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Employment and Social Developments in Europe 2019

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CHAPTER 5

Towards a greener future: employment and social impacts of climate change policies

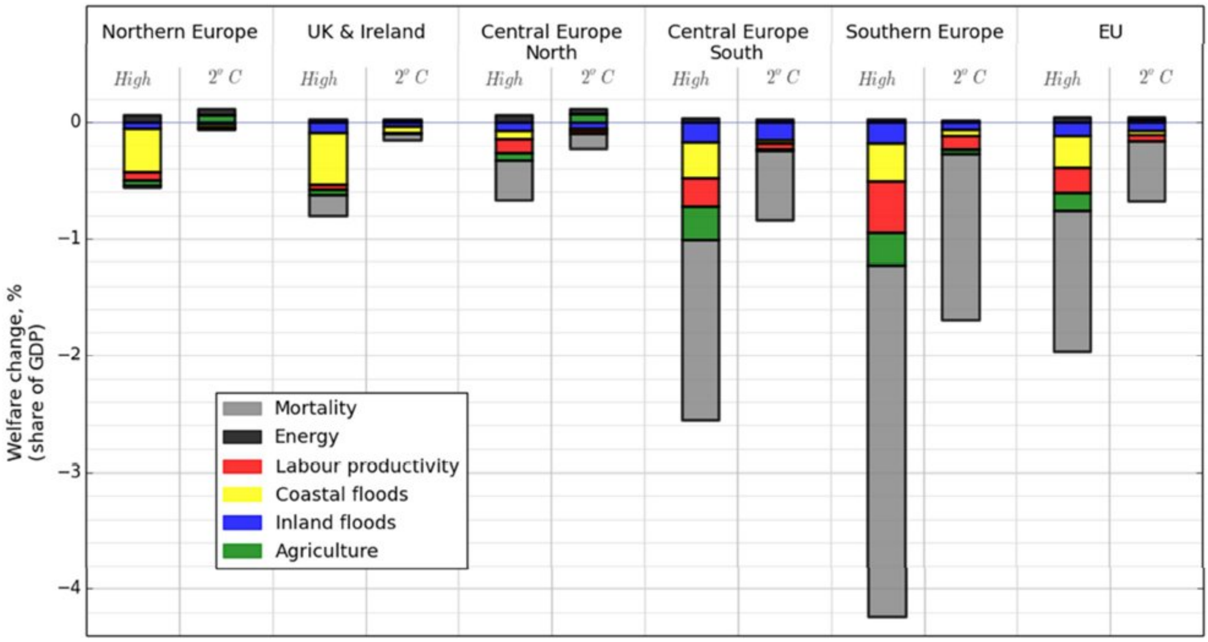
1. Introduction and main challenges

Environmental sustainability is one of the main dimensions of sustainable development and, for many, is the essence of sustainability. It plays an important role in research and in raising awareness of sustainability as a whole, and it is often used as the primary yardstick for assessing and ranking sustainability performance overall. While the environmental dimension is a broad concept, this chapter focuses on the main linkages, complementarities and trade-offs between climate change policies and social sustainabilityincluding the role of social policies to ensure just transition to climate-neutral economy.

Environmental and social sustainability are interlinked, as environmental and climate change risks and related economic activities and policy measures affect regions, sectors, workers and population groups in different ways. While job gains can be expected across many sectors and regions, adverse employment impacts will be concentrated in regions depending on sectors that will have to undergo extensive transformations to enhance environmental protection and achieve climate neutrality. Through its impact on natural ecosystems, water quality and quantity and infrastructure, climate change has a particularly significant impact on agriculture, fisheries and food production, as well as on global transport routes and activities. In November 2018, the Commission put forward a strategic long-term vision for a competitive, prosperous and climate neutral economy by 2050. This is a necessary contribution of the EU to the Paris Climate Agreement objectives.

Attention to social and environmental inequalities and distributional impacts of climate action is important for ensuring that the burden is fairly distributed across individuals, groups, sectors and regions. The right to a safe and healthy environment is a crucial element of well-being. However, access to natural resources and the impacts of climate change and pollution (air, water, noise, chemicals) are generally distributed unequally and are likely to affect low-skilled workers and vulnerable, low-income households more than others. These population groups may also be disproportionately subject to the effects of more frequent extreme weather events, partly because they have fewer resources with which to take precautionary or evasion measures. Furthermore,

Chart 5.1
Climate inaction would have significant socio-economic costs for Europe, particularly southern Europe
Welfare losses (% of GDP) for two climate inaction scenarios (high warming scenario and 2˚C scenario)



Source: European Commission, PESETA III studies, Joint Research Centre, Sevilla
Click here to download chart.

though these groups probably contribute less to overall emissions, they may be more affected by the direct or indirect costs of climate action, such as environmental taxes when these are regressive, rising energy bills, changing mobility costs and new product standards or targeted regulatory bans of certain goods, products or technologies as well as harmful consumption patterns.

Inaction on environmental degradation and climate change has significant economic and social costs. In its PESETA III study, the Commission provides a detailed assessment of six specific climate impacts in Europe for two scenarios - a high-warming scenario and a 2 degrees scenario. The impacts are significant, and risk annual welfare losses of up to 2% of GDP in the EU, and of more than 4% of GDP in southern Europe. The strongest impacts are on mortality, coastal floods and labour productivity, and Southern Europe is most affected (*Chart 5.1*). Similarly, for the US, the costs of past extreme events since 1980 are estimated at above $1.1 trillion. Future economy-wide direct damages, interpreted as costs of inaction, are estimated to reach up to 1.2% of GDP per year per 1°C, of global warming and up to around 20% of total income in the regions most affected, thereby increasing inequalities between regions and potentially social conflict.

Since there are evident synergies between environmental sustainability and economic performance, tackling climate change can be an opportunity for EU businesses. By greening production and consumption patterns and promoting green jobs , climate action not only has an impact on labour markets, job quality and health and safety at the workplace , but also fosters innovation and productivity and enhances opportunities for green, climate-smart growth. Putting a price on environmental harm such as waste and pollution, either by environmental taxation or by a cap-and-trade system such as the Emissions Trading System (ETS), can help in this regard. Such measures can help internalise social and environmental externalities, prevent 'pollution havens', encourage reallocation of resources and re-orient global value chains towards low energy-intensive and low carbon production. The revenue generated can contribute to the financing of social policies and of targeted, growth-enhancing social investments, e.g. education and reskilling, or it can fund temporary support for the transition to new activities and other accompanying or compensatory measures.

Broad social acceptance of environmental protection and climate action measures is vital for their effective implementation and for making progress towards the Sustainable

Development Goals. Societal trends have a strong impact on the environment, through changing preferences and consumption choices, including e.g. dietary changes or changes in travel behaviour. Social networks and social movements such as the school climate strikers contribute to raising awareness, changing perceptions and re-framing political and public debates. The debate is also intensifying among academics and policy makers, recognising the need to improve the understanding and modelling of social and distributional aspects of environmental degradation and climate change and related policy action; to take better account of social concerns and social acceptance; and to design and implement policies to promote necessary behavioural changes, including mitigating measures or compensatory actions where relevant. These elements are recognised in the Commission's Reflection Paper 'Towards a Sustainable Europe by 2030' putting forward three scenarios for the discussion on how to implement the SDGs.

This environmental-social intersection is at the heart of the Commission's proposed strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050, 'A Clean Planet for All'. The strategy shows how Europe can lead the way to climate neutrality by investing in realistic technological solutions, by empowering citizens and aligning actions in key areas such as industrial policy, finance or research, while ensuring social fairness for a just transition. The strategy covers many EU policies; it is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and to pursue efforts to keep it to 1.5°C.

