It provides examples of changing job roles and potential new jobs that might emerge as part of this process. This study also looks at implications of the green transition for people, as they enable 'the greening' of production processes, products, and services² in the green transition. Adjustment is needed from workers as well as education providers and wider industrial ecosystems, including public administrations on all levels.

Three different perspectives are taken into account:

The **expected developments** (forecast) describe developments that can be estimated with the knowledge we already have today. The expected developments were derived from a review of existing quantitative analyses.

The **drivers of change** (foresight) highlight what we can see already, on a small scale, and could have a big influence on the future. The drivers of change were collected through a literature study and validated with a Delphi study.

The **snapshots of future jobs** sketch possible visions of how future employment could look, taking the expected developments and drivers of change into consideration. These help to get a tangible understanding of transformations in the job market.

What are green jobs?

According to the definition of the International Labour Organisation (2016)³, "Green jobs are decent⁴ jobs that contribute to preserve or restore the environment, be they in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency." They are divided into two categories:

1) jobs that design and produce goods or provide services that benefit the environment, such as green buildings, clean transportation, and renewable energy, sustainable food.

2) jobs that contribute to more environmentally friendly processes in the production of any product or service, e.g., increasing water/energy efficiency, improving recycling systems. These more environmentally friendly processes should apply along the whole life cycle from resource mining to waste management.

¹ European Commission (2019a)

² See taxonomy "enhanced skills" (Bowen et al., 2018)

³ International Labour Organization & United Nations (2016)

⁴ A definition for decent jobs used by ILO and the Commission "productive work for women and men in conditions of freedom, equity, security and human dignity" with a focus on fair income secure employment and safe working conditions, equal treatment, social protection and social dialogue.

Expected developments

In this chapter, we present an overview of expected developments in the EU labour market triggered by the green transition.

It brings together estimates on the effect of the green transition on the number of jobs, sectoral implications, regional implications, skills needs, and gender equality. The overview builds on a review of already existing economic modelling results.⁵



The green transition could have substantial implications for different economic sectors and regions

The green transition could have a moderately positive impact on total jobs in the EU

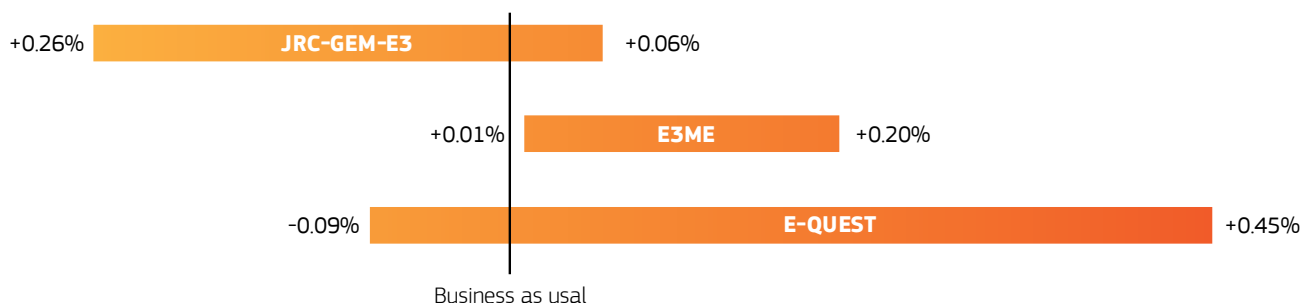
The impact of the green transition on employment has been assessed frequently in the past without reaching consensus on the net job impact of such a transition.⁶ Previous

assessments have singled out two opposing outcomes of green policies. Environmental standards limiting pollution are estimated to lead to job losses in some sectors,⁷ such as coal mining or polluting industries. On the contrary, innovation and investment support to clean technologies is estimated to lead to job growth in other sectors,⁸ for example along renewable energy and low emission transport related value chains (including the manufacturing of batteries).

In the EU, the green transition is estimated to lead to a net increase in jobs. Figure 1 shows the potential employment impact of policies that would deliver a 55 % reduction in greenhouse gas emissions by 2030⁹, compared to 1990 levels. The bars show ranges of results for three different economic models using different labour market assumptions.¹⁰ The analysis shows that these policies could lead to a net increase in jobs of up to 884 000 or +0.45 % by 2030, compared to a business-as-usual scenario.

The green transition can potentially lead to economy-wide net job gains. This will happen through realignment of employment between different economic sectors. Jobs will flow from

Figure 1: Comparison of total number of jobs in the EU 27 between a 'business-as-usual' scenario and a policy scenario delivering a 55 % climate target by 2030, using three different models (JRC-GEM-E3, E3ME, E-QUEST)



Source: European Commission (2020b) **Note:** Business as usual = achieving the existing 2030 targets (as at September 2020) for greenhouse gas emissions, renewable energy shares, and energy efficiency.

⁵ Existing modelling results for 2030 underwent a sensitivity analysis that showed that the results are valid despite the impact of the pandemic on the EU's economy (European Commission, 2020a). Regarding modelling results for 2050, the impact of the pandemic is considered negligible.

⁶ Marin & Vona (2019)

⁷ Walker (2011)

⁸ Gagliardi et al. (2016), Flachenecker et al. (2021)

⁹ European Commission (2020b)

¹⁰ Each model evaluates several policy option scenarios that would deliver the 55% climate target. The bars show the range of potential job impacts across the scenarios for each model, comparing a scenario that would deliver the 55% target with a scenario with no additional climate policies (as of 2020). For a detailed description of model assumptions, please refer to European Commission (2020b).

more fossil fuel intensive, high greenhouse gas emitting economic activities to growing 'green' sectors:¹¹ in the electricity supply sector, up to 315 000 jobs can be created by 2030 in coal regions alone by deploying clean energy production technologies.¹² Renovation and decarbonisation of the existing building stock could lead to a creation of 160 000 additional jobs by 2030.¹³ Increased electrification of transport including the production of batteries for vehicles could lead to 800 000 additional jobs by 2025.¹⁴ In addition, the circular economy could lead to the creation of 700 000 additional jobs by 2030.¹⁵

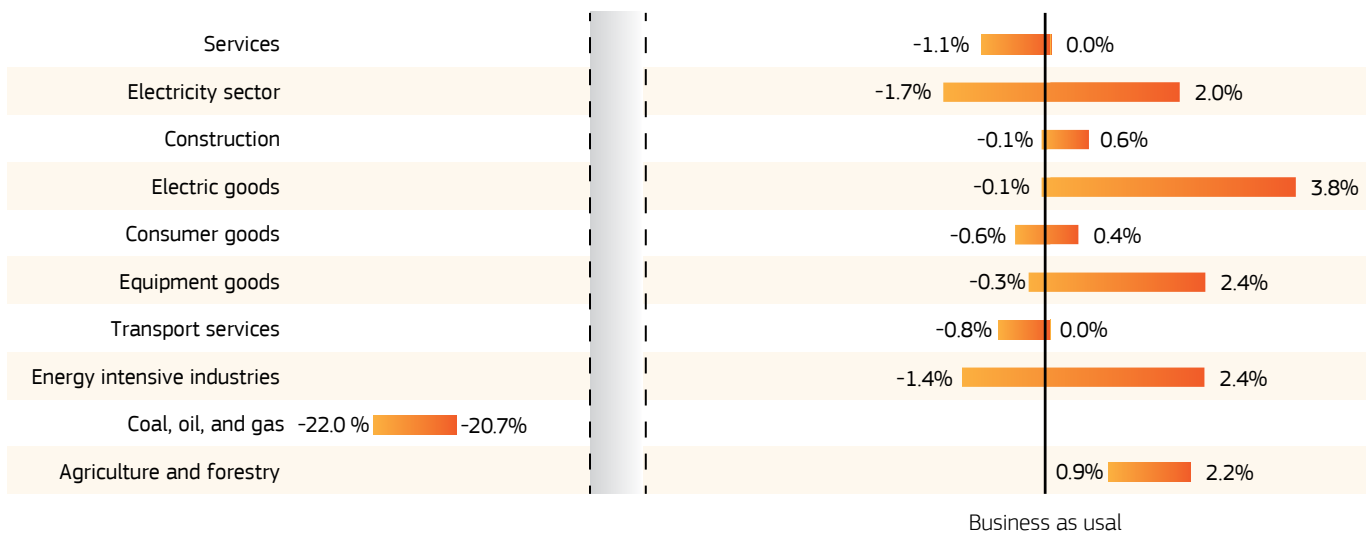
The quality of green jobs does not differ systematically from those of brown jobs.

Promoting institutional protection and raising formal and informal employment protection and enforcement across all jobs should be the focus of policy to improve the manageability of the transition.¹⁶

The green transition could lead to job shifts between economic sectors

While the impact of the green transition will be substantial on some sectors, such as coal mining, studies show that the overall effect on job reallocation will be limited.¹⁷ The reason for this circumstance is the high concentration of carbon-intensity in a limited number of sectors that account for only a small

Figure 2: Future potential impact of the climate transition on sectoral employment in the EU in a policy scenario delivering a 55% reduction climate target by 2030



Source: European Commission (2020b) **Note:** Business as usual = achieving the existing 2030 targets (as at September 2020) for greenhouse gas emissions, renewable energy shares, and energy efficiency

11 McCarthy et al. (2018)
 12 Estimate for the EU and UK (Kapetaki et. al., 2020)
 13 Estimate for the EU (European Commission, 2021a)
 14 Estimate for the EU and UK (Cambridge Econometrics, Trinomics, ICF, 2018)
 15 Estimate for the EU and UK (Cambridge Econometrics, Trinomics, ICF, 2018)
 16 Hancke, Van Overbeke, Neos (2020)
 17 Chateau et al. (2018)

amount of employment: 80 % of greenhouse gas emissions in OECD countries is emitted by sectors that account for 8 % of total employment.¹⁸

The green transition could lead to additional jobs in some sectors compared to a business-as-usual scenario. The electrification of the economy is expected to lead to job growth in the electric goods sector (up to 3.8%) and the electricity sector (up to 2.0%); an increase in demand for raw materials needed to build renewable energy power plants could lead to job growth in energy-intensive transforming sectors (up to 2.4%); and an increased demand for biofuels and renewable materials could lead to job growth in agriculture and forestry (up to 2.2%). Figure 2 shows the employment effect of the green transition on different sectors by comparing a 'business-as-usual' scenario¹⁹, with a policy scenario delivering a reduction in greenhouse gases of 55 % by 2030, compared to 1990 levels. It shows that the green transition will lead to a shift of jobs from coal, oil, and gas to other sectors.

Some regions will be more affected by the green transition than others

Positive employment impacts are geographically spread out, as shown for jobs gained in the construction sector or the circular economy. The positive employment effect in the construction sector will be related to an increase in energy efficiency measures that would lead to local job creation throughout the EU.²⁰ The implementation of a circular economy is expected to create jobs predominantly in urban but also in rural areas for example in the areas of circular architecture, circular design, and repairs.²¹

Additional jobs in the renewal energy sector would be spread out across the EU.²² This positive job effect of the green transition is spread out throughout the EU. Figure 3 shows the potential for onshore solar and wind energy across Europe²³, as well as the regions that are most exposed to declining fossil fuel-based sectors. The left map shows a conservative estimate of the energy potential while the right map shows an optimistic estimate.²⁴ Particularly the potential for solar energy is spread out throughout the EU.

Employment in fossil-fuel based industries has been falling in the EU in the past. This development is due to a decreasing competitiveness of EU coal mines and will continue even without any policy intervention.²⁵ Regions that formerly depended on coal mining as their economic backbone often do not have a diversified economy with other sectors that could absorb displaced labour, or there is a mismatch between local labour market needs and the skills in the declining industries. Therefore, coal regions have the challenge to attract new industries to build future-proof local economies.²⁶

Employment in fossil fuel based sectors is due to decline but poses a substantial challenge only in a few regions in the EU. This is illustrated by Figure 3, which shows potential job shifts away from coal mining and coal-based power generation as well as their supply chains between 2020 and 2030.²⁷

The economic diversification of former coal regions is the most beneficial way forward. The support that is required to keep non-competitive industries running is

18 OECD (2019a)

19 European Commission (2020b)

20 European Commission (2018b)

21 Circle Economy, & EHERO (2017)

22 International Labour Organization (2018)

23 ENSPRESSO, JRC (2021a)

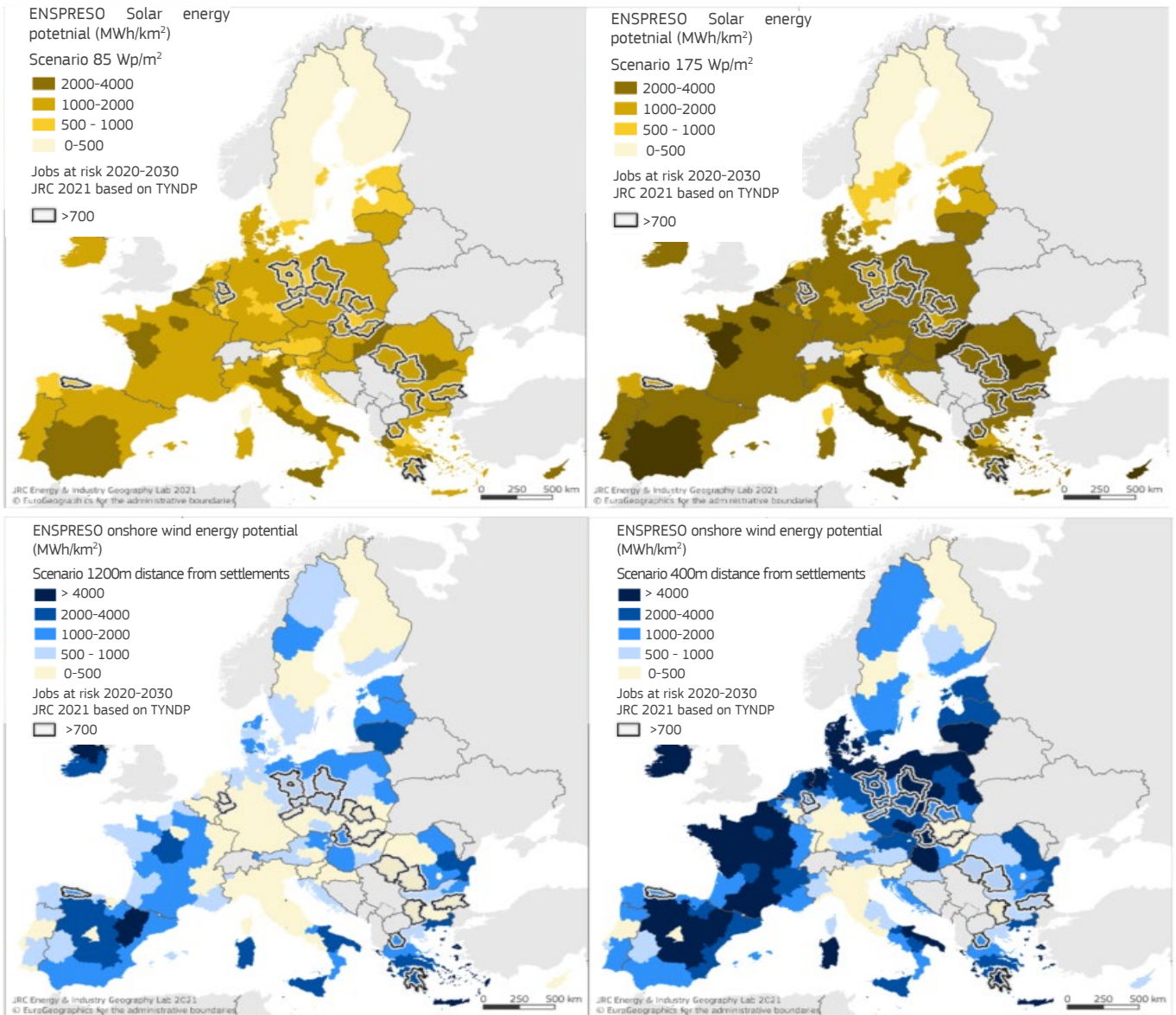
24 For more information on the underlying assumptions, please refer to Dalla Longa et al. (2018)