However, the intended transition to an environmentally sustainable, climate-neutral economy is not socially inclusive by default. Employment and social policies therefore are key to supporting a just transition. The Commission Communication mentioned above recognises that the transition is likely to have significant employment and social impacts and could result in regional disparities if not well managed. It also recognises the vital role that social acceptance and social policy will play in the success of any climate action, notably for making growth green and inclusive at the same time. It calls on the EU and Member States to take the social implications of the transition into account from the outset, and to deploy all relevant policies to mitigate the risks, particularly for those on low incomes. It further stipulates that social issues are generally better addressed through social policy and welfare systems, the financing of which could benefit from tax shifts and revenue recycling. The European Council discussed the Long Term Strategy on several occassions and the conclusions of the 20-21 June meeting stressed that the transition to a climate-neutral EU should be just and socially balanced, taking into account Member States' national circumstances.

The EU budget and employment and social policies, as well as cohesion policies, have a key role to play in this context. Support for a just transition can be provided in accordance with the principles of the European Pillar of Social Rights, notably to support transitions, adequate social protection systems and inclusive education, training and lifelong learning. Social partners need to be involved in the design and implementation of transition measures. With a budget of EUR 100 billion in the 2020-2027 period, the ESF+ programme will help to ensure that Europeans have the right skills and will be proactive in supporting the most vulnerable in the EU. It will contribute to achieving a greener, climate-neutral Europe through the improvement of education and training systems necessary for the upskilling and reskilling of the workforce, and it will support job creation in sectors related to the environment, climate and energy and the bioeconomy.

This chapter focuses on three aspects of environmental and social sustainability in the EU: first, the taxonomy and development of green jobs and occupations in the EU economy; secondly, the key findings of recent climate action scenarios on the expected impacts of the transition to a climate-neutral economy on employment, skills, income and task structures at disaggregated levels; and thirdly, energy poverty and the link between climate action, air pollution and human health.

Building on recent climate action scenarios and related impact assessments, the chapter presents an additional focus on social outcomes. It does so by presenting additional detail on the impacts of the transition to a climate-neutral economy by 2050 on employment, skills and tasks and by focussing on distributional impacts and links to income and poverty. It also highlights synergies between environmental and social goals, for example in relation to job creation, skills acquisition, energy efficiency and reduced health expenditure.

2. TOWARDS A TAXONOMY OF GREEN JOBS AND OCCUPATIONS

The labour market potential of green jobs and eco-industries has long been recognised. In 2009, the European Commission emphasised the scope for creation of green jobs and the greening of existing jobs. However, due to the challenges surrounding the definition and measurement of such jobs the estimates of the scale of green jobs varied greatly, from 2.4 to 36.4 million in 2000. The definition of green jobs has evolved, from initially focussing only on direct jobs to introducing indirect jobs, and subsequently a broader understanding of varying degrees of "greenness" and a spectrum of green jobs , covering occupations with green(ing) tasks and/or jobs in circular economy value chains more generally. Irrespective of the definition, the overall net employment effect of the transition to a green economy as assessed by the European Commission was expected to be neutral or slightly positive, at least in the long term.

In its 2014 Communication on the Green Employment Initiative, the European Commission put forward a framework for a job-rich recovery. This was in response to the job creation potential of the green economy, which had been well anticipated notably in the 2013 and 2014 Annual Growth Surveys (see *Box 5.1* for further detail on green and inclusive growth). There has in fact been considerable, above average job creation in the environmental goods and services sector (EGSS) since 2000, including during the economic crisis , highlighting the resilience of green jobs. In 2016, there were 4.5 million people (full-time equivalent) employed in the environmental economy in the EU, up from 3.2 million in 2000. To exploit the job potential in these areas more fully during the recovery, the Communication emphasised the need to bridge skill gaps, anticipate change, secure transitions and promote mobility as well as support further job creation. It also recommended improving data quality and recognised the need to address existing bottlenecks and challenges, for example: regions with energy-intensive, high-carbon industries and poor economic diversification could suffer; older and low-skilled workers would be more vulnerable to change; and job quality and health and safety should not be neglected in the transition.

While the transition to a greener, circular and climate–neutral economy is expected to have a slightly positive impact on total employment levels, its sector-specific employment and skills impact will be significant (e.g. in the construction and renewable energy sectors). The roll-out of increasingly ambitious climate action will coincide with other megatrends, such as automation and digitalisation that are likely to have major impacts on future skill needs. Preparing workers for new occupations and tasks in a green economy is important. While these changes are expected to affect a minority of European workers, they will be substantial for specific occupations and sectors. In general, developing specific new green skills may be less important for the overall transition to a greener economy than the continuous improvement of existing transversal and specific skills, including digital skills.

Measures to address the skills challenge can help to harness the employment potential of the green economy for the benefit of all skill levels. The impacts of greening across the skills and income distribution will be balanced to some degree.. Initially high-skilled labour may benefit more than lower-skilled labour but as the green economy develops, many traditionally lower-skilled sectors will see increased demand too, notably waste management and sectors related to the circular economy, making it possible to harness the employment potential of the green economy in a way that could benefit all skill levels in society. In turn, these sectors can be expected to also employ more sophisticated technologies and become more capital intensive, thus demanding higher skills.

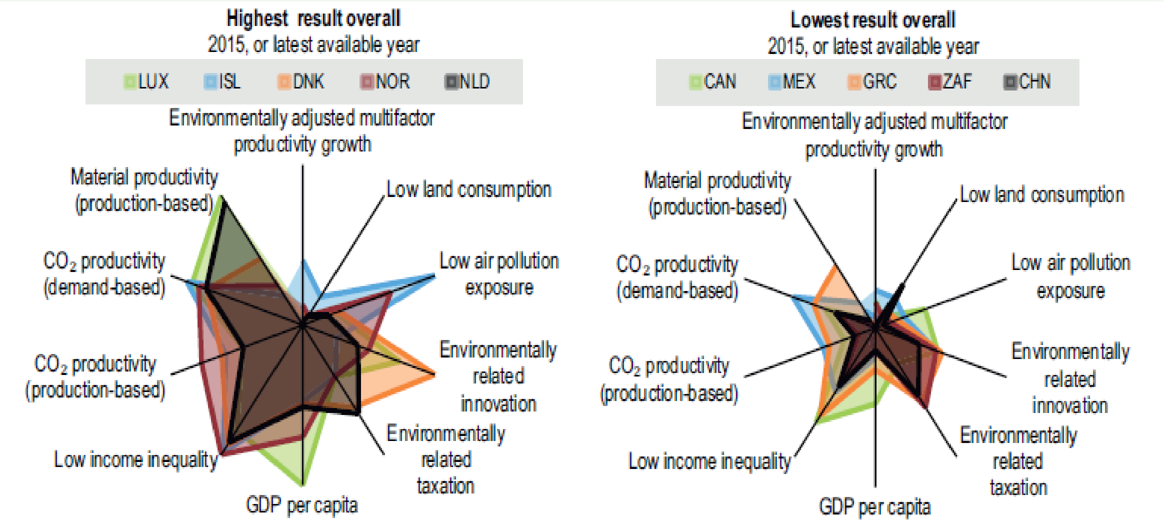
Box 5.1: Measuring and monitoring green and inclusive growth

Several measurement initiatives for green growth have been developed in recent years. The Global Green Growth Institute is currently developing the Green Growth Potential Assessment and the Green Growth Performance Measurement, which offer country-specific indicators and simulation tools to help highlight the potential benefits of green policies and investments. Its Green Growth Index is based on more than 35 indicators that represent green growth dimensions including socioeconomic resilience, green economic opportunities and social inclusion. Meanwhile the Global Green Economy Index ([1]) measures the green economy performance of 130 countries using quantitative and qualitative indicators on four key dimensions. It is used to benchmark performance, communicate areas that need improvement, and help diverse stakeholder promote progress in these areas.

The OECD Green Growth Indicators facilitate better monitoring of green growth. ([2]) They enable the monitoring of progress towards four primary objectives: "establishing a low-carbon, resource-efficient economy; maintaining the natural asset base; improving people's quality of life; and implementing appropriate policy to realise the economic opportunities of green growth". ([3]) Indicators that reflect how environmental conditions and risks interact with people's well-being are included. These also demonstrate the role of amenities in supporting well-being and show the extent to which income growth is matched by improvements to well-being (or not). Such indicators, along with other well-being indicators such as those of the OECD Better Life Index ([4]) are crucial to understanding the interplay between economic, social and environmental sustainability. OECD analysis indicates that while several EU countries are global leaders at the forefront of the transition towards green growth (including Luxembourg, Denmark and the Netherlands), others lag behind, notably Greece, among the five weakest performers. These measures account for multiple dimensions of green growth, but often even high performers make progress on one aspect while standing still on others.

Several EU initiatives exist to support green growth. In the European Semester exercise, annexes to Country Reports include a green growth table containing several intensity indicators reflecting the relative decoupling of environmental pressure from GDP growth. A monitoring framework has been developed in the context of the circular economy action plan ([5]) as well as key indicators for each dimension of the Energy Union for both the EU and each Member State. ([6])

Figure 1: Monitoring green growth, relative to the leaders



Source: OECD 2017

([1]) http://dualcitizeninc.com/global-green-economy-index/
([2]) http://www.oecd.org/greengrowth/green-growth-indicators/
([3]) OECD (2017a)
([4]) OECD (2017b)
([5]) COM/2018/029, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:29:FIN
([6]) https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf

2.1. Broadening the scope of the green economy

The increased importance of the service sector and its lower carbon intensity can help to drive the EU towards a low-carbon future. The EU has been experiencing a structural shift to the service economy, with lower value added and employment shares of traditional 'brown' sectors and higher shares of employment in intrinsically 'green' sectors. Employment and value generation are taking place increasingly in business sectors that are relatively low in carbon emissions and material inputs (see *Chart 5.2*).

Most of the employment in the EU is not in carbon intensive sectors (*Chart 5.2*). More than 70% of the workforce works in sectors which produce less than 10% of all CO2 emissions. Construction, wholesale and retail trade and other services sectors together create more than 70% of gross value added and employ more than 75% of the workforce, while producing less than 12% of all CO2 emissions. Employment also grows most strongly in these sectors. On the other hand, electricity production, transport , manufacturing, agriculture and mining sectors together produce close to 90% of all CO2 emissions in the EU, while they account for 25% of gross value added and less than 25% of employment. If well managed, the shift towards a climate-neutral economy can provide employment opportunities for all skill levels.

Progress is not automatic, and targeted policies are needed to accompany, steer and accelerate the ongoing process of decarbonisation. Although the increasing share of services in the economy contributes to reducing the carbon intensity of output, parallel action is needed to decarbonise the energy-intensive activities. Moreover, some service sectors rely on heavy use of electricity (especially those associated with fintech, data servers or block chain technologies). As long as electricity is produced through carbon-rich methods, the growing energy demands in these sectors remain problematic and hence shifts towards sustainable energy production are necessary. Moreover, shifts towards increasingly integrated global value chains bring with them increased demands for transport of intermediate and final goods. This can significantly increase the ecological footprint of final goods production. Furthermore, given the global nature of the greenhouse effect, the risk of the most polluting activities being outsourced to other parts of the world needs to be addressed. Lastly, with workers' and consumers' behavioural responses to shifting rules and opportunities, there are potentially important second-round effects of the transition towards a low-carbon economy. In this perspective, 'greening the economy' does not simply mean doing the same things with lower CO_2 emissions and material inputs, but doing fundamentally different things, with knock-on effects on incentives and wages and economic policymaking.

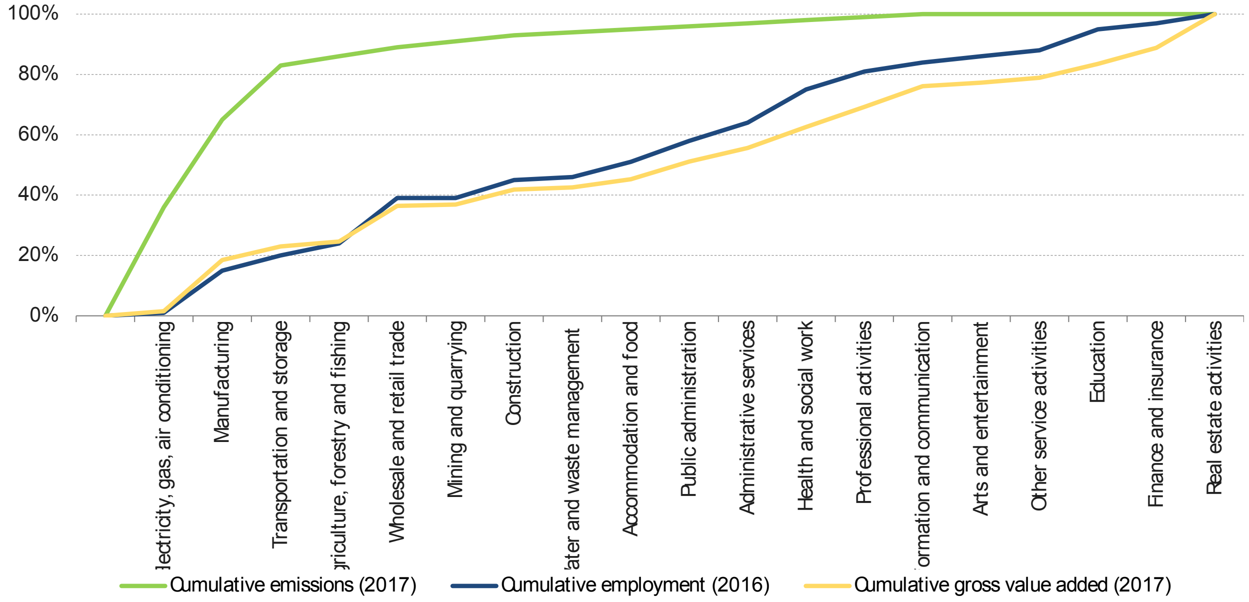
Circular economy policies and new business and work organisation models are related to climate action and have labour market implications. New forms of work organisation that allow for more flexible, telework can reduce the need for commuting and thus have an impact on traffic and related emissions. Moreover, processes that make the economy increasingly circular through more efficient use of raw materials contribute to total factor productivity improvements and hence to economic growth and job creation. It has been shown that a set of mainly technological changes to improve resource efficiency in five key sectors (food, motor vehicles, construction, electronics and waste management) can potentially create an additional 700,000 jobs in the EU by 2030, compared with a business-as-usual scenario. This favourable impact is mainly driven by job creation in the waste management sector, but an overall shift from capital-intensive towards more labour-intensive activities also plays a role. However, some of the emerging activities could be automated.

A narrow definition of 'green jobs' leads to underestimating the potential labour market impact of the transition towards a climate-neutral economy. Based on the Eurostat definition, there are currently (2016) 4.5 million jobs in the EU in the so-called environmental goods and services sectors, up from 3.2 million in 2000. These include jobs in areas such as waste management, environmental protection and energy preservation, usually jobs in easily-identifiable industries that are clearly shaped by environmental regulation. However, focusing on existing jobs in existing industries (such as the environmental goods and services sectors) risks missing larger and more diffuse developments associated with low-carbon and environmentally sustainable activities in the economy and the labour market, and ignores significant changes

Chart 5.2

More than 70% of jobs are in sectors that emit less and grow faster

CO2 emissions, employment and Gross Value Added (GVA) across industries in the EU, 2016-17



Note: Cumulative employment, emissions and GVA in % of total, with sectors (NACE 08) ordered by decreasing share of CO2 emissions.

Source: Eurostat, and calculations by Bowen and Hancké (forthcoming).

Click here to download chart.

in occupational profiles, task structures and skill requirements.