25 E.g. Climate Analytics (2017) or Alves Dias et al. (2018)

26 Heyen et al. (2020)

27 JRC (2021a)

Figure 3: Onshore solar and wind energy potential and jobs at risk in 2020-2030 in coal mines and power plants



Source: ENSPRESO, JRC (2021) Factsheet on EU Trends - Coal peat oil

Note: Solar includes open-field PV using 3% of the available cropland, abandoned or set aside land; assumed performance ratio of 0.75. Wind includes only locations with wind capacity factor >20%; assumed turbine with 300 W/m² specific power and 100m hub height.

substantial²⁸ and efforts to reanimate declining sectors have been fruitless in the past.²⁹ Experience from past transitions shows that two success factors of coal region transitions include i) the focus to move to sectors with long-term growth potential, such as renewable energy or circular economy-related sectors³⁰ and ii) a transition has to be planned well in advance, as it usually takes at least a decade to complete in an optimal way.



The green transition can bring employment benefits in energy-intensive transforming sectors

All sectors will have to become greener in the environmental transition. This is particularly challenging for energy-intensive transforming sectors, such as cement, chemicals, and steel production. These sectors use production processes characterized by high greenhouse gas emission and pollution. As these energy-intensive sectors will still be needed in a climate-neutral future, the development of climate-neutral production processes will be crucial for them.³¹

A potential risk is the global relocation of energy-intensive transforming sectors to regions with lower environmental standards, also referred to as ‘carbon leakage’. To prevent carbon leakage, several economic sectors have received a higher share of free emission allowances in the EU. As a result, for the period 2005-2012 no carbon leakage has been identified in the EU.³² Deep decarbonisation of the energy-intensive transforming sectors might further increase the operating costs of these sectors and could make additional protective measures necessary³³ to safeguard the competitiveness of a zero-carbon EU industry sector.

Energy-intensive transforming sectors such as steel, cement or chemicals production, can benefit from the green transition if there is a global effort to decarbonise. Figure 4³⁴ illustrates the employment impact of policies that would deliver a 55% reduction in greenhouse gas emissions by 2030, compared to 1990 levels. With a global effort to reach the goals of the Paris Agreement, energy-intensive transforming sectors can benefit as their products are and will be used in technologies enabling the green transition. Employment particularly in the ferrous metals sector is assumed to increase by up to 7% compared to a business-as-usual scenario.

28 Spain spent approximately €22bn on subsidies for mining activities between 1992 and 2014 (Del Rio, 2017)

29 Schulz & Schwartzkopf (2016)

30 Schulz & Schwartzkopf (2016)

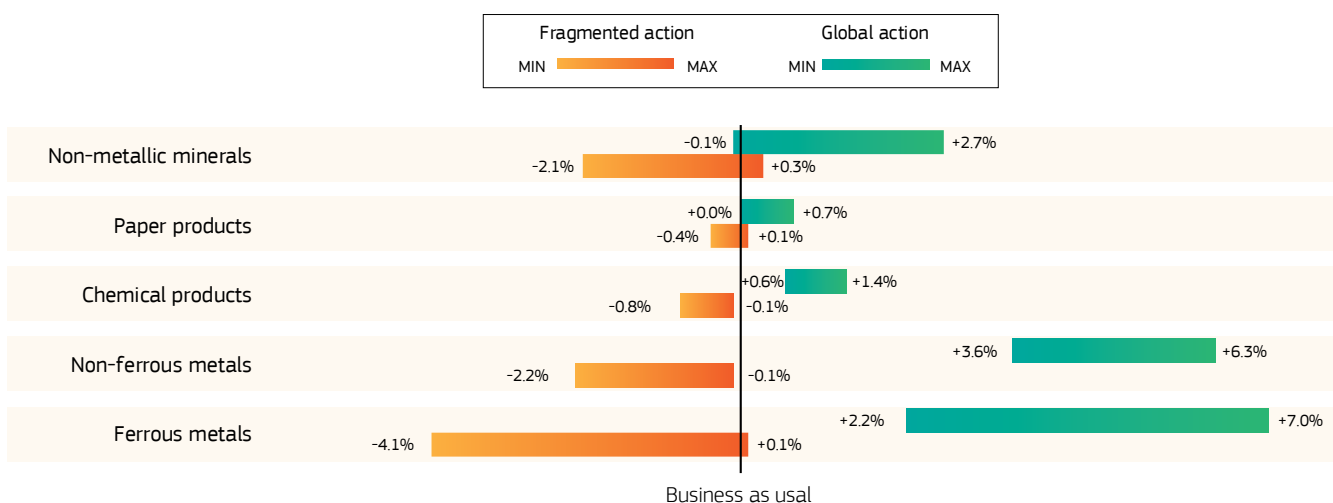
31 Heyen et al. (2020)

32 Rademaekers et al. (2012)

33 Such as the Carbon Border Adjustment Mechanism which was proposed by the European Commission

34 European Commission (2020b)

Figure 4: Comparison of jobs in carbon-intensive sectors between a ‘business-as-usual’ scenario and a policy scenario delivering a 55% climate target in EU 27 by 2030



Source: European Commission (2020b) **Note:** Business as usual = achieving the existing 2030 targets (as at September 2020) for greenhouse gas emissions, renewable energy shares, and energy efficiency. Fragmented action: EU reaches the Green Deal climate targets but the rest of the world implements only their Nationally Determined Contributions. Global Action: EU reaches the Green Deal targets and the rest of the world follows on a trajectory compatible with the 1.5°C Paris Agreement target.



The green transition will lead to job growth across skills categories but re-skilling will be important for labour to work in new or changing sectors

In the greening energy sector, demand for manual workers and technicians will remain dominant.³⁵ Manual workers in the sector are highly trained, qualified and skilled. The energy sector offers examples of overlaps in skill requirements of declining and growing sectors in the green transition. Due to the similarities in installation, construction, operation

and maintenance processes, the offshore wind sector shares many complementary skills and occupational patterns with the offshore oil and gas sector.³⁶ Technical and engineering profiles with transferable skills from high greenhouse gas emitting sectors are also strongly sought after in other renewable energy industries (e.g. biomass, geothermal, ocean, small hydro, PV and solar thermal).³⁷ Technical and mechanical skills of coal miners, who work in challenging environments, can also be transferred to other industries such as the installation of renewable energy power plants.

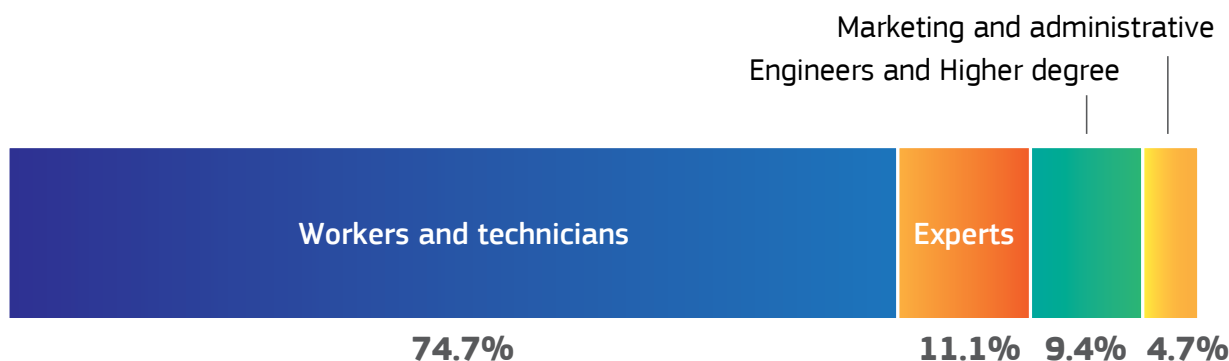
The digital transition and technological advancement increase requirements for technological skills across the economy. For example, in the building sector, information and communication technology in general is increasingly embedded in the everyday tasks of construction workers. The use of advanced

³⁵ IRENA (2020a)

³⁶ IRENA (2018)

³⁷ Czakó et al. (2018)

Figure 5: Occupational requirements along global solar, wind and geothermal renewable energy value chains by 2050



Source: IRENA (2020b)

electronic machinery requires increased levels of technological competence. The development of smart buildings is also pointing in this direction.³⁸ In the agriculture sector, fisheries and forestry sectors are increasing the implementation of technology and ‘agri-tech’ poses a similar challenge.³⁹ STEM (Science, Technology, Engineering and Mathematics) skills are therefore critical to drive the green-digital twin transitions.⁴⁰ At the same time the supply of STEM graduates needs to increase by promoting STEM education pathways from at least secondary school onwards.

Continuing education and dedicated retraining programmes are still crucial to ensure successful job migration between more fossil fuel intensive, high greenhouse gas emitting and polluting economic activities and growing ‘green’ sectors. A challenge for people working in the energy-intensive transforming sectors is that they have often already completed extensive training to gain the skills specifically needed in their sector. They might fear to lose their investment in developing these skills if production processes change substantially.⁴¹ This is in particular valid as motivation to re- or up-

skill decreases in the late stages of professional life. Also in the energy sector, a shift may occur in the composition of tasks. For example, if drones are used to monitor wind turbines⁴² in the future, technicians may spend more time on problem prevention and problem solving.⁴³

Figure 5⁴⁴ shows that **in the energy sector, the green transition is expected to continue to generate demand for low- and medium-skilled roles with 75 % of employees being manual workers and technicians (i.e. not experts or engineers requiring higher degrees) in 2050.**



Women’s increased participation in technical education is a prerequisite of a successful transition towards green jobs

Women are under-represented in the workforce, particularly in the energy sector. Even in the relatively more gender balanced renewable energy sector (compared to for

38 EU Skills Panorama (2014)

39 E.g. technologies related to primary production for both food and non-food uses; soil science; crop and livestock genetics; agri-chemicals; and general purpose technologies such as remote sensors, satellites and robotics (EU Skills Panorama, 2014)

40 European Commission (2020c)

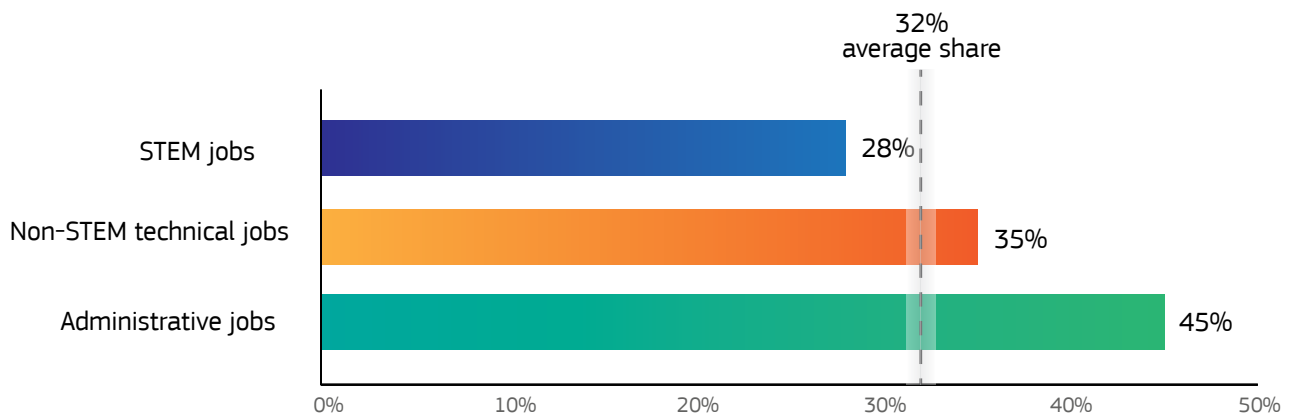
41 European Commission (2019b)

42 International Energy Agency (2017)

43 Bughin et al. (2017)

44 IRENA (2020b)

Figure 6: Share of women in STEM jobs, non-STEM technical jobs and administrative jobs in the renewable energy sector in 2018 (global, based on IRENA online survey)



Source: IRENA (2019)

example fossil fuel industries) women constitute only 32% of the overall work force. They are more likely to work in administrative roles (45%) than in Science, Technology, Engineering and Mathematics (STEM) (28%) or other technical jobs (35%).⁴⁵ Administrative roles tend to have lower salaries and no major decision-making opportunities that foster change. They are also associated with lower chances for career progression, compared to core business-related, managerial, or technical fields. At the same time, women are underrepresented in occupations requiring specialised technical knowledge in STEM fields, as shown in Figure 6.⁴⁶ In connection to this, women are listed in less than 11% of the energy sector-related patent applications globally.⁴⁷

Increasing women’s share in education in technical fields is a prerequisite for improved participation and thus increased overall labour supply in the greening energy sector. Currently in the EU-27, less than a third of higher education students in “Engineering,

manufacturing and construction”, and less than a fifth in “Information and Communication Technologies” are female. Only the “Natural sciences, mathematics and statistics” sub-fields of STEM education are gender balanced.⁴⁸

Associations have been set up around the world, including in Europe, to enhance women’s participation in traditionally male-dominated, greening sectors (e.g. energy, construction). These networks facilitate the entering of women in STEM fields of education, the retention of the female STEM workforce in the labour market and support their career progression. At the same time, the participation of utility, energy and technology companies in gender diversity initiatives is lower than in other sectors.⁴⁹

Improvements in gender balance at the workplace will also be driven by digitalisation and automation and through associated changes in job profiles and task compositions. For example, in the transport sector, freight transport may significantly

45 IRENA (2019)

46 IRENA (2019)

47 International Energy Agency (2020)

48 Eurostat (2021a)

49 International Energy Agency (2020)

change because of an increased use of connected, automated, low-emission vehicles. These will be operated from remote control rooms, increasingly requiring supervision and selective intervention skills,⁵⁰ as opposed to physical strength and endurance in turn potentially leading to higher participation of women in this sector. A similar shift towards remote operation could improve gender balance in other sectors as well.



⁵⁰ Raposo (2018)

Drivers of change

In this chapter, we present an overview of drivers of change that are already perceptible now and likely to impact the future of jobs in the green transition. Based on the scanning and review of forward-looking literature on green transition and jobs, the JRC gathered trends and developments. In an iterative process, these trends and developments were then converted into eight key drivers of change. They comprise four drivers that relate to the green transition and four drivers related to expected general changes in the job market. These drivers have been validated by experts via a Delphi survey.⁵¹

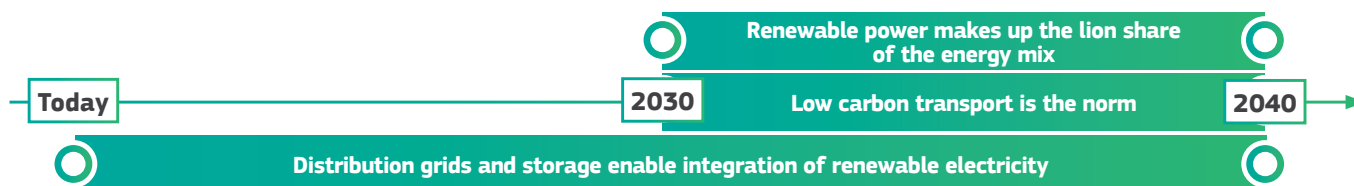
Drivers related to the green transition

Clean electrification



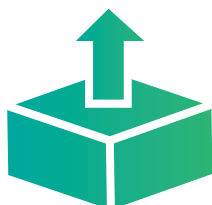
The potential of electrification in combination with renewable energy is key to achieve climate neutrality. Climate neutral power generation and necessary storage capacity will be important to decarbonise the energy sector. Through electrification, end user applications such as heating and cooling, transportation, and industrial processes can also be decarbonised by replacing carbon-intensive processes and products such as cars with combustion engines.⁵² Crucial is the adjustment of electricity grids to be flexible and to integrate high shares of renewable energy.⁵³

The following trends will most likely happen somewhere between now and 2040:



Green power and provisioning of renewable energy will be the dominant sector to provide new green jobs (e.g. in the upgrade of the electricity system to 100% RES with smart grids, storage, decentral renewable energy production, provisioning of energy technologies, bioenergy, decarbonisation of mobility).

Resource efficiency



With a growing global population, resource efficiency plays an increasingly crucial role for a sustainable way of living.⁵⁴ One important element is energy efficiency, which helps to keep high standards of living while reducing costs of energy.⁵⁵ Another pillar of resource efficiency is the circular economy, which fosters longer product lives by re-use and repairs and reduces resource consumption by recycling. A shift towards a more circular economy could substantially reduce emissions and pollution, for example, up to 60 % reduction of materials-related greenhouse gas-emissions in the buildings sector.⁵⁶ Lastly, replacing carbon-intensive or polluting materials with greener ones will also increase resource efficiency.⁵⁷ The efficiency gains lead to higher resource productivity, i.e. the relation between economic activity and domestic material consumption. In the EU, resource productivity has increased by 35 % in the last 20 years.⁵⁸

51 Online survey technique for collecting and synthesising expert opinions, where participants see the results of other contributions and can rethink and revise their own input (Millennium Project 2017). It is therefore a structured way to reach consensus in a group (Hasson et al. 2000)

52 Potočník et al. (2020), European Commission (2018a), and European Federation for Transport and Environment (2018)

53 Sustainable Development Solutions Network (2021) and European Commission (2018b)

54 United Nations Environment Programme (2011)

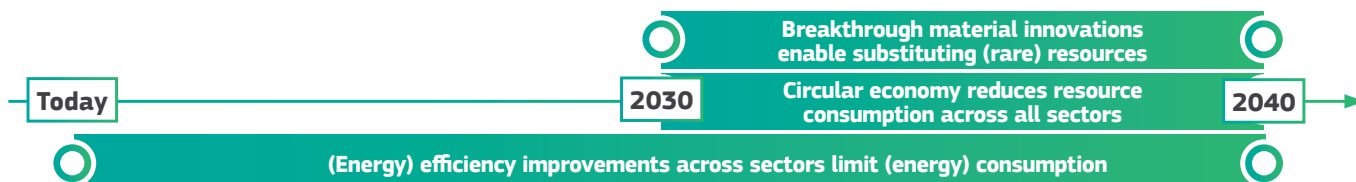
55 International Energy Agency (2019)

56 International Labour Organisation (2018), Ellen McArthur foundation (2019) and EEA (2020)

57 Pavel et al. (2017)

58 Eurostat (2021c)

The following trends will most likely happen somewhere between now and 2040:



Jobs and tasks cover issues such as improving energy, material, resource and land-use efficiency, reducing negative environmental and social impacts. New jobs emerge to monitor the footprint and manage improvements and innovations.

The circular economy is a huge lever for new jobs. Affected areas are, for example, eco-design, re-use, repair and upgrade of products, recycling to close material loops, secondary materials trading. Resource-intensive product value chains with a high potential in circularity are in the focus of political strategies to push circular economy in Europe; these are electronics and Information and Communication Technologies, batteries and vehicles, packaging, plastics, textiles, construction and food.⁵⁹

Jobs shifts will occur, and new jobs will raise in material research, resource mining, raw material processing (mineral and metallurgical processes, chemical industry), and material production. Sectors most affected by critical raw material dependency are renewable energies, e-mobility, defence and space, and ICT.⁶⁰

Responsible behaviour



Responsible choices make it possible to live a sustainable life.⁶¹ All stakeholders will have to be on board, including governments and public institutions, the private sector, and consumers.⁶² Including social and environmental costs in decision-making will be a catalyst for becoming more sustainable and for guiding all these stakeholders in the green transition.⁶³

The following trends will most likely happen somewhere between now and 2040:



Sales and selling will shift to sharing and lending, which will require new production, organisational and transportation systems. Repair of products and social service workspaces for 'Do It Yourself' will grow. Besides, the development of technologies to enable sustainable consumption will improve (sensors to track carbon footprint, use-by date warning to reduce food waste, energy waste warmer, demand management of energy consuming devices, etc.).

Jobs that support eco-innovation,⁶⁴ will be more and more implemented in private and social businesses.

⁵⁹ European Commission (2020d); CEN & CENELEC (2021)

⁶⁰ JRC (2020)

⁶¹ Demos Helsinki (2011)

⁶² Potočnik et al. (2020), Dinnie et al. (2017), One Planet Network (2019) and Ernst & Young (2021)

⁶³ World Business Council for Sustainable Development (2021)

⁶⁴ Schiederig et al. (2011)

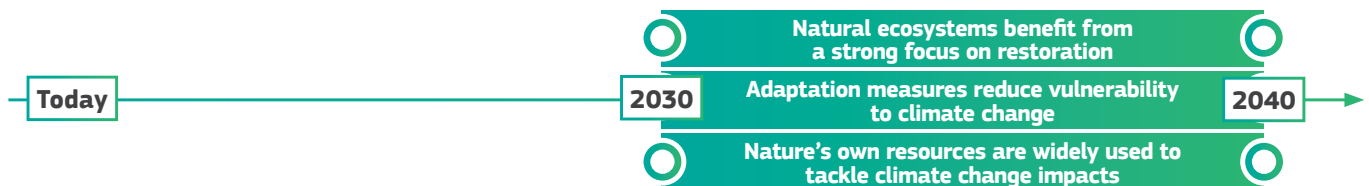
Auditing and screening of sustainability criteria will grow. Finally, new technologies will be developed to track sustainability criteria as well as social and environmental costs along the value chain.

Healthy and resilient planet



A deteriorating natural environment has severe negative effects, like the depletion of resources, which also affects human and planetary health.⁶⁵ Therefore, the protection of ecosystems and biodiversity as well as the restoration of ecosystems will become more important.⁶⁶ Adaptation measures make natural and human habitats more resilient against the increasingly negative effects of climate change.⁶⁷

The following trends will most likely happen somewhere between now and 2040:



Jobs and tasks cover vulnerability and risk assessment, planning, implementing of measures, monitoring and evaluation, communication and awareness raising. Tasks of farmers, foresters and landscape planners as well as construction workers will be shifted towards adaptation, such as coastal habitat restoration, agroforestry, integrated water resource management, livelihood diversification, and sustainable forest management.

Drivers related to changes in the job market

The job market related drivers affect the job market in general. The specific relevance for jobs in the green transition is illustrated.

Digital transformation



Data is of substantial economic value and the IT sector is expected to continue to grow in the future, which means that the demand for IT and programming skills will also increase.⁶⁸ The digital transition will also change how jobs will be performed. For example, Artificial Intelligence could support workers to carry out mainly routine tasks more efficiently and focus on more varied tasks. In fact, 14 % of today's jobs (over 66 million workers across 32 OECD countries) are highly automatable reaching levels as high as 33 % in Slovakia, for instance, and need to transition to the green and digital economy.⁶⁹ Occupations with related skills requirement will transition to new positions to meet the surging demand for roles at the forefront of the data and Artificial Intelligence economy, as well as new roles in engineering, cloud computing and product development.⁷⁰ These occupations rely more on non-routine interactive tasks, which are out of reach for computers.⁷¹

⁶⁵ Gupta et al. (2019)

⁶⁶ Convention on Biological Diversity (2010) and Joint NGOs (2020)

⁶⁷ International Union for Conservation of Nature (2021) and United Nations Environment Programme (2021)

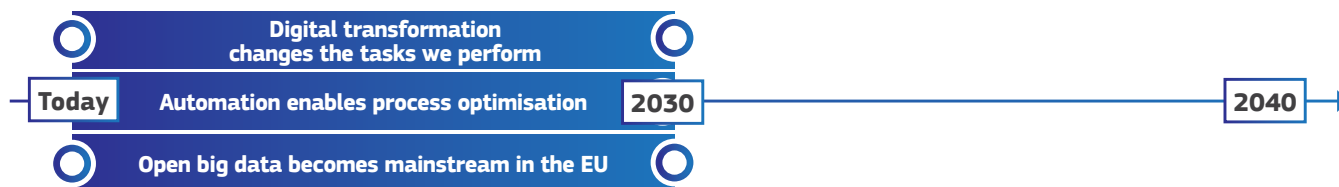
⁶⁸ Bughin et al. (2018)

⁶⁹ OECD (2019b)

⁷⁰ WEF (2020)

⁷¹ Nedelkoska & Quintini (2018)

The following trends will most likely happen somewhere between now and 2040:



Digitalisation creates new jobs directly, like data analyst, blockchain specialist and Internet of Things architect. But also, indirectly, by transforming existing jobs into new dimension like hologram stylist, virtual couture designer and augmented reality life designer, and through new jobs that guide and support the digital transformation, like empathy officers and avatar translators.

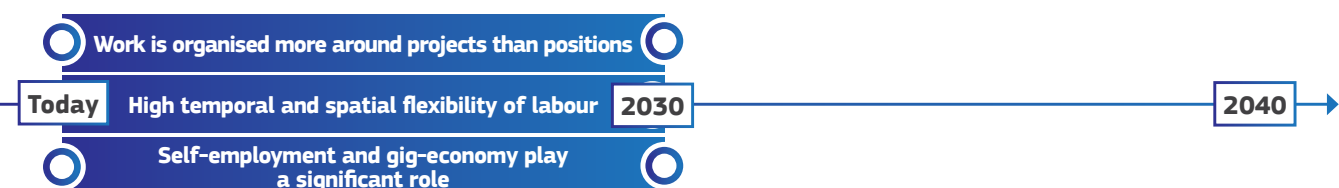
Digitalisation is a key enabling technology for many green jobs: For example, smartening of processes and use phase can increase resource efficiency, balance power demand and generation, and provide information about the state of the environment and environmental impacts to direct ‘greener’ decision making. Most green jobs presented in the next chapter contain digital tools or depend on digital platforms.

New organisation of work



New approaches of work increase the role of project-focussed teams, the gig-economy, freelancers, and micropreneurs. There is also an increase in regional and temporal flexibility of work, enabled by modern information and communication technology. This flexibility may lead to improved work-life balance reconciling work schedules with personal one,⁷² but may also boundaries between in and outside of the workplace.⁷³ Remote working could reduce emissions and pollution⁷⁴ and allow employees to reconnect with nature, for example by working in a greener environment compared to a traditional office space.⁷⁵

The following trends will most likely happen somewhere between now and 2040:

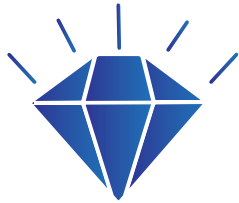


The tasks of Human Resources and recruiters will become more important, e.g. to match skills and projects as increasingly more work will be project-based and remote. New flexible and multifunctional location, transportation design and coordination will rise. Career coaching and work life balance specialists will guide workers throughout their lives. Digital hard and software will have a big influence on creating and managing the systems that make this possible.

Green jobs are similarly affected by the new organisation of work trends: Tasks are mainly organised around projects, in particular ecosystem restoration and adaptation or environmental monitoring already requires flexibility to work where and when green issues are present. Voluntary work and commitment for environmental issues already is a particular form of temporal self-employment, the rising need for green solutions will open up new start-up opportunities for self-employment; digitalisation of green jobs opens the possibility for platform based virtual job collaboration.