For a better assessment of the potential and impact on jobs of the transition towards the green economy, broader typologies of green(able) activities need to be considered. This has been recognised in particular in the European Commission's recent action plan on financing sustainable growth. Under the plan, the EU Technical Expert Group on Sustainable Finance presented a Technical Report setting out the basis for an EU Taxonomy for sustainable activities. The Taxonomy considers three kinds of activities that can make a substantial contribution to climate change mitigation. These are:

- Activities that are already low carbon (e.g. zero emissions transport);
- Activities that contribute to a transition (e.g. cars with emissions below 50g CO_2/kWh);
- Activities that enable those above (e.g. manufacture of wind turbines).
- The suggested taxonomy will be subject to stakeholder consultation and further negotiation with the EU legislators.

2.2. The potential of green(able) jobs in the EU

In this section, we explore a taxonomy of 'greenable' jobs in the EU, based on the taxonomy proposed for the US under the O*NET programme. Such a taxonomy could help to identify the potential for 'greening' activities or tasks within existing jobs, their evolution over time and the scope for handling the distributive costs of the transition through job redesign, retraining, labour reallocation and wage formation. The taxonomy is based on a broad definition of greenable jobs as all jobs/occupations that will be affected by greening, i.e. reducing fossil fuel usage and addressing environmental degradation and greenhouse gas emissions, recycling materials, increasing energy efficiency and developing renewable energy sources. The term does not necessarily describe the actual current amount of green jobs today, but rather the potential of 'green and greenable' jobs in the sector or the economy.

In terms of 'greenness', the following five categories of jobs can be identified.

1. Green Increased Demand (Green ID) jobs are existing jobs that are expected to be in high demand due to greening, but do not require significant changes in tasks, skills or knowledge. These jobs are considered indirectly green because they support green economic activity, but do not involve any specifically green tasks (e.g. bus drivers as key actors in public transport, counted in the occupational category 'bus drivers, transit and intercity', as well as e.g. renewable energy engineers, sales and marketing professionals, organic agriculture farmers, etc).

2. **Green Enhanced Skills (Green ES) jobs** are existing jobs that require substantial changes in tasks, skills and knowledge as a result of greening (e.g. electric vehicle electricians, counted in the occupational category 'automotive speciality technicians', but also construction workers, architects, urban planners, teachers, human resource professionals, etc).

3. **Green New and Emerging (Green NE) jobs** are unique jobs (as defined by worker requirements) created to meet the new needs of the green economy. (e.g. fuel cell engineers, counted in the occupational category 'engineering professionals' as well as e.g. sustainability auditors and sustainable finance experts).

4. **Green Rival Jobs** are non-green jobs that are 'similar' to one of the three 'green' job categories, either because they involve very similar tasks or (in the case of new employees) because they require similar skills and other worker attributes. They are likely to be affected by the greening of the economy because of their similarity to existing green occupations (e.g. lorry drivers, industrial engineers in fossil-fuel-based production or investment managers concentrating on non-green economic sectors and criteria other than sustainability).

5. **Other Non-Green Jobs** are non-green jobs that are less likely to be affected (at least in the short term) by the greening of the economy, because of their lack of similarity to green occupations (including perhaps occupations such as notaries, medical doctors and pharmacists or nurses).

According to this taxonomy, European labour markets have a significant green potential and job growth over the past decade has been green to some extent. Many occupations have a significant green component, and their number has grown, both in absolute terms and as a proportion of total employment (*Table 5.2*). Across all industries, by 2006 more than 75 million jobs, i.e. around a third of all jobs, were green(able) by the above definition based on the task content of occupations. Since then, net job creation has added more than 6.5 million jobs in the EU (equivalent to 3.2% overall job growth). The rise in the number of green(able) jobs between 2006 and 2016 was more striking, and exceeding12 million jobs. Consequently, the proportion of jobs (across all categories) that have the potential to be affected by greening increased from 35% to 40% of all jobs.

Table 5.1
Many occupations have a significant green component
Green jobs in total in the EU, 2006-2016

	2016		2006	
	Employment (million persons)	Proportion of total employment (%)	Employment (million persons)	Proportion of total employment (%)
Total	219.0	100	212.3	100
Green Increased Demand	51.3	23.4	49.7	23.4
Green Enhanced Skills	43.9	20	34.8	16.3
Green New and Emerging	38.2	17.4	22.9	10.8
Green Total	87.6	40	75.4	35.5

Note: Total in millions, and share in % of total employment (15-64) in the respective category. Green Total adjusted to correct for potential 'double-counting'; the figures for the different categories of green jobs (G-ID, G-ES and G-NE) cannot be added up as some occupations at 3-digit ISCO level contain green jobs (defined in O-NET at a more disaggregated level) of more than one type. For a detailed explanation, see Bowen and Hancké (forthcoming).

Source: Eurostat (LFS) and own calculations; based on Bowen and Hancké (forthcoming)

Click here to download table.

Employment in such green(able) jobs has increased for all categories, but most strongly in occupations requiring new green skills and retraining in response to new activities and technologies. The largest sub-category of green(able) jobs remain Green Increased Demand (G-ID) jobs, with almost 50 million jobs in 2016, or 22.5% of total employment. The fastest employment growth, however, was recorded in Green Enhanced Skills (G-ES) jobs and in Green New Emerging (G-NE) jobs that saw their employment shares rise to 20% and 17% (up by 4 and 6 pp), respectively. While the largest number of jobs potentially affected by greening can be found in manufacturing and construction sectors, there was important growth in green(able) jobs in some (large) service sectors such as transport and communication, as well as in the financial sector, including carbon credit trading, and in health and social work. However, some of these service sectors, especially the financial sector (above 50%), still record relatively high levels of non-green jobs (e.g. when concentrating on financing activities based on fossil fuels rather than supporting activities promoted in the Sustainable Finance Action Plan). Furthermore, the proportion of Green Rival Jobs declined

Table 5.2

Highest job growth in occupations with new or enhanced green skills

Employment composition and change in selected sectors in the EU, by green job typology 2016

	Total ecoonomy	Total green jobs		G-ID		G-ES		G-NE		Green rival	
Sectors	2016 (in thousands)	share 2016	change 2006-2016	share 2016	change 2006-2016	share 2016	change 2006-2016	share 2016	change 2006-2016	share 2016	change 2006-2016
Agriculture, forestry and fishing	8737	25.9	4.22	18.64	0.13	8.5	4.89	8.35	4.32	53.17	-8.31
Mining and quarrying	757	54.36	17.2	33.47	4.46	31.66	12.89	29.56	18.32	41.25	-1.57
Manufacturing	34157	52.23	-1.36	34.18	-1.53	22.5	-0.29	15.55	1.4	28.91	-6.33
Energy and water supply and waste managment	3236	58.01	3.78	29.75	1.6	33.87	2.33	29.8	3.27	23.52	-5.69
Construction	14716	73.32	6.33	58.67	9.52	36.74	-2.88	19.46	9.14	22.74	-8.77
Wholesale and retail trade and repair	30712	33.87	-0.26	17.62	-3.92	20.11	6.01	14.93	-1.75	45.18	-7.61
Accommodation and food service activities	10567	21.83	-4.5	17.47	-5.05	5.05	1.8	5.18	-3.71	19.52	0.61
Transportation, storage and ICT	18180	60.7	9.83	36.63	2.1	30.09	8.49	21.01	11.1	38.41	-2.95
Financial and insurance activities	6476	36.79	14.85	12.96	1.56	23.69	10.56	42.21	32.81	55.81	2.42
Professional, scientific, technical and administrative activities	22994	51.55	8.06	25.38	4.37	29.12	1.68	35.48	13.44	35.67	-6.51
Public administration	15176	45.28	7.92	28.9	2.09	18.07	3.86	22.72	16.99	40.38	-5.96
Education	16639	15.31	9.32	5.53	1.34	4.28	2.09	6.93	5.12	39.92	-0.79
Human health and social work activities	23820	21.41	10.03	9.68	3.09	15.62	9.38	11.34	8.01	21.96	-5.47

Note: See defintions and comments for Table 5.1.