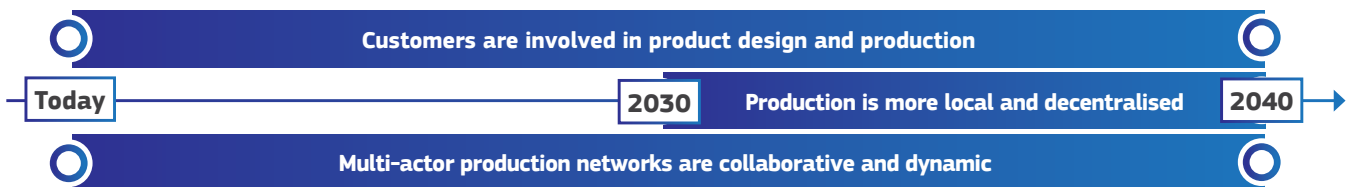
72 OECD (2021)
 73 Cone Communications (2017)
 74 Global Action Plan (2020)
 75 Haasova et al. (2020)

New forms of value creation



The transformation towards a fairer society will involve a re-design of how production chains work. The development of local production systems could take a more ‘people-centred approach’ and reduce the negative environmental impacts associated with transportation over long distances.⁷⁶ New production systems will also involve customers more closely and in a more democratic way when it comes to designing and producing products, turning them into ‘prosumers’;⁷⁷ it can already be observed in crowd-funding campaigns.

The following trends will most likely happen somewhere between now and 2040:



New jobs in running sharing platforms and services will emerge, traceability of quality and environmental and social conditions across more complex value networks will require specific data analyst jobs and managers to orchestrate the network.

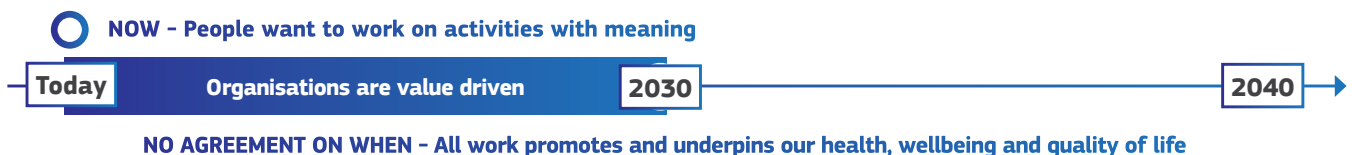
Many green jobs will have a user interaction as the optimisation of the use phase and behavioural change are central elements. Replacing product ownership through services, such as sharing as well as local value chains are key components of many green jobs that drive decentral production, multi-actor networks and prosumerism (as increase involvement of consumers in production of goods).

Purpose driven work



The vast majority of Generation Y employees (96 %) want their employers to be sustainable.⁷⁸ Green business initiatives and a commitment to sustainability can increase motivation and productivity of the work force⁷⁹ and increase employee loyalty.⁸⁰ A sustainable workplace should also fuel reskilling and upskilling uptake that, in turn, increases a sense of purpose and achievement among staff.⁸¹

The following trends will most likely happen somewhere between now and 2040:



Value driven jobs will rise and become more and more popular, even becoming a standard for all jobs. Green jobs, one core group of value driven jobs, beyond social business jobs and others. Non value-driven jobs will have to find ways to add value to society.

76 FAO (2020)
 77 Lüdeke-Freund & Froese (2020)
 78 Greene (2021)
 79 NBS (2021)
 80 Sustainability Institute (2021)
 81 World Economic Forum (2020)

Snapshots of future jobs

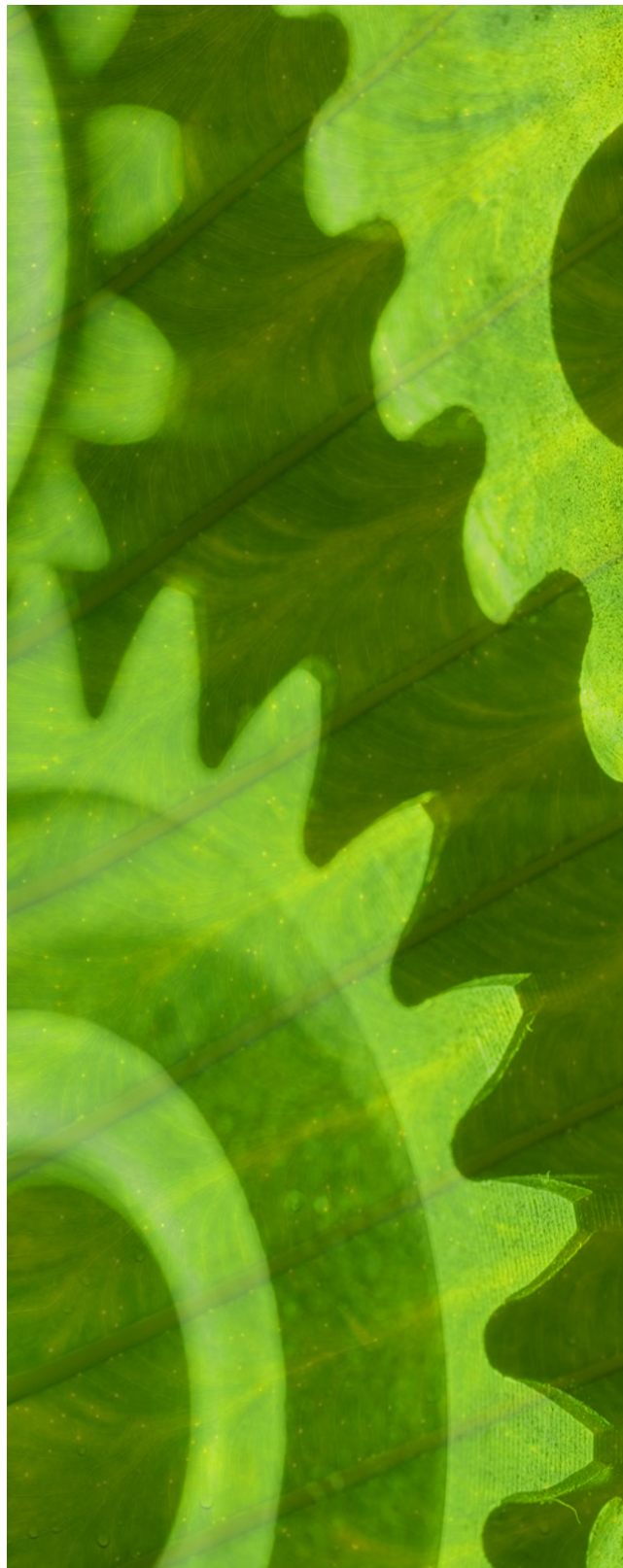
In this chapter, we present snapshots of future jobs, based on the expected developments and the identified key drivers of change. These snapshots highlight how already existing jobs might evolve and provide examples of potential newly emerging jobs in the context of the green transition.

The snapshots of the future describe different types of jobs in 2040 and beyond. They take a tangible real-life perspective to make the future more accessible.⁸² Policy makers, and others, can start to reimagine how the transformation of the job landscape could evolve and what it needs to enable an inclusive green labour market.

The transition towards a more sustainable and green economy influences jobs through changes in tasks, skills and knowledge requirements.

Demand may increase for some existing jobs without significant changes in tasks, skills and knowledge (e.g. installation of onshore wind power plants). Other existing jobs may undergo significant adjustments (e.g. electric vehicle electrician). Entirely new jobs are also being created through the expansion of the green economy (e.g. material passport producer).⁸³ Therefore, we grouped future jobs into three categories:

- **EXISTING JOBS** - jobs that have new green elements and/or there is an increased demand for these roles
- **EMERGING JOBS** - jobs that are currently popping up at a small scale
- **FUTURE JOBS** - jobs that are currently not there yet, but could in the future become regular jobs



⁸² Haarbosch et al (2021)

⁸³ European Commission (2019c)

SUSTAINABLE FINANCE SPECIALIST

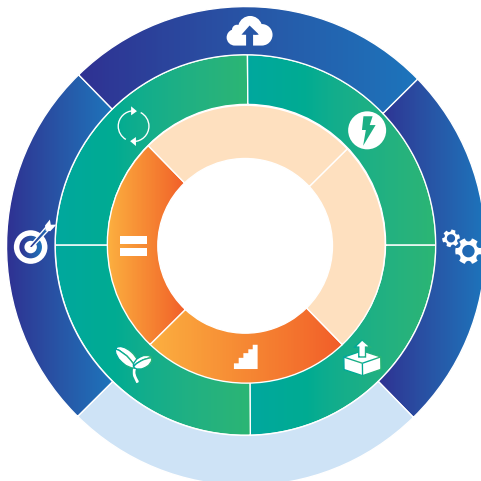
Antonia (43), Luxembourg - Freelance environmental economist and sustainable finance specialist.

Background: Since she was a teenager, Antonia has felt extremely concerned about the future of her generation. In middle school, she joined the Fridays for Future climate strike movement. She was also inspired by the success of the young man who alleged “that his pension fund was failing to protect his retirement savings against climate change”. In 2019, the almost 2-million-member fund agreed to align its portfolio to net zero⁸⁴ by 2050 (i.e. investing in climate friendly ventures). Antonia has one child now. She has a Bachelor’s degree in Environmental Economics and a Master’s degree in Sustainable Finance.

The world in 2040: Due to social pressure and in connection to the increased occurrence of climate change-related extreme weather events, financial institutions are concerned about climate risk. They are monitoring it and aiming to improve their understanding of how it affects their performance.

The ‘climate proofing’ of all of their investment portfolios includes the analysis of carbon footprints, investing in clean energy technologies and climate mitigation- and adaptation-related research & innovation, and ensuring that assets are protected against the consequences of climate change. Antonia works as a freelancer, from her home-office.

Job description: Her job is to design and support the implementation of sustainability action plans and programmes in banks and companies. She assesses the maturity and risks of potential investments from a sustainability perspective. The work produces sustainability reports and assessment reports, including social or environmental due diligence reports. She conducts research, writes guidelines, and organizes and prepares trainings on sustainability topics for companies.



Expected developments

- ▲ Up & reskilling
- Gender-balanced green transition

Green - Drivers of change

- ⚡ Clean electrification
- ♻️ Resource efficiency
- 🌱 Responsible behaviours
- 🌍 Healthy and resilient planet

Jobs - Drivers of change

- 📡 Digital transformation
- ⚙️ New organisation of work
- 🎯 Purpose-driven work

⁸⁴ Net zero refers to the balance between the amount of greenhouse gas produced and the amount removed from the atmosphere by companies and all of the various technologies and production techniques that emit carbon. Net zero would be when the amount added is no more than the amount taken away.

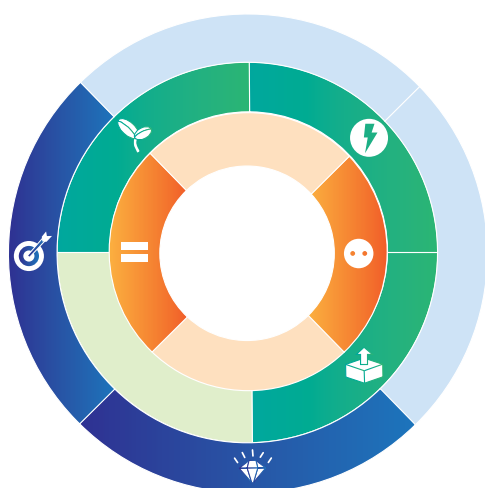
INCLUSIVE URBAN LANDSCAPE ARCHITECT

Nadia (38), Greece - Urban planner and architect creating inclusive and sustainable urban ecosystems

Background: As daughter of refugees that fled the Syrian war, Nadia studied Civil Engineering in Greece. Following her graduation, she returned to the Middle East and worked for ten years in the construction sector. In the UAE, she participated in the development of the eco-city of Masdar. She wanted to replicate solutions found and implemented there in as many cities as possible in both Europe and the Middle East. Therefore, she returned to Greece to complete a Master's degree in Sustainable Urban Planning. Her experience with hot climate environments makes her a sought-after professional.

The world in 2040: The construction industry used to be traditionally a major polluter. Therefore, a shift towards more sustainable construction was inevitable by 2040 and new and innovative materials gained ground. Historic materials were also rediscovered. Wildlife has been re-integrated into cities, using permaculture to restore natural habitats, and creating systems that respect biodiversity. The same philosophy is being applied to the 'built environment',⁸⁵ leading to neighbourhoods that are more inclusive.

Job description: The job makes innovative uses of natural materials such as water and vegetation to improve ecosystems in an urban context. Connecting urban residents with the natural world while regulating the climate at the same time, cleaning air and water resources, and improving human health. Nadia set up and maintains a register of local producers and organises a network for local uptake of their products. Her job fosters neighbourhood inclusiveness and applies diversity-centred urban planning and design.



Expected developments

- Transformation of energy-intensive sectors
- = Gender-balanced green transition

Green - Drivers of change

- ⚡ Clean electrification
- ♻️ Resource efficiency
- 🌱 Healthy and resilient planet

Jobs - Drivers of change

- 💡 New forms of value creation
- 🎯 Purpose-driven work

⁸⁵ The built environment includes all of the physical parts of where we live and work (e.g., homes, buildings, streets, open spaces, and infrastructure). The built environment influences a person's level of physical activity.

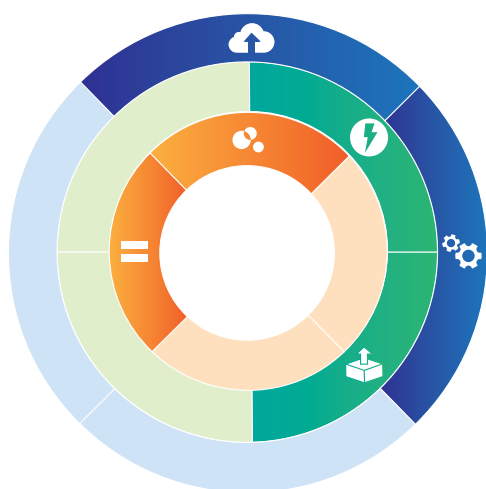
BUILDING-INTEGRATED PV INSTALLER

Anna (33), Austria - Industrial alpinist working with façade-based solar PV systems.

Background: Anna grew up in the Alps and is passionate about mountain climbing. A friend in her climbing community introduced her to the building façade PV installation trade. The green transition requires increased renewable energy generation on surface areas other than land. Adding a thin photovoltaic film onto windows and façades of buildings is a technology suitable for this. The large-scale rollout of smart building 'skin technologies' increases demand for façade-based PV installers and inspectors. Anna completed training on working at height, and on the job training to perform façade PV installation.