Source: Eurostat and own calculations,; based on Bowen and Hancké (forthcoming)

Click here to download table.

significantly across all industries between 2006 and 2016, suggesting that the divide between green and other jobs is becoming more pronounced.

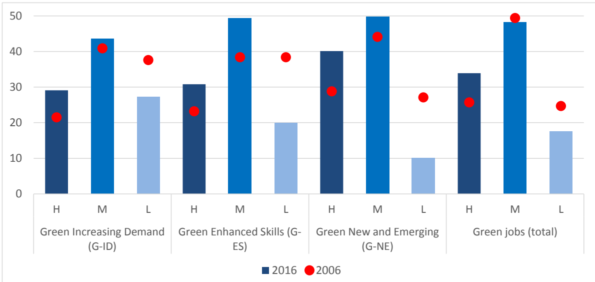
Skill requirements and education levels are increasing fast in the green economy, faster than in the economy overall. Educational attainment levels rose in all categories of green jobs between 2006 and 2016 (*Chart 5.3*), most strongly for green new and emerging jobs (G-NE) of which more than 40% in 2016 were held by people with tertiary education (more than 6pp above the average, and more than 12pp higher than ten years before). The proportion of middle-skilled jobs, while stagnating or even declining in the economy overall , increased in all categories of the green economy, particularly for green enhanced skills (G-ES) jobs. The proportion of workers with low skills declined twice as much in green jobs as in the economy overall, and by up to 18pp for green enhanced skills (G-ES) and green new emerging (G-NE) jobs, compared with an average decline of 7pp in the economy overall.

The sectors supporting a transition towards green jobs are mainly construction, transport, manufacturing and services sectors. The highest proportions of employment in green(able) jobs are found in construction (73%), transport (61%) and in manufacturing, energy and waste management and professional service activities (*Table 5.2*). The highest proportions of employment in 'green rival' jobs, on the other hand, are found in the financial sector, wholesale and retail trade and mining, and interestingly also in agriculture. 'Other non-green' jobs, i.e. jobs with tasks and activities very different from those required by green jobs as defined in the taxonomy, are most prevalent in accommodation and food services as well as in education and health and social work. Employment trends differ significantly across these categories: proportions of new and emerging green jobs have increased in all sectors except accommodation and food services, while proportions of green rival jobs have decreased. This suggests that change towards green(er) occupational profiles and activities is underway across the economy, supported by retraining and upskilling. However some high-emission sectors, notably manufacturing, have not seen an increase in green(able) jobs in the period 2006-2016.

Chart 5.3

Skills requirements increase fast in green(able) jobs

Proportion of green jobs in the EU as a share of total employment in %, by category of green jobs and by educational attainment, 2006-2016



Note: Shares of employment, total and by qualification level, in a given green job category in % of total employment (15-64), correcting for potential inclusion of certain ISCO occupational categories in more than one of the proposed green job categories.. H denotes 'Tertiary education' (ISCED11 levels 5-8), M denotes 'Upper secondary and post-secondary non-tertiary education' (ISCED11 levels 3 and 4) and L denotes 'Less than primary, primary and lower secondary education' (ISCED11 levels 0-2).

Source: Eurostat and own calculations; based on Bowen and Hancké (forthcoming).

Click here to download chart.

Change is also driven by the services sector. Job creation due to increased demand is positive in all service sectors, often leading to relatively high proportions of jobs with green characteristics. More interestingly, the service

Table 5.3
Need for significant upskilling for new emerging green jobs, particularly in manufacturing, construction and transport
Skill composition of green new and emerging (G-NE) and non-green jobs in selected sectors in the EU, 2016

	G-NE			Green rival		
Sectors	**H**	**M**	**L**	**H**	**M**	**L**
Agriculture, forestry and fishing	31.6	38.9	29.5	23.7	33.0	43.3
Mining and quarrying	24.1	51.8	24.1	15.4	38.3	46.3
Manufacturing	38.8	52.2	9.0	32.5	46.9	20.6
Energy and water supply and waste managment	41.9	49.3	8.8	30.3	49.9	19.9
Construction	40.8	49.5	9.7	25.2	48.5	26.3
Wholesale and retail trade and repair	23.1	65.5	11.4	18.5	52.5	29.0
Accommodation and food service activities	28.1	48.0	23.9	21.3	48.1	30.6
Transportation, storage and ICT	41.8	48.5	9.7	25.1	50.3	24.6
Financial and insurance activities	49.5	46.3	4.2	38.6	52.6	8.8
Professional, scientific, technical and administrative activities	42.8	42.8	14.4	33.8	45.9	20.4
Public administration	41.8	50.5	7.8	27.4	49.2	23.3
Education	55.4	41.0	3.6	42.4	46.0	11.7
Human health and social work activities	44.9	51.8	3.4	35.5	42.8	21.6

Note: See legend and comments for Table 5.1.
Source: Eurostat and own calculations; based on Bowen and Hancké (forthcoming)
Click here to download table.

sectors also create a high number of new jobs with a significant green task component. These could be energy auditors, sustainability officers, compliance managers, carbon credit traders and analysts, sustainable finance investment underwriters, climate change analysts or others.

There is further scope for greening public services, notably education. Significant increases in green jobs and tasks, as defined in the taxonomy, took place in some parts of public administration, notably in health and social work. However the education sector, one of the largest civil sectors in public administration, stands out as having a particularly low percentage of jobs potentially affected by greening, and growth in these jobs has also been weak. On the other hand, the sector obviously has a fundamental role in shaping environmental awareness, consumer behaviour and new skills of current and future generations, and encouraging the transition to a green and climate-neutral economy and society overall.

As regards skills development, there has been relatively less upskilling in the EU's traditional industrial sectors. In most traditional sectors, such as agriculture, mining, manufacturing, water and energy, the demand for skills has barely increased. Construction is the exception, probably because of increasing demand for renovation and upgrading of the building stock, including insulation and more efficient heating, electricity or plumbing. In addition, the construction sector has undegone a rapid technological change in its production methods, such as pre-fabricated housing and greening of materials. This increased demand mainly results from policy changes and related shifts in relative prices for energy and other natural resources. By contrast, the relative stability of skill profiles and employment in manufacturing may indicate a need to accelerate adjustments to production processes and training provision in order to respond to current ecological pressures and opportunities.

Given the pace at which new and emerging green jobs require increasingly high skill levels, people employed in non-green jobs may well need transition support. *Table 5.3* shows the contrast in skill composition between new and emerging green jobs on the one hand and non-green 'green rival' jobs on the other. This contrast is significant for all sectors, notably manufacturing, construction and transport, which have high proportions of workers in low-skilled employment in non-green jobs. This illustrates the skills challenges of the transition to the green economy and the need for significant upskilling in these sectors. The skills profile of new and emerging green jobs, the fastest growing cateogry, can be seen as a proxy for future skill needs in these sectors.

Going forward, the transition to a green economy is expected to accelerate and to involve large segments of the workforce. It has to be recognised that there is no dichotomy, and certainly no normative distinction, between green and non-green jobs as defined above. Their task structures and occupational content may differ substantially and warrant a different 'green' or 'non-green' categorisation. Yet they may have an important role to play in supporting the transition to a climate-neutral economy. A case in point is that of teachers, who are vital for educating and training future generations of green jobholders and responsible consumers. This said, the low green growth figures for several large service sectors, such as education and health and social work, as well as the relative stagnation of the skills profile of large sectors such as manufacturing, suggest that much more can be done. In the UK, for example, government research estimates that 21% of all jobs will see a shifting skill requirement, where "around 10% of workers have skills that could be in more demand, while 10% are more likely to need reskilling". If anything, the taxonomy of green jobs and occupations and the related trends presented in this section probably show that such estimates may be too conservative.