The world in 2040: The job is weather-dependent, seasonal and requires travel between different locations, resulting in a modern 'nomadic' lifestyle. She works in new urban areas, mostly in Asia. Her job enables her to make a good living and at the same time travel the world. When not working, she is climbing in breath-taking locations. She loves the changes and contrasts associated with this lifestyle. The underlying technology of this job is an extremely lightweight, very thin and flexible organic solar film that is produced in an energy-efficient, roll-to-roll process.

Job description: Anna leads a team that installs façade-integrated PV on high buildings. She manages and coaches local teams to work safely and efficiently. The fact that security is more important than physical strength contributes to the gender neutrality of this role. Tasks include the use of remotely operated surveillance equipment at times, as part of the maintenance work of existing installations. The job offers premium wages for working in this challenging environment.



Expected developments

- Sectoral & regional impacts
- Gender-balanced green transition

Green - Drivers of change

- ⚡ Clean electrification
- 🏠 Resource efficiency

Jobs - Drivers of change

- ☁ Digital transformation
- ⚙ New organisation of work

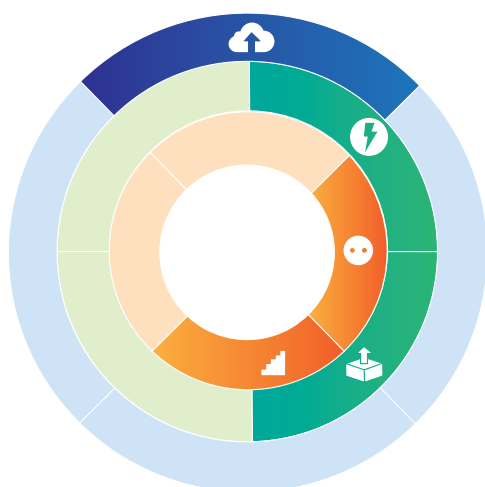
STEEL WORKER

Franz (49), Germany - Furnace master, producing specialised steel products through sustainable processes.



Background: Since the beginning of his career, Franz has worked in the smelting plant of a big steel producer. He completed vocational training to be a machine and equipment operator. Franz had feared that the green transition would lead to him losing his job when increasing carbon prices forced his company to abandon conventional primary steel production processes. The production was completely re-vamped, switching to secondary steel production using the more environmentally friendly ‘electric arc’ process. Franz went through intensive re-skilling and was able to continue working in his job.

The world in 2040: The steel industry is experiencing a renaissance. Using novel steel production processes, smaller batches of steel are produced in a more labour-intensive manner. As renewable energy is used increasingly to produce steel, the demand of steel in the construction of renewable energy installations also grows. Franz works in a unit for specialised steel products with higher technical specifications. His day-to-day job relies on analysis techniques coupled with Artificial Intelligence, process optimisation, and merging scraps of metal from different sources to produce high-end products (in composition and structure).



Job description: Franz ensures that products meet the highest quality criteria. He does an analysis of the initial scrap metal composition. He then manages the robots that load the furnace and performs constant monitoring and fine-tuning of the steel composition throughout the smelting process. He also tests the final products to ensure they meet the customer’s requirements. Franz has been suffering from back pain for a while. However, the need to move around analysing scrap metal and steel composition during the melting process provides him the opportunity to move across the production plant, reducing this problem.



Expected developments

-  Transformation of energy-intensive sectors
-  Up & reskilling

Green - Drivers of change

-  Clean electrification
-  Resource efficiency

Jobs - Drivers of change

-  Digital transformation

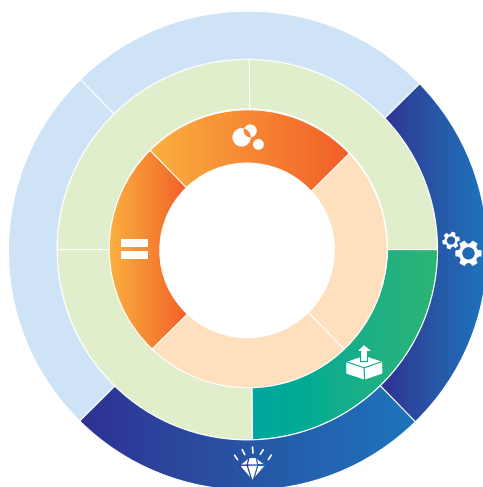
MATERIAL PASSPORT PRODUCER

Magda (44), Poland - Materials engineer producing sustainability passports for buildings and consumer products.



Background: Magda's father had worked as a coal miner in the Upper Silesia region but lost his job due to the mine closures. The high level of air pollution in the area and social decline that followed the closures in her home region triggered Magda's interest in sustainable development. She obtained her degree in Materials Engineering at a university financed by the 'Just Transition Fund' as part of the Commission's European Green Deal. Many of her childhood friends are now returning home because of the possibility of working remotely and keeping close ties to the region.

The world in 2040: Magda is a morning person and starts her day at 5am. This allows her to finish work early to spend time with her children in the late afternoon. She has been working as a material passport⁸⁶ designer since 2030, initially for buildings, but now also covering consumer products. She works in a 'co-working space' set up in her city to support workers and enable diversification of the economy. The EU implemented the third circular economy package in 2030, which requires material passports. She never expected to work in a male-dominated sector like construction.

Job description: The job is to analyse products and their environmental footprint. Then to record the data in 'a passport', i.e. a list detailing the materials used. This gives them a value for material recovery, and enables recycling and re-use and circularity. Magda uses large databases to calculate footprints, which means she does not have to (chemically) assess all the raw materials and components individually. She collaborates with recycling companies that are now widespread in the EU, feeding the secondary raw material market, which is now bigger than the primary raw material market.





Expected developments

-  Sectoral & regional impacts
-  Gender-balanced green transition

Green - Drivers of change

-  Resource efficiency

Jobs - Drivers of change

-  New organisation of work
-  New forms of value creation

⁸⁶ A material passport is a document containing data describing defined characteristics of materials in products or constructions, and which give them value for recovery, recycling and re-use.

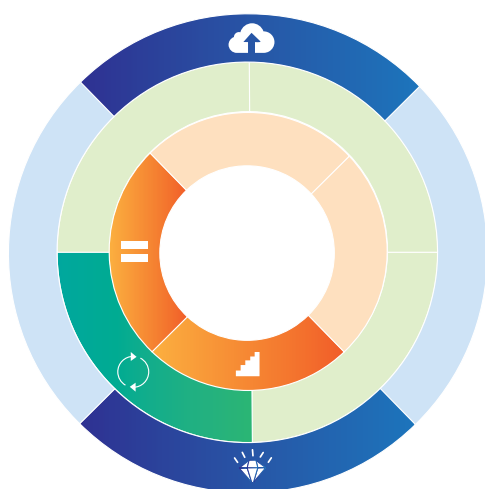
SEAMLESS MOBILITY ASSISTANT

Gérard (55), France - Transport mode coordinator, acting as human interface in a complex, digitalised, shared transport environment.



Background: Gérard is from Mulhouse. He lives and works at the border tripoint between France, Germany, and Switzerland. Bilingual in French and German, he is a trained emergency responder familiar with the local region and culture. He routinely navigates in the increasingly complex transportation system. Gérard has received further on-the-job training to become a seamless mobility assistant. He is an emphatic, socially sensitive, resilient person, with the good interpersonal skills needed to deliver a premium assistant service.

The world in 2040: In densely populated areas, seamless mobility is increasingly becoming the norm, with people sharing micro-mobility (e.g. bicycles, ebikes, scooters, and shared transport systems) which is replacing individual car ownership. There is an increasing need for guidance with multiple different vehicles to use, less experienced drivers, optimisation of routes that lead to changing and charging transaction points. Sharing of autonomous vehicles enhances this trend even more. Transport services are closely interlinked. One central service coordinates several different transportation offerings, including autonomous taxi, air taxis, bikes, scooters, buses, tram and train services.

Job description: As a transport mode coordinator, Gérard provides backup to the virtual assistant, giving support in unusual situations (e.g. accidents, attacks). His task is to calm down people who are affected, to guide them and organise help for them. He provides a luxury service for those who still want to interact with a human, instead of a machine. He assists the mobility of individuals with special needs too (e.g. due to health, advanced age). He also provides assistance in the use of services that are automated, drawing on the speech interpretation and recognition interfaces (technologies), as well as augmented reality tools.





Expected developments

-  Up & reskilling
-  Gender-balanced green transition

Green - Drivers of change

-  Responsible behaviours

Jobs - Drivers of change

-  Digital transformation
-  New forms of value creation

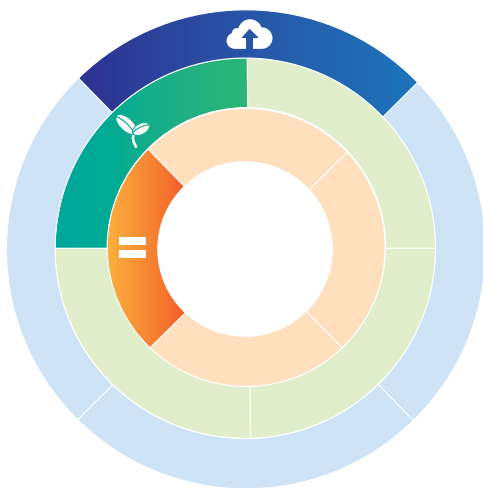
ENVIRONMENTAL DATA ANALYST

Mihaela (25), Romania - Environmental data analyst from East Romania who studied at the University of Amsterdam and obtained her Bachelor's degree in data analysis.

Background: Mihaela took STEM (Science, Technology, Engineering and Mathematics) remote courses, which were part of a special upskilling initiative supported by the local school in Romania, financed by the European Social Fund. Building on her strong math and sciences skills, she went to the Netherlands to study data analysis and now works at Danube Delta Environmental Agency. Her job is to provide the data and information necessary to understand the current environmental situation and identify potential threats.

The world in 2040: The Danube Delta river area still has a huge spectrum of biodiverse habitats in 2040, and there has been a 'rewilding' of several species. The Internet of Things and cheap sensors provide data on the river's flow characteristics and pollution. Micro sensors, the use of remote sensing results, publicly available pictures of visitors, webcams, and audio recordings help tracking the activities of wildlife. Environmental restoration is now a job opportunity in the economically weak region.

Job description: Miheala needs to have knowledge about sensors, geolocation data management as well as crowd data management, and video usage in order to analyse the environmental situation. She performs data quality checks regularly, analyses consistency, and designs real time data dashboards that enable data usage for farmers in the wider area. She cooperates with data acquisition crowd-sourcers, information architects, measuring instrument inspectors, and fact inspectors. While a foundation in machine learning is still a very useful asset in this job, big data analysis is already being performed by the AI.



Expected developments

- Gender-balanced green transition

Green - Drivers of change

- Healthy and resilient planet

Jobs - Drivers of change

- Digital transformation

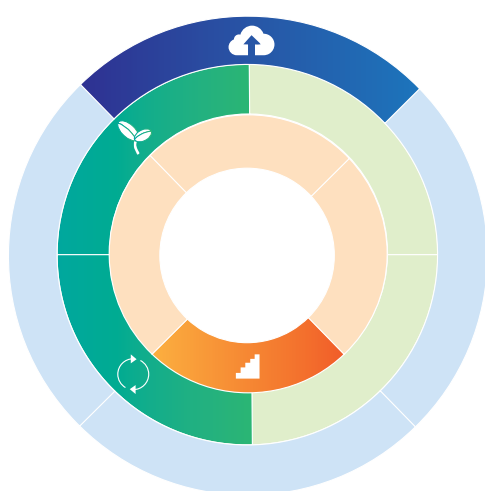
URBAN MICRO FARMER

Rodrigo (37), Spain: - School dropout who used to work on a family farm, now combines his passion for city life with organic farming.

Background: His father was a farmer who used a lot of pesticides although Rodrigo was never in favour of the use of chemicals on a farm. After inheriting the farm, Rodrigo moved towards organic farming. As the government was offering subsidy programmes to buy out farmlands, he accepted and moved to the city. He followed an urban farming training programme with a focus on digital tools such as temperature, humidity, and pollution control and AI-powered yield-improving light systems. His determination and passion for organic farming and producing the best fruits and vegetables, and the urban farming training programme, allowed him to earn a decent living, which sustains his new life in the capital.

The world in 2040: The food systems in 2040 have become healthier, more environmental friendly and fairer. Because a substantial share of food is now also produced locally within the cities, there is less need for long-distance transportation, and this has made seasonal local fruits and vegetables better quality and more reliable. Growing fruits and vegetables in a controlled environment was the only disaster-proof way to guarantee food supply.

Job description: Rodrigo grows crops on rooftops and in small patches of arable land that can still be found within cities. As part of his tasks, it is important to control and monitor the digital farming system, which can be done remotely. The engagement of urban residents by distributing weekly crop packages to their doorsteps using green delivery helps to reinforce the success and sustainability of the organic farm.



Expected developments

- ▲ Up & reskilling

Green - Drivers of change

- 🌱 Responsible behaviours
- 🌍 Healthy and resilient planet

Jobs - Drivers of change

- ☁️ Digital transformation

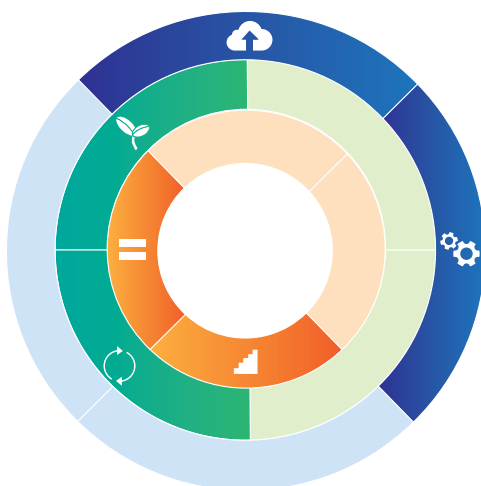
AUGMENTED REALITY NATURE TEACHER

Keith (52), Ireland - Elementary school teacher with a training on Sustainable Development Goals and future oriented education.



Background: Keith was one of the first graduates of the New and Innovative Teaching College in Ireland. His dissertation was on the topic of nature-inspired classrooms. He had to adjust the training he received to make it work in an outdoors environment. Every week, he visits a different school to organise field trips and teach students about the relationship between the environment and humans using augmented reality (AR) as an educational tool. The nature-inspired classroom proved to be a success story making headlines in national press and on TV. Ten years ago, Keith won an award for ‘the most innovative teacher’.

The world in 2040: The use of AR is now widely spread in classrooms. Half of Keith’s classes are taking place in an outdoor setting, which makes the learning experience more practical and memorable. For example, to learn about recycling Keith’s class goes to a plant and is taught by the community manager. Teaching is no longer an under-appreciated job, thanks to higher pay and benefits, as well as respect from communities due to their pivotal role in teaching the future generation about eco-system restoration and protection.



Job description: Keith needs to motivate young children to take notice and have an interest in sustainability. He needs to have an up-to-date knowledge on a variety of sustainability matters, as the classes choose themselves their environmental topics of interest every month. He plans field trips, often those where there is involvement in ecosystem restoration. He needs technical skills to explain DIY repair, and for the application of AR in classroom.





Expected developments

-  Up & reskilling
-  Gender-balanced green transition

Green - Drivers of change

-  Responsible behaviours
-  Healthy and resilient planet

Jobs - Drivers of change

-  Digital transformation
-  New organisation of work

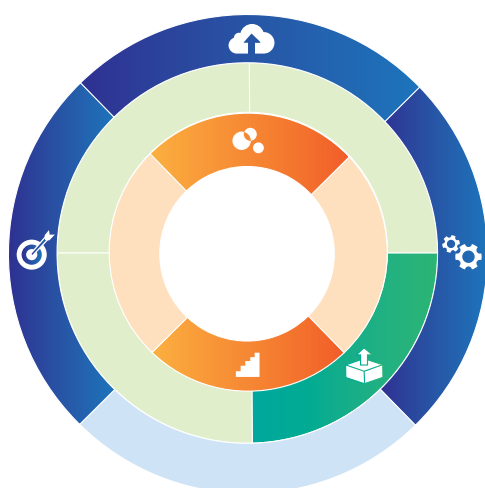
GREEN OPPORTUNITY SPOTTER

Janis (31), Latvia - Unemployment counsellor passionate about green opportunities and focusing on green career advice.



Background: Janis holds a Political Science degree. He did a gap year in Costa Rica where he became passionate about ‘green opportunities’ which led him to find a job at the local job centre back at home. Most job centres already have the green transition officer to guide people towards their next opportunity within the region. He is a member of the European Environmental Association where he attends a summer school every year. This life-long learning experience allows him to stay on top of new developments and the evolutions in the world of green jobs.

The world in 2040: The green transition implies that some people have to find jobs in new economic sectors. This transfer often entails upskilling and reskilling programmes to gain new digital skills, which then allows them to work in a new organisation. The newly found green jobs in 2040 also pay higher salaries on average, which leads to a high interest of job seekers.

Job description: Janis performs research and gives advice to people who are passionate about having an environmental career but are not sure which green career paths best match their skills and interests. He explores green career niches, for example: community engagement, environmental engineering, environmental policy, international development, landscape architecture, material science, natural resources, sustainable agriculture, and sustainable energy.






Expected developments

-  Sectoral & regional impacts
-  Up & reskilling

Green - Drivers of change

-  Resource efficiency

Jobs - Drivers of change

-  Digital transformation
-  New organisation of work
-  Purpose-driven work

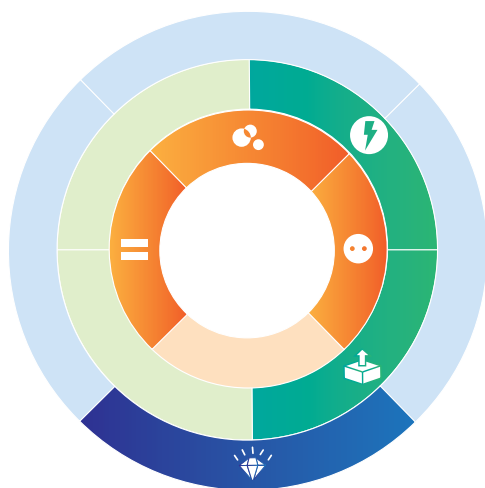
TIDAL ENERGY PRODUCER

Sara (28), Portugal - Tidal power plant technician working in a growing local sector in her hometown

Background: Sara grew up in a coastal town in a family that used to run a ship repair company. She was always fascinated by the work, and by repairing broken things. Her curiosity led her to become well acquainted with tools at an early age. Because she was always worried that her father might succumb to an accident, she pledged to work in a safer sector. While most of her friends went to bigger cities, she decided to stay with her family. She was pleasantly surprised to see that more than half of the co-workers are also women, including the head engineer.

The world in 2040: Modern advances in turbine technology are increasing amounts of power being generated from the ocean, especially from technologies that use tidal stream designs. Coastal areas, many of which are in need of the economic regeneration, benefit greatly from the revenues of tidal energy production.

Job description: Being a self-taught technician, Sara maintains and repairs equipment in a challenging environment, often during extreme weather conditions. In addition, she installs micro-hydropower devices and dynamic braking resistors that help to prevent damage during strong currents. Although in this role she uses everything she learned during the training programme in mechanics, she also updates her knowledge continuously by attending seminars and workshops.



Expected developments

- Sectoral & regional impacts
- Transformation of energy-intensive sectors
- Gender-balanced green transition

Green - Drivers of change

- Clean electrification
- Resource efficiency

Jobs - Drivers of change

- New forms of value creation

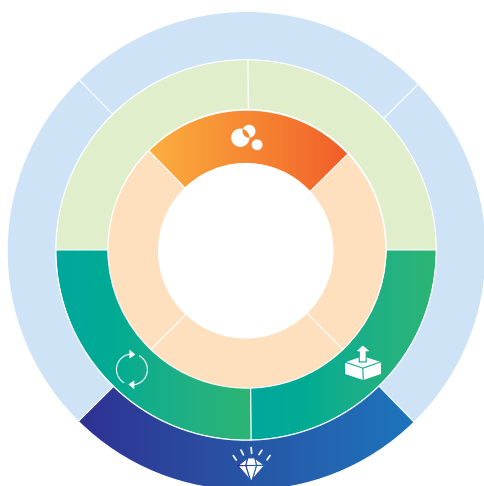
APPLIANCE SHARING HUB CONNECTOR

Ivica (24), Croatia - Environmental entrepreneur with experience in accounting, inventory management, and information systems

Background: Ivica worked in a retail store as a floor supervisor following his graduation from high school. Displeased with consumerism, he no longer wanted to continue working at the store and left to contribute to a more sustainable use of appliances. He then joined a group of three high school friends (an engineer, a computer software application developer, and a mechanic) in a new venture connecting communities. It facilitates the sharing of household appliances and uses 3D printing for spare parts for repairs. Being active on social media, Ivica is able to connect communities using his large network.

Job description: The start-up has developed and run an online website for sharing appliances and for 3D printing of spare parts, depending on the nearest available 3D printer. It connects with communities through social media and a mobile application, helping people to repair their appliances or to give away unwanted items to community members in need. Ivica needs digital and social media skills to help run the platform and uses some of the inventory and marketing training he picked up working at the retail store to help position their products.

The world in 2040: Some people are still consuming (foods, services and products) in an unsustainable fashion in 2040. Nevertheless, others and especially the younger generations are now pushing for a consumption style that is based on sharing and repairing, up cycling, and re-using. 'Handy people' are back in fashion thanks to a strong DIY culture and the sharing platform.



Expected developments

- Sectoral & regional impacts

Green - Drivers of change

- Resource efficiency
- Responsible behaviours

Jobs - Drivers of change

- New forms of value creation

Policy Implications

Combining the insights gained from forecasting (expected developments) and foresight (drivers of change), we derived policy implications for the future of jobs & skills in the green transition. This chapter analyses expected developments and drivers of change to emphasise and suggest the need for innovative actions from the policymaking side in the medium to long term both on national and supranational level. It also presents some examples on how Member States successfully support the green transition and its impact on labour market and skills.

Support regions in transition

In most regions in the EU, green jobs can do more than replacing those lost in fossil fuel-based sectors with adequate investments in economic diversification. Economic diversification is particularly urgent in coal mining regions, as a large share of the economic activity in those regions tends to depend on the mining sector. Such economic diversifications should start well in advance before phasing out a coalmine. The recently proposed Social Climate Fund could accelerate economic diversification as it supports green activities such as energy efficiency measures.⁸⁷ Support to eco-innovation can help to create new jobs in sectors with long-term growth potential, such as the renewable energy sector. The EU's Just Transition Fund can support economic transformations with investments that establish economic sectors with long-term potential that also contribute to the realisation of the European Green Deal. Concretely, material infrastructure investment need to go beyond environmental restoration and renewable and alternative energy with investment in support sectors such eco-tourism and sustainable farming. Beside, a region-centric approach allows to identify comparative advantages and reform educational systems for a local supply of skilled workers.

There are several examples that show that economic diversification of former coal regions can be a success:

One promising instance of a successful phase out are the two Greek regions of Western Macedonia and Arcadia that are due to phase out lignite mining. Initial estimations of the effect of the Greek Just Transition Development Plan show that the total vacancies from the planned investment are higher than the current number of jobs in the lignite sector.⁸⁸

Another example is Poland's Eastern Wielkopolska region where up to 22,000 new jobs will be created by 2030 in the renewable energy sector alone, thus overcompensating for the loss of employment due to the abandonment of coal. Workers employed in these new jobs will receive remunerations at the national average level.⁸⁹

While the returns of economic diversification are not immediate, studies in Bulgaria have shown that the process of investing in a just transition would likely show benefits in the short term. According to the latest projections, job creation and environmental restoration show positive effects already three years after the implementation of economic diversification measures and the move away from coal-fuelled electricity generation.⁹⁰

In addition to coal intensive regions, other regions with high renewable energy potential will also need support. Indeed, as part of the Green Deal, the EU is supporting alternative energy sources such as hydrogen. Together with full cell technology, they can play an important ecological and societal role in contributing to the decarbonisation of the economy and creating additional job opportunities and revenues. According to Fuel Cells and Hydrogen Joint Undertaking (2019), the EU hydrogen industry (hydrogen, equipment, supplier industries) could provide employment for about 1.0 million workers

87 European Commission (2021b)

88 Greek Ministry of Environment and Energy (2020)

89 WWF (2021)

90 WWF (2021)

by 2030 jobs and reach 5.4 million by 2050 (excluding indirect effects).⁹¹

Provide adequate training, guidance and support to workers in transition

Skills for green jobs need to be developed through a combination of in-company training, upskilling programmes and education providers. Re-skilling will enable workers to find jobs in green sectors and this is particularly important for those working in fossil fuel-based sectors that will decline in the future. The focus should thus be on specialised programmes, which are more adequate for green activities compared to more general and transversal training programmes (more suited for ICT). Consequently, VET is better suited to supplement the workforce with the specific skills needed in the emerging green occupations, especially in the case of transitioning occupations with closely related skill-sets.

Training offers could include courses given by industrial associations as vocational trainings, or publicly/EU funded certification programmes as a supplement to workers with a skill proximity to emerging green occupations. Take for instance the Belgian EPFC⁹², the largest Social Development Education centre in the Brussels-Capital region, which is funded by a combination of the European Social Fund and the Regional Employment Office. It has recently received additional funding from the Chamber of Commerce (BECI)⁹³ to specifically offer new courses in line with the needs of the green transition such as mobility, energy savings and climate change⁹⁴.

In Ireland, there has been a significant ramp up of Higher Education and FET (Further Education and Training) courses developed for the green economy to ensure that the skills supply is aligned to the

skill needs of enterprises. Green Tech Skillnet and Lean and Green Skillnets are examples of private-public partnerships (PPP), funded from the National Training Fund, and led by enterprise networks to offer training support to companies, improving their sustainability and competitiveness.⁹⁵

In Germany, the involvement of the private sector in green skills training features strongly, owing to the dual vocational education and training system. For instance, the German chemical industry runs a sustainability initiative, put in place jointly by the sectoral industry association (VCI), the trade union (IG BCE) and the employer association (BAVC).⁹⁶

Textiles is an example of a sector that will remain vital to the economy, but must address its environmental footprint, which on current projections will increase significantly by 2030 in terms of greenhouse gas emissions and water consumption. The Latvian Design4Circle, co-funded by the EU's Erasmus+ Programme, aims to tackle this by equipping designers with the required skills to implement new eco-innovative practices, using an e-learning platform as a prime example of twinning the green and digital transition in practice.⁹⁷

Support sectors and companies in the green transition

Providing opportunities including the right regulatory framework and incentives to change is key to ensure that businesses are fully on board for the green transition. Some sectors, such as construction, will experience an expansion in labour demand to achieve the Green Deal objectives. However, productivity has been stagnant for nearly a decade, mainly due to the lack of workforce that is not equipped with the right skills for the more complex environmentally friendly buildings. As such, actors in the sector

91 Fuel Cells and Hydrogen Joint Undertaking (2019); Scenario for hydrogen deployment in the EU to achieve the 2-degree target, as part of the Paris agreement. Under the recommendations of the IPCC not to exceed 1.5 degrees, the deployment of hydrogen and its impact would be even greater.

92 Enseignement de Promotion et de Formation Continue

93 Brussels Enterprises Commerce and Industry

94 BECI (2021)

95 Walker (2020)

96 Cedefop (2019)

97 EU Commission (2021c)

need support for upskilling to gain knowledge about the possibilities offered by new emerging technologies to apply them in practice. Horizon Europe funds are being used to fund projects such as INSTRUCT to build up skills for building professionals. Such initiatives will allow mobilising private investments backed up by EU guarantees. Nevertheless, dedicated financing instruments are needed to support the implementation of largescale renovation programmes, together with an adapted regulatory framework to ease the deployment of renovations.⁹⁸

In addition, the EU needs to accelerate its support to breakthrough eco-innovation to reach its climate targets. A recent study by Capgemini (2020) estimates that investment in 55 technology quests will allow to the EU to achieve 55 % carbon dioxide reduction while supporting 12.7 million high-quality and resilient jobs by 2030 and an additional 11.6 million jobs by 2050.⁹⁹

Ensure that the green jobs are also decent jobs

The green transition should ensure that the creation of green jobs goes hand in hand with decent, safe and healthy working conditions that ensure fundamental rights and equality, especially given the relatively less developed regulatory framework for emerging green occupations. Digitalisation has brought an acceleration of labour markets shifting to telework supported by ICT tools. As workplaces are getting more dispersed and more difficult to reach, monitoring and enforcement of good working conditions and safe working practices are likely to become more challenging in such an environment.