While the transition to the green economy is well underway, novel green occupations are not limited to the production of narrowly-defined environmental goods and services. In addition, some of the high-emission sectors have not shown any significant increase in green jobs over time. There is considerable potential for new green jobs and greener jobs in all sectors of the economy, and substantial need to speed up adjustment processes, notably in agriculture, manufacturing and public services. Means of achieving this include regulation, financial incentives, training support, active labour market policies and education sector reforms.

3. Employment and skills in the transition to a climate-neutral economy

This section projects the main economic and employment impacts of climate action until 2050. It builds on the most recent available scenarios and simulations, notably the in-depth analysis and modelling of impacts of various pathways at EU level underpinning the Commission's proposal for a long-term vision up to 2050 for a prosperous, modern, competitive and climate neutral economy (European Commission, 2018a, 2018b). It is also based on additional assessments with shorter time horizon, including the impact assessments for related individual initiatives, such as the ETS revision or the review of the Energy Efficiency Directive, which make it possible to identify the impact of specific initiatives by 2030. Moreover, the section discusses the available evidence on the expected impact of climate action on skills and task structures by 2030 (based in particular on Eurofound (2019)).

Climate action has gained considerable momentum in recent years at a global and EU level. The Paris Agreement was adopted in December 2015, aiming to keep the rise in global temperature well below 2 degrees Celsius above pre-industrial levels and pursue efforts to keep it at 1.5 degrees Celsius, through Nationally Determined Contributions (NDCs), with enhanced support for developing countries to achieve this. Since then, the European Commission has outlined in its Communication and associated analyses its long-term vision for climate neutrality, highlighting opportunities ahead and the need for a socially just transition to a green economy. Member States also need to prepare National Energy and Climate Plans, a requirement under the Energy Union Governance Regulation. At the Katowice Climate Change Conference (UNFCCC COP 24) of December 2018, 196 countries worked together to agree the Katowice Rulebook, implementing the Paris agreement. Parties agreed to revise and enhance their NDCs and to detail financial support for developing countries and a consensus was found on how to carry out a "global stocktake" and assess progress.

In the current section, 'climate action' is understood to be the set of policy measures that either disincentivise greenhouse gas emissions or promote investment in low-emission structures or technologies. The first category of policies are disincentive measures including regulatory standards and price mechanisms (such as the ETS and environmental taxation) that penalise emissions. The second category includes investment projects, subsidies, loans etc. to encourage low-emission methods of producing capital goods (notably buildings and power generation equipment), and promoting research and development in climate-neutral energy generation, energy efficiency and the like. Climate action also needs to be supported by training, reskilling, upskilling and other measures that help to address the need for labour reallocation across sectors, occupations and regions, as well as other social and distributional impacts of climate change.

Economic, social and employment impacts of climate action arise from an aggregate of policy components, with some interventions having a stimulus effect and others acting as a drag. First, investment projects, such as the building of energy efficient structures and the refurbishment of existing structures, have a generally positive economic impact. However, assumptions about financing and crowding out are crucial i.e.if investments with the sole purpose of improving energy efficiency could only be carried out by redirecting resources from other productive uses, the balance may be negative. Second, with energy as an important input to production, policies that increase energy prices in order to reflect the full environmental and social costs may have a negative impact on the macro-economy in the near term, as well as lead to increases in household expenditure and energy poverty. Third, in the European context, a shift from imported fossil fuels to domestically sourced renewables improves trade balances and creates new employment in the EU. Fourth, developments in the price of capital, triggered by investment policies, can lead to a reallocation of factors of production, including labour, between sectors that differ in capital intensity. Fifth, a comparative advantage in the production of environmentally sustainable goods can translate into a boost in economic activity, particularly if partner economies increasingly demand such goods. Sixth, carbon revenue recycling to cut labour taxation, including labour taxation for vulnerable groups or to finance social investment and social protection systems, can lead to a boost in employment and strengthen the welfare state.

Assessing such impacts with the help of macroeconomic simulations requires a baseline scenario. The long-term strategy models both 2°C and 1.5°C scenarios, the latter achieved through carbon neutrality in the EU by 2050. The economic and social impacts are expressed as differences compared with a baseline scenario that includes all policies of the so-called 2030 climate package (see section 3.3). Implementing these policies by 2030 presents a significant challenge, for which social acceptance and public support will be important (see also section 3.7). With regard to employment, the baseline assumes a slightly decreasing employment figure in the EU until 2050, which mainly reflects a small decline in working-age population.

3.1. Main economic and social impacts of long-term climate change scenarios

Overall, the economic and employment impacts of deep transformations – notably technological change and climate change - are expected to be positive. These transformations will require significant additional investment in all sectors of the economy as well as a significant reallocation of labour across certain sectors and regions and changing skill requirements. Simulations based on two global macroeconomic models (JRC-GEM-E3 and E3ME) provided detailed results for sectoral employment under ambitious climate policies (1.5°C scenarios, implying zero net emissions by 2050, and 2°C scenarios implying an 80% reduction in emissions compared with 1990 levels). In terms of total employment in 2050, the 1.5°C scenarios point to potential gains of 0.6% to 0.9%, or about 1.5 to 2 million jobs, compared with the baseline.

Employment impacts will differ significantly across sectors and regions. Job gains in construction, agriculture and forestry and renewable energy sectors could be partly offset by a contraction in sectors such as fossil fuel-related mining and quarrying. Furthermore, some sectors such as steel, cement and chemicals will have to transform themselves as part of the low-carbon transition,. Car manufacturers, too, will see a shift to new production processes with new skills required. Moreover, the regions most affected will be those where economies depend on sectors that are expected to decline or be transformed in the future. Many of these are located in Central and Eastern Europe but some are in Germany.

The biggest projected winners are the agriculture, power generation, construction and consumer goods sectors (see *Table 5.1*)**.** In *absolute* terms, agriculture, forestry and construction combined could add up to 2.4 million jobs to their baseline levels (depending on the specification, see below). The power sector could gain up to 250,000 jobs. In *relative* terms, some of the biggest expected winners are power generation and agriculture, with almost

25% of job gains in electricity supply. The range is also positive under all scenarios for the construction sector, while agriculture and forestry could gain significantly under some scenarios. Gains in agriculture and forestry are explained by a higher biomass demand, while gains in the power sector are driven by increased electrification of the economy in all climate scenarios. The positive employment developments in construction result from a predicted investment hike driven by the increased demand for energy-efficient structures. In relative terms the biggest job-losing sectors are fossil fuel extractive industries, which could experience a loss of up to 60% of their jobs. On the other hand, small relative gains in the services sector could translate into an additional 1.5 million jobs, though some scenarios also see job losses of up to 3 million in this sector due to reallocation of the labour force across the economy and potential impacts on GDP developments.

The model specifications underlying these simulations differ in their assumptions, first as regards climate policies implemented by global partners, and secondly as regards market behaviour. Some specifications (labelled 'Fragmented') assume that Europe alone would be implementing measures aiming at zero net emissions by 2050 - an 80% reduction im emissions - while the rest of the world does no more than maintain current ambitions set out in Nationally Determined Contributions under the Paris Agreement. Other specifications (labelled 'Global') are based on the assumption of a worldwide take-up. They assume that the rest of the world reduces emissions by 2050 by 46% to 72%, compared to 1990 levels, respectively in line with global pathways to limit climate change well below 2°C and to 1.5°C.

Global demand is determined by choices made by trading partners through three principal channels. First, according to the JRC-GEM-E3 model, stepping up climate policies worldwide could lower moderately the economic growth of the trading partners, leading to a subdued demand for exports to these economies. By contrast, the E3ME model assumes that higher climate ambition boosts investment and increases economic growth. Secondly, demand for environmentally friendly products originating in Europe would be stronger as trading partners increasingly import energy-efficient products. Thirdly, more ambitious climate action by global competitors would give a competitive advantage to European industry which is already more carbon- efficient than other regions. On balance, the 'Global' specifications show more EU employment in traded goods sectors including energy intensive goods, consumer goods and agricultural products, but a negative employment impact related to declining EU exports in other sectors, including business services.