The farming sector is a prime example of how the green transition can improve workers conditions. With increasing pressure on agriculture

to become greener and the drive to reduce the use of pesticides in farming by 50 % before 2030 has resulted in a significant improvement in the safety and health of farmers and foresters.¹⁰⁰ At the same time, the large number of technological and organisational changes needed to manage the sector's impact on the environment are cited by many farmers as a major stress factor. As such, inclusive and preventive management approaches built on social dialogue are necessary for a just transition in this crucial sector. Especially given that the Farm to Fork Strategy, aiming to make food systems fair, healthy and environmentally-friendly, is at the heart of the European Green Deal.¹⁰¹ To achieve these goals, an adequate regulatory framework needs to be setup. These instruments will include operational platforms to raise stakeholders' awareness and best practices exchanges between farming professionals in order to build up the skills required for the green transition.

More generally speaking, it has been established that green jobs typically pay higher wages, and involve less routine and manual tasks, on average, implying that the scale and scope of the green transition may result in a positive effect for current occupations with a skill proximity to the green emerging ones.¹⁰² However, the transition pathways are less obvious for communities with vulnerable categories which are the most exposed and less adequately equipped, on average.¹⁰³ Public institutions can actively reduce these mismatches through sustained social dialogue to inform stakeholders on the developments and implementations of the green transition but also plan and design investment programs targeting groups such as women and youth.¹⁰⁴ Furthermore, labour rights and standards need to be guaranteed in green jobs and European green transition policies, as suggested by the ILO guidelines for a

98 Ernst & Young (2020)

99 Capgemini (2020)

100 European Union (2009)

101 European Agency for Safety and Health at Work (2020)

102 Brookings (2019)

103 Bowen et al. (2018)

104 Sharpe and Martinez-Fernandez (2021)

just transition toward environmentally sustainable economies and societies for all. Such measures will enhance institutional arrangement to support a fairer green transition.¹⁰⁵

*Such programmes already exist in Member states. Finland for instance has set up the EPIQUS scheme, which ensures that no one is left behind by providing training in green and digital skills for migrants and refugees. The program is co-funded by InvestEU and guaranteed by the EIF into a social impact bond.*¹⁰⁶

Perform active monitoring of greening labour markets to equip people with the right skill set

Skills development programmes can allow workers to adapt to new changes in skills requirements. To achieve such flexibility, constant monitoring and evaluation are necessary, taking into account the integration of new technologies is required. In this way, people acquire skills that are useful in the long-term and can continue to be part of the active work force. Supporting instruments exist at Member State and EU-level (e.g. the European Social Fund Plus or the Just Transition Fund).

*The French Mobilisation Plan for Green Jobs includes an observatory for emerging environmental professions, with a particular focus on skills requirements. To be even more effective, the observatory has established partnerships with trade unions, employer organisations, and the public employment service.*¹⁰⁷

*Similarly, Estonia has launched a new System of Labour Market Monitoring and Future Skills Forecasting OSKA (Oskuste Arendamise koordineerimisüsteem), which allows to quantify the green skills mismatch. Such a system could be even more beneficial with dedicated green economy modules.*¹⁰⁸

In addition to active labour market policies, additional policies are needed to support

young people in the EU facing barriers to join the green economy workforce. This hurdle arises from skills mismatch.¹⁰⁹ To address this issue, JRC and DG EAC are developing a European competence framework on sustainability centred on core sustainability competence areas, such as embracing complexity in sustainability, envisioning sustainable futures, embodying sustainable values, enacting for sustainability.¹¹⁰ Such competences need to be developed from early childhood, thus ensuring that young people will be able to adapt to the changing world of (green) work.

Education programs need also to change, adapting a more agile approach with modular curricula that can be assembled to meet the needs of time and of the green economy.

*In Ireland, for instance, innovative methods of teaching and delivery are being promoted under the Human Capital Initiative; a EUR 300 million fund running over a 5-year period co-funded by the European Social Fund. In particular, Pillar 3 of the initiative: Innovation and Agility will allow learners to benefit from improved quality and more engaging ways of learning, providing lifelong learning and upskilling opportunities for all. The projects include the use of virtual laboratories in higher education, a new hub to upskill the building sector on green construction, and the establishment of Creative Futures Academy to support digital and screen culture.*¹¹¹

Another good example is the FEDORA-project, funded by Horizon 2020. Its aim is to develop a future-oriented model to enable creative thinking, foresight and active hope as skills needed in formal and informal science education.

More recently, Belgium has requested a EUR 480 million funding as part of its Recovery and Resilience Facility (RRF) plan for the Education 2.0 programme. The aim of the program is to provide students with

105 International Labour Organization (2016)

106 European Investment Fund (2021)

107 EU Commission (2021c)

108 Cedefop (2020)

109 UNICEF (2021)

110 JRC (2021b)

111 Higher Education Authority (2020)

*a more inclusive and future-proof education with a focus on STEM and skills for the green transition.*¹¹²

Achieve a crucial shift in values and behaviour through sustainability awareness

Sustainability awareness is essential to ensure that individuals can evaluate the implications of their actions in terms of sustainability.

Increased transparency and well-defined sustainability metrics are key to enable consumers to make better informed decisions. Initiatives, such as the sustainable product policy, supported by the European Parliament need to be more comprehensive and apply to the broadest possible range of products, harnessing the ICT technologies for improved traceability.¹¹³ For that matter, digitally aware individuals have more tools to track their contribution to the green transition, helping them make the best possible choices. A workforce that is aware of the need for the green transition could create bottom-up pressure in companies and organisations to increase sustainability performance.

*Experiences in Greece, Italy and Sweden have shown the effectiveness of initiatives in schools. For instance, the Green Awareness in Action project deployed an Internet of Things infrastructure to gather data on energy consumption and sustainable infrastructure of classrooms. This enabled school communities to monitor energy efficiency results thus raising awareness regarding the need to save energy.*¹¹⁴

Similarly, Denmark is raising environmental awareness through a network of around 100 institutions across the country with roughly 3 600 programmes lasting from between one day to six weeks. The offerings include programmes such as “Environmental care for property caretakers”, where participants learn to contribute to the

*implementation of both technical and behavioural preventative environmental measures in homes and institutions.*¹¹⁵

*Another example of grass-root initiatives that promote better knowledge of the green economy is the Basque-country eco-design hub. The platform works to improve the unemployed, young people and students’ environmental awareness through an online resource for training on future environmental technology. A major expansion of such initiatives will be needed in the next few years.*¹¹⁶

Promote women’s participation in green sectors

Transitioning to a greener economy while ensuring gender equality requires a gender-responsive industrial policy for the EU. Only by empowering women to take up leadership positions in the green sectors and supporting their entrepreneurship ventures will the green transition realise women’s potential to meet this dual objective. In order to alleviate the barriers for their participation in the green economy, women need to have the skills and resources to compete in the labour market.

Ensuring equal access to skills development opportunities will allow to increase the talent pool by including vulnerable categories¹¹⁷ such as women. Indeed, while over-represented in the students’ population, women are still under-represented in STEM disciplines. As a matter of fact, recent statistics show that the rate of NEET (Not in Education, Employment or Training) of women is always higher than men in all EU Member States. This is yet another reason why forward-looking policies need to integrate disaggregated measure by age and gender, as well as to the gender employment gap as key metrics to monitor the progress and implement reforms.¹¹⁸

¹¹² European Commission (2021d)

¹¹³ EP (2020)

¹¹⁴ Maurer et al. (2020)

¹¹⁵ EU Commission (2021c)

¹¹⁶ Cedefop (2019)

¹¹⁷ “Women, children and persons belonging, or perceived to belong, to groups that are in a disadvantaged position or marginalised, such as migrants and refugees.” European Institute for Gender Equality (2021)

¹¹⁸ Eurostat (2021b)

For instance, in Ireland, the SOLAS Green Skills Action programme provides training to address climate and low carbon economy issues. The plan, co-funded by NextGenerationEU, also provides reskilling and upskilling opportunities to workers adversely impacted by the transition – among whom women in vulnerable situations are overrepresented. The policy also supports small and medium-sized enterprises (SMEs) who need some assistance to invest in and develop their workforce.¹¹⁹

Setup a coherent incentive system

Providing people with the skills needed for the green transition will not be enough to support the green labour markets with the qualified task force. Talented engineers with the relevant skill-set needed for green jobs will abide by the law of supply and demand that determines the value of their wages. As such, these critically needed workers in green occupations may lean toward jobs in financial firms, for instance, where they are handsomely paid for high-frequency trading jobs. Such perverse incentives constitute a market failure, even more so in a public good such as the environment, and thus require regulatory intervention.

Policymakers need to design a fiscal system that ensures a fair value for economic activities, internalizing negative environmental externalities and supporting those with positive ones. A carbon tax is supported by economic theory for its efficiency in levelling the playing field.¹²⁰ Indeed, under such a scenario, the shift from fossil fuels will foster eco-innovation, as emitters are free to choose their preferred way to reduce their emissions, while boosting sales in labour-intensive clean-technology activities, thus promoting employment opportunities. Sustained labour-demand will consequently drive the wages of emerging green occupations up, thus attracting skilled individuals willing to actively contribute to economic activities in line with their values.

Support willing and able learners from the earliest learning stages

Learners with the willingness to acquire the skills and knowledge required for the green transition need to have easier access to qualified instructors and revamped curricula. In fact, students' associations in higher education institutions continue to voice their concerns regarding access to courses to supplement their training to better reflect the needs of emerging green occupations in the labour market.

Working on attitudes toward the environment and equipping learners with a set of core sustainability competences is necessary but not sufficient. Learners, both in formal education institutions or informal social settings, require adequate access to mentors and eligible career guidance counsellors, and preferably from the earliest learning stages and not until they reach higher education levels or when they are in the labour market.

It is critical to nudge individuals with coherent incentives to ensure that those willing to equip themselves with the skills needed for the green transitions, or those who want to acquire the sustainability knowledge required for the sustainability behavioural shift, get the qualified educators and advisers. As such, training teachers and getting qualified individuals to join the teaching occupation ranks is key for setting the right incentives and providing the prerequisites for the green transition with individuals at the heart of the transformation.¹²¹

¹¹⁹ European Commission (2021e)

¹²⁰ Brown and Ahmadi (2019)

¹²¹ JRC (2021c)

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Annexes

Annex: Selected job estimates of the green transition

Source	Year	Geographic scope	Sector	Employment
IRENA 2021	2019	Global	Energy related total	58 million total jobs
IRENA 2020c	2019	Global	RES	11.5 million total jobs
IRENA 2021	2050	Global	Energy related total	122 million total jobs
IRENA 2021	2050	Global	RES	43 million total jobs
EurObserv'ER 2021	2018	EU-27	RES	1.38 million (total: direct and indirect jobs)
Kapetaki et al. 2020	2030 and 2050	EU-27 and UK	Clean energy technologies, focusing on coal regions	By 2030, up to 315,000 jobs can be created in total by deploying clean energy production technologies, reaching more than 460,000 by 2050.
European Commission 2021a	2030	EU-27	Battery cell production (alone)	60,000 - 90,000 direct jobs and 180,000 upstream jobs
	2025		Transition to electric mobility (including battery cell production)	800,000 additional jobs
	2030		Renovation and decarbonisation of the existing building stock	160,000 additional jobs (if EUR 275 billion per year until 2030 is invested in renovation)
Cambridge Econometrics 2018	2030	EU-27 and UK	Low-carbon mobility	670,000 additional jobs
Cambridge Econometrics et al. 2018	2030	EU-27 and UK	Moving towards a more circular economy	700,000 additional jobs

Annex: Delphi survey

Delphi questionnaire - The future of jobs and skills in the green transition

To stress test the timeframe and importance of the proposed key drivers, we conducted a Delphi survey. A Delphi survey is an online survey technique for collecting and synthesising expert opinions, where participants see the results of other contributions and can rethink and revise their own input.¹²² It is therefore a structured way to reach consensus in a group.¹²³ We asked experts to rank the different drivers according to their impact on the labour market and the time of their likely manifestation.

Over 240 experts participated in this survey. Of these, over 80 % were very knowledgeable in the fields the survey covered (labour market and employment, economy, education and training, environment, digitalisation, foresight / future studies). They came mainly from public sector (54 %) followed by private sector (24 %), academia (14 %), NGOs (5 %) and other sectors (3 %). They assessed the drivers according to their potential to fuel a transition of EU labour markets and by when they could become mainstream in the EU. Furthermore, they could point to additional and newly emerging drivers, as well as skills implications of the green transition.

Question 1

By when is it likely that the below green developments become mainstream in the EU?

	Now	2022- 2030	2031- 2040	2041- 2050	After 2050	Never	No opinion
Low-carbon transport is the norm							
Circular economy reduces resource consumption across all sectors							
Nature's own resources are widely used to tackle climate change impacts							
Energy efficiency improvements across sectors limit energy consumption							
Consumption patterns are sustainable (e.g. sharing economy, less meat consumption)							
Natural ecosystems benefit from a strong focus on restoration							
Smart grids and storage enable integration of renewable electricity							
Companies account for environmental cost of their activities							
Breakthrough material innovations enable substituting rare resources							
Publicly funded projects will be compliant to sustainability criteria							
Renewable power is the lion share in the energy mix							
Adaptation measures reduce vulnerability to climate change							

¹²² Millennium Project 2017

¹²³ Hasson et al. (2000)

Question 2

By when is it likely that the below work-related developments become mainstream in the EU?

	Now	2022-2030	2031-2040	2041-2050	After 2050	Never	No opinion
Digital transformation changes the tasks we perform							
Customers are involved in product design and production							
High temporal and spatial flexibility of labour is the norm							
Organisations are value driven							
Self-employment and gig-economy play a significant role							
Multi-actor production networks are collaborative and dynamic							
People want to work on activities with meaning							
Automation enables process optimisation							
Work is organised more around projects than positions							
Open data becomes mainstream in the EU							
Production is rather local and decentralised							
All work promotes and underpins health, wellbeing and quality of life							

Question 3

Do you agree that the below green developments will lead to a transformation of the EU labour market (e.g. emergence of new types of jobs, change in the way we work)?