Table 5.4
Long-term employment impacts differ significanly across sectors
Sectoral employment impact, difference from baseline in 2050, %

Sector	Share of total jobs in 2015	Range of change in jobs by 2050, compared to
Construction	6.7%	↗ +0.3% to +2.8%
Services	71.7%	→ -2.0% to +0.9%
Agriculture	4.5%	↗ -0.7% to +7.9%
Mining and extraction	0.5%	↘ -62.6% to -2.9%
Power generation	0.7%	↗ +3.6% to +22.3%
Manufacturing (Energy intensive industries)	2.0%	→ -2.6% to +1.8%
Other manufacturing	13.3%	→ -1.4% to +1.1%

Note: Employment effects from JRC-GEM-E3 and E3ME. Ranges of estimated changes in jobs in 2050 depend on the underlying model and modelling assumptions.
Source: Adapted from European Commission (2018a) pp. 227-229
Click here to download table.

The second dimension in which the JRC-GEM-E3 model differs concerns the assumptions on the behaviour of European product and labour markets and the use of carbon revenues. The 'revenue recycling' scenarios assume imperfect wage adjustment in the labour market, the use of carbon revenues to reduce labour taxation and market-share-maximising firm behaviour. 'Lump-sum transfer' scenarios, on the other hand, are based on the absence of wage rigidities in the labour markets and the lump-sum redistribution of carbon revenues to households and profit-maximisation by firms. In these scenarios, labour market changes are captured by the wage channel only, assuming an unchanged overall employment level in the EU relative to the baseline, while allowing for structural changes that imply a reallocation of jobs between sectors.

Policies will have significant impacts on labour market outcomes. The scenario modelling using the JRC-GEM-E3 model points to an important policy conclusion: that using revenue from environmental taxes, including carbon pricing, to generate a tax shift away from labour taxation, generates employment gains as it reduces labour costs overall. This finding is as valid for the fragmented specification as it is for the global specification and does not depend on the level of ambition (1.5° or 2°C).

The various model runs all show an increase in total employment relative to the baseline. The baseline scenario implies a moderate reduction in EU total employment between 2015 and 2050, including as a result of falling total population and population ageing. The 1.5°C scenarios as simulated under the JRC-GEM-E3 and E3ME models would lead to an employment increase over the baseline scenario of up to 1.5 to 2 million jobs, equivalent to an increase of 0.6% - 0.9%. By contrast, the JRC-GEM-E3 and E3ME models differ in their conclusions on GDP. The former indicates that a small negative impact on output could be expected as a result of crowding out of investment in other sectors. The latter, which assumes only partial crowding out, foresees a small positive impact on real GDP, following an increase in total investment.

3.2. Regional impacts

In the transition to a carbon-neutral society certain regions will need to undergo significant adjustments. Fossil fuel extraction and mining industries will decline, which will mostly affect the few regions with a high proportion of employment in these sectors: North Eastern Scotland (11.3%), Silesia in Poland (5.3%) and Sud-Vest Oltenia in Romania (1.8%). (See *Box 5.2* for details on transitions in coal and carbon-intensive regions in the EU).

Box 5.2: EU and regional initiatives for coal and carbon-intensive regions

The decline of coal production and use in the EU and a slowdown in global coal demand growth are well under way. Phasing out coal is seen as a low hanging fruit of climate policy, with coal-based energy accounting for a substantial amount of greenhouse gas emission, yet a low share of total employment. (1) However, such activities appear in 41 EU regions, with most of the jobs in coal sector concentrated in a handful of those regions, where they are a cornerstone of livelihoods and the overall economy. While the environmental impacts of a reduced coal sector will benefit all, the social and employment will affect some regions more than others. Ensuring a just transition to a greener economy for these regions is crucial.

The low-carbon economy will go some way to filling gaps which arise from a move away from coal, but may not appear in the right places at the right time and these structural imbalances must be tackled head on. Forward-looking policies that consult workers, provide timely information, recognise the needs of different workers (retirement, reskilling), individualised active labour market policies and personalised guidance are ways to make the transition work for all.

The role of the EU in the just transition away from coal

The EU aims to help Member States achieve EU 2030 energy and climate targets through National Energy and Climate Plans. These were submitted by all Member States by early 2019 and the Commission will help Member States to hone and implement these plans. The importance of a just transition will be reflected in these documents. The European Commission has also formally endorsed the Silesia Declaration on Solidarity and Just Transition at COP24 in Katowice.

The EU has a number of funds available to help coal-dependent regions transition to a green economy. In terms of EU Cohesion policy, the European Structural and Investment Funds (ESIF), the Cohesion Fund (CF), the European Social Fund (ESF) and the European Regional Development Fund (ERDF) can all contribute. The EU's LIFE Fund can support projects regarding EU environmental legislation such as the ecological restoration of old mining sites. (2) The Modernisation Fund of the EU Emissions Trading System can support employment transition and reskilling and the European Investment Bank (EIB) and the European Institute of Innovation and Technology (EIT) promote the development of clean energy technologies.

EU Initiative for coal and carbon-intensive regions in transition

The coal sector provides direct jobs to an estimated 180,000 workers in coal and lignite mining and an additional 60, 000 in coal- and lignite-fired power plants across the EU. (3) The EU Initiative for Coal and Carbon-Intensive Regions in Transition assists in mitigating the social consequences of the low carbon transition, and helps 41 coal regions across 12 Member States to define low-carbon transition strategies and address potential negative socio-economic impacts. The Initiative consists of a series of Countries Teams to support pilot coal regions in their transition efforts and a dedicated Platform for Coal Regions in Transition for the exchange of best practices, and discussion of strategies and projects to kick-start the transition process.

The platform has facilitated a broad range of activities, including working group sessions and regular trilateral meetings with EU Member State Governments and coal regions. Within the platform, over 120 project ideas were proposed by 10 coal regions in Germany, Poland and Czechia, including proposals for infrastructure and renewable energy investments, as well as the development of tourism and agricultural activities.

In the context of the EU's Cohesion Policy, over 120 smart specialisation strategies for the 2014-2020 period have been developed with more than EUR 40 billion allocated to regions through the European Regional Development Fund. (4) Interregional smart specialisation partnerships focus on industrial modernisation, energy and agrifood.

(1) Galgóczi (2019)
(2) ibid.
(3) https://ec.europa.eu/energy/en/topics/oil-gas-and-coal/coal-regions-in-transition
(4) https://ec.europa.eu/clima/sites/clima/files/docs/pages/initiative_5_support_en_1.pdf

(Continued on the next page)

Box (continued)

Examples of regional transition strategies are being developed in coal regions in Greece, Slovakia and Romania which benefit from technical assistance delivered by the European Commission Structural Reform Support Service. For the EU's largest coal region, Silesia, EUR 100 million have been ring-fenced under the Regional Operational Programme to support projects in urban infrastructure, clean air and redeveloping former mining sites. In addition, 12 pilot industrial transition regions are offered region-specific support by the Commission for boosting innovation (including Wallonie (BE), Piemonte (IT) and Cantabria (ES)).

Phasing out coal extraction in Germany

The German Commission on Growth, Structural Change and Employment (or so-called "coal commission") presented its final report ([5]) on Germany's strategy to phase out coal by 2038 at the latest. States traditionally reliant on coal (North Rhine-Westphalia, Brandenburg, Saxony and Saxony-Anhalt) will receive considerable help to transform their industries. EUR 1.3 billion will be set aside over the course of 20 years as well as EUR 700 million a year to related particular projects. The report estimates that 60,000 jobs are directly or indirectly dependent on brown coal. An adjustment fund and compensation for pension deficits will apply for those aged 58 or older. This has an expected cost of up to EUR 5 billion for the German federal government and firms. Education and training investments will foster younger workers' employment opportunities.