	(1) Strongly agree	(2) Agree	(3) Neutral	(4) Disagree	(5) Strongly disagree	No opinion
Low-carbon transport is the norm						
Circular economy reduces resource consumption across all sectors						
Nature’s own resources are widely used to tackle climate change impacts						
Energy efficiency improvements across sectors limit energy consumption						
Consumption patterns are sustainable(e.g. sharing economy, less meat consumption)						
Natural ecosystems benefit from a strong focus on restoration						

	(1)	(2)	(3)	(4)	(5)	No opinion
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
Smart grids and storage enable integration of renewable electricity						
Companies account for environmental cost of their activities						
Breakthrough material innovations enable substituting rare resources						
Publicly funded projects will be compliant to sustainability criteria						
Renewable power is the lion share in the energy mix						
Adaptation measures reduce vulnerability to climate change						

Question 4

Do you agree that the below work-related developments will lead to a transformation of the EU labour market (e.g. emergence of new types jobs, change in the way we work)?

	(1)	(2)	(3)	(4)	(5)	No opinion
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
Digital transformation changes the tasks we perform						
Customers are involved in product design and production						
High temporal and spatial flexibility of labour is the norm						
Organisations are value driven						
Self-employment and gig-economy play a significant role						
Multi-actor production networks are collaborative and dynamic						
People want to work on activities with meaning						
Automation enables process optimisation						
Work is organised more around projects than positions						
Open data becomes mainstream in the EU						
Production is rather local and decentralised						
All work promotes and underpins health, wellbeing, and quality of life						

Question 5

Which additional developments do you see relevant for the future of green jobs and skills in Europe 2050?

(open question)

Question 6

Which new sectors, activities, and types of green jobs do you expect emerging by 2050?

(open question)

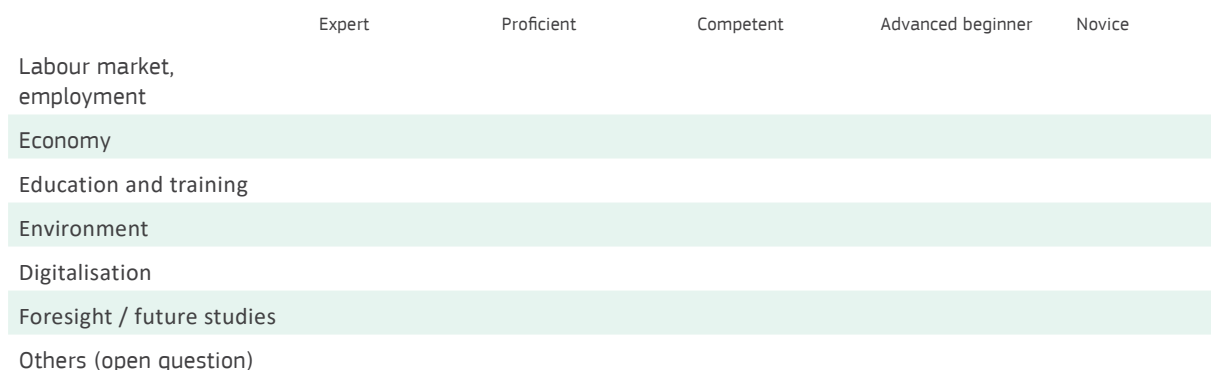
Question 7

Which skills will become most relevant for supporting the green transition by 2050?

(open question)

Question 8

What is your area of expertise?



Question 9

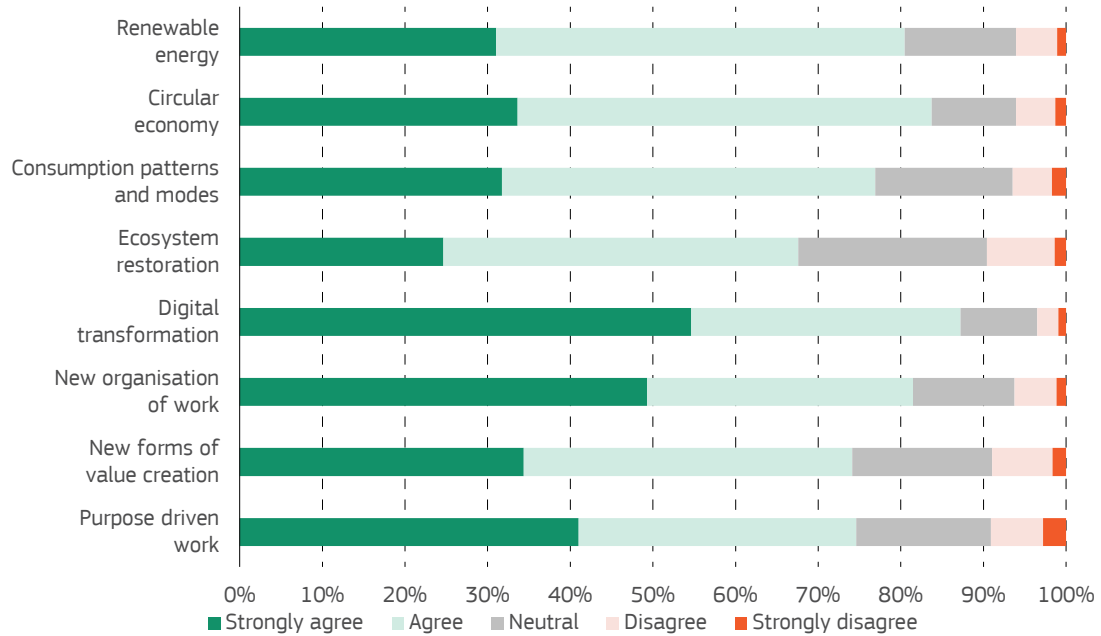
In which area do you work?

- Public sector
- Private sector
- Academia
- NGO
- Others: (open question)

Delphi results

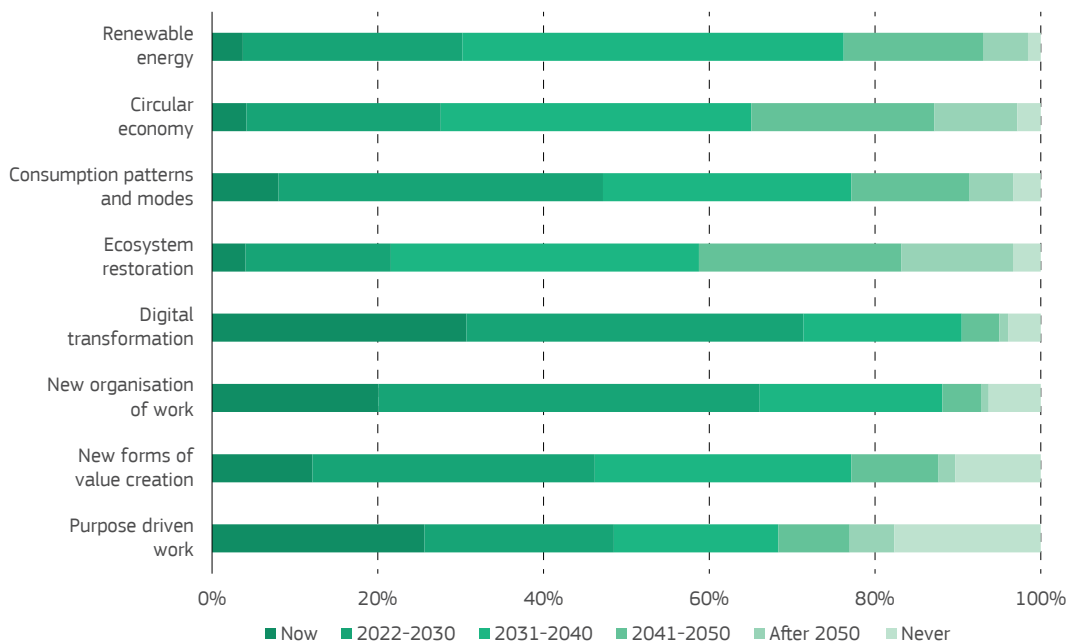
Regarding the potential to transform the EU labour market, the majority of experts either agreed or strongly agreed that all the drivers are relevant. However, more experts strongly agreed that job related drivers will transform the labour market more than drivers related to the green transition (see Figure A.1). The results confirm that the literature review yielded a robust set of drivers to look into the future development of jobs in the green transition.

Figure A.1: Do you agree that the below green developments will lead to a transformation of the EU labour market (e.g. emergence of new types of jobs, change in the way we work)?¹²⁴



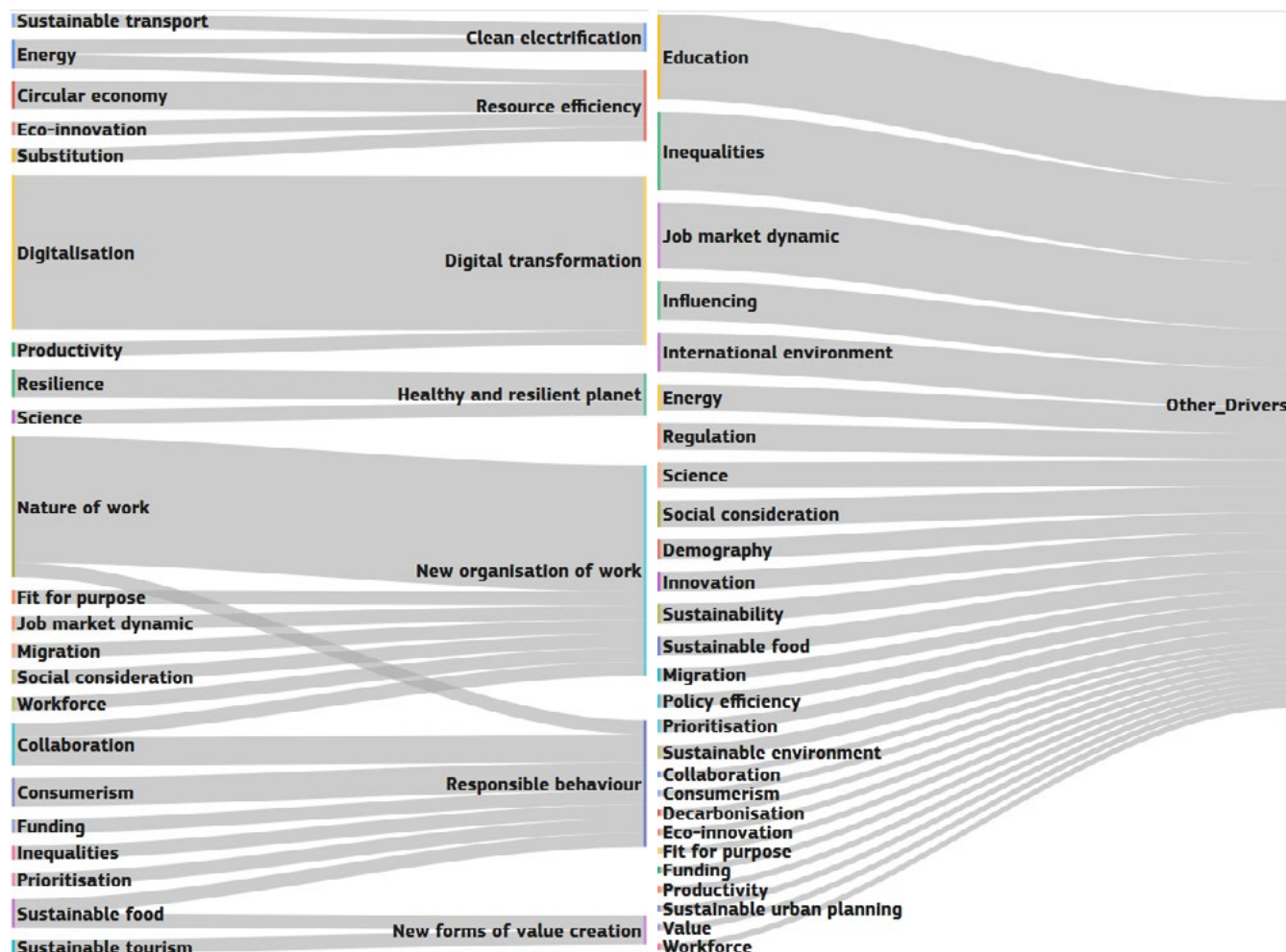
Regarding the temporal relevance of the drivers, a similar view prevails in that job-related drivers are expected to become relevant earlier than the green drivers. In particular, ecosystem restoration was not considered to be relevant in the near term (Figure A.2). At the same time, green drivers are deemed to become important in the future while more experts tended to believe that the job-related drivers would never be mainstream in the EU.

Figure A.2: By when is it likely that the below green developments become mainstream in the EU?¹²⁵



124 JRC Delphi survey
125 JRC Delphi survey

Figure A.3: Which further developments do you see relevant for the future of green jobs and skills in Europe 2050?¹²⁶



The survey also included open questions related to further developments and skills of relevance for green jobs by 2050 (figure A.3).

Among other “further developments” relevant for green jobs and skills by 2050, the Delphi survey hints at themes connected to education, inequalities and job market dynamics:

- The evolution of education (quantity, topics, formats, methods) calling for timely updates of curricula;
- Educational strategies to favour high-skilled labour, so as to promote innovation towards green deal objectives;
- Job market bottlenecks being lifted by lifelong and adult education, also stimulated by flexibility on demand and supply sides;
- An increased awareness of inequalities linked to wealth, class, age, gender, diversity and competences.

Since these themes are guiding the vision of the European Education Area¹²⁷, one can expect those to

¹²⁶ JRC Delphi survey
¹²⁷ European Commission (2020e)

be the focus of specific actions. Yet beyond policy development, policy effectiveness will need to be monitored, thus calling for the development of additional indicators and improved methodologies¹²⁸.

Among others, education is key. Its overall objective is to timely provide sufficient competences to the employment market. The ongoing green transition calls for an evolution of occupations, underpinned by different and/or additional competences. Some of them, collected through the Delphi survey are displayed below (Figure A.4), aggregated in 17 categories of the ESCO classification¹²⁹.

Figure A.4: Which skills will become most relevant for supporting the green transition by 2050?¹³⁰



Note: Skills (green), knowledge (purple) and attitudes and values (red), according to ESCO classification

Though compiled by experts, this collection of competence hardly refers to attitudes and values. This (attitudes and value) category refers to “Individual work styles, preferences and work-related beliefs that underpin behaviour so that knowledge and skills are applied effectively”¹³¹. In other words, attitudes and values reinforce knowledge and skills. Considering the impact of behaviours on sustainability (also as consumer), there is a need to increase awareness on sustainability-driven attitudes and values, hence capitalising on (readily available) knowledge and skills. Paradoxically, specific further developments provided in this Delphi survey do refer to the need for changes in attitudes and values. This evolution better starts within expert circles, before broadening to the whole society.

¹²⁸ Alberti et al. (2021)

¹²⁹ European Commission (2019d)

¹³⁰ JRC Delphi survey

¹³¹ European Commission (2019d)

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