Phasing out coal extraction in Poland

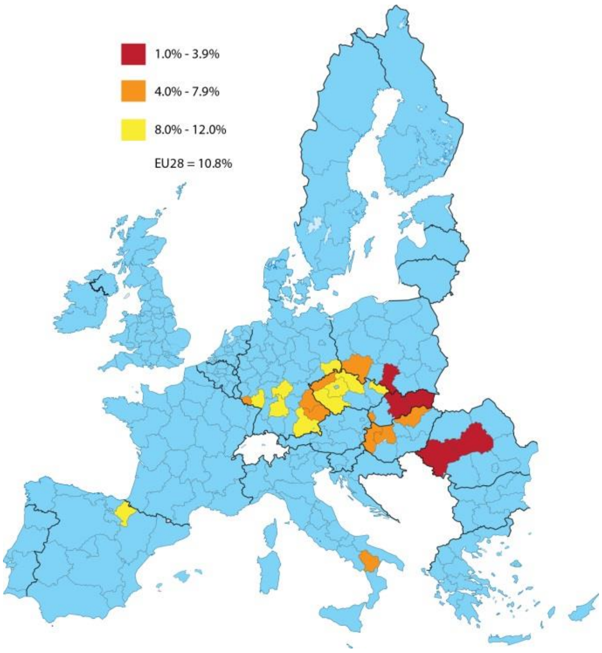
The role of hard coal in electricity production in Poland will decrease over time, according to the National Energy and Climate Plan (NECP) for 2021-2030, however, coal will remain the most important source of electricity production in 2030. The NECP will be subject to revision and input from the Commission during 2019 and there will be both support and pressure for greater reduction in carbon intensity in Poland. The expected rise in demand for electricity will be covered mostly by gas, wind and solar and later also by nuclear generation.

([5]) https://www.handelsblatt.com/downloads/23912864/3/190126_abschlussbericht_kommission-wachstum-strukturwandel-und-beschaeftigung_beschluss.pdf?ticket=ST-1651747-mabuNGf03qQtr0Etjcxy-ap1,

Energy intensive industries and automotive manufacturing will also have to be transformed. Almost all Member States have a region with a higher than 1% share of employment in these sectors, but only in 25 regions this share is higher than 5%, requiring a large scale adjustment. In Slovakia and Czechia almost all regions are expected to undergo this transformation, while in Germany at least eight regions are affected. In Hungary, Poland and Romania the transformation will mostly affect regions with a higher than average national GDP per capita (excluding the capital region) and an impact on the national economy as a whole.

The tertiary education level in all of the above regions is far below the EU average, as is adult participation in training (ranging from 1.1% - 7.5% in 2016 compared with the EU average of 10.8%), posing an additional challenge to the adjustment process (see *Figure 5.1*). Similarly, some affected German regions have a lower than national and EU average level of participation of adults in training coupled with a relatively low-educated adult population (especially in lower Bavaria and Saarland). This may be a constraint on adjustment but the traditionally strong engagement of social partners in training provision should help. The Spanish region of Navarra stands out: it is a region with relatively high GDP per capita, an above-average tertiary education attainment level and an above-average rate of participation in adult training (11.8% in 2016). Moreover, it is also a leader in renewable energy, mostly wind turbines.

Figure 5.1
Most regions with a high proportion of employment in energy-intensive industries and automotive manufacturing have low participation rates in adult training (2016)
Percentages of adults participating in training, in regions with >5% of employment in energy intensive industries and automotive manufacturing



Note: Sectors considered are the following: C20, C23, C24 and C29 in line with European Commission (2018a)

Source: Eurostat, trng_lfse_04. No data on sectors at the NUTS 2 level in some regions, e.g. Braunschweig. The latter has a participation rate of adults in traning below the EU average and would fall into the yellow category.

Click here to download figure.

At the same time, many regions are likely to benefit from the transition to a green economy, including those that are or could be involved in the production of renewable energy. The potential for producing renewable energy depends on the geo-physical characteristics of the regions as well as on the strategy and policy choices and their effective implementation at national and regional levels. Coastal regions have a high potential for producing wind energy, especially those along the shores of the North and Baltic Seas and some Mediterranean islands. Other regions are better placed to invest in the production of solar energy, hydroelectricity or biomass. Yet others may decide to pilot and champion the development of the bio-economy or the circular economy, and develop new ways of combining rural and urban planning, traffic, production and waste management.

Comprehensive strategies and effective policies are needed at regional and local level, to avoid hysteresis effects and multiple, persistent disadvantage. This is especially important as repeated restructuring and multiple disadvantage at regional level are one of the main drivers - perhaps the most important driver - of political discontent and democratic backlash. Those may in turn reduce public support for climate action and related policies, thereby compromising the effective transition to a green, more circular and climate-neutral economy.

3.3. Medium-term adjustment costs and benefits: simulations up to 2030

The employment impacts described above are relative to a baseline scenario that assumes full implementation of all adopted policy initiatives. They incorporate the effects of climate policies that are part of the 2030 EU climate and energy framework already adopted ('the 2030 package', key elements of which are listed in *Table 5.5*), against the backdrop of the 'Paris Agreement' and subsequent 'Katowice roadmap'. Impacts by 2050 compound the effect of measures to 2030 that have already been adopted, and therefore are reflected in the baseline for the long-term scenarios presented above, and the net-zero GHG objective. The full impacts of climate action by 2050 can be derived by aggregating the impacts of the existing climate policies included in the 2030 package and those of the assumed post-2030 policies.

Table 5.5
Employment impacts of elements of the 2030 package are mostly positive but modest
Employment impacts of selected elements of the 2030 climate package

Legislative act	Impact Assessment	Methodology	Employment impact
Energy efficiency directive revision	SWD(2016)405	E3ME + GEM-E3	+2% and -1.5%
Renewable energy directive recast	SWD(2016)418	E3ME + GEM-E3	- 0.2 to 0.2%
Energy performance of buildings directive	SWD(2016)414	E3ME	+ 0.1 to 0.25%
Emission performance standards for LDVs	SWD(2017)650	E3ME + GEM-E3; sectoral results	Small positive
Amendment to the ETS directive	SWD(2015)135	Sector-specific effects, based on elasticities	Negligible positive
Emission standards for heavy duty vehicles	SWD(2018)185	Macro-model: EXIOMOD	Negligible

Source: European Commission, impact assessments (references included in the table).

The employment impacts of the various elements of the 2030 package are often positive, yet modest, with sectoral differences. In order to obtain a more complete picture, it is important to review the estimated labour market impacts of the 2030 package. The analysis related to the revision of the Energy Efficiency Directive (European Commission (2016a)) in particular employs the same two models as the European Commission (2018a) and presents similar sector-specific conclusions.

As various elements of the policies interact, there is no straightforward way to produce an estimate of the aggregate effects. Some elements may reinforce one another, while other measures may overlap. Moreover, as the table indicates, the methodologies applied in various impact assessments are different, with some of the impact assessments relying on general equilibrium or similar models, and others presenting partial effects on the markets directly affected. Baselines, too, are defined in different ways across the impact assessments, in line with the fact that the studies were prepared over the course of several years. With each study incorporating the most recent macroeconomic scenario available at the time of writing, the baselines differ across the studies. Hence the same percentage effect in two assessments may indicate different absolute effects. Subject to these caveats, it is possible to state the following conclusion: the available studies point to small, and overall positive , economy-wide impacts on the 2030 horizon. Those that include sectoral breakdowns present significant impacts for some sectors, and an important re-structuring across sectors.

Implementation issues have been identified in the impact assessments related to the policy initiatives included in the 2030 package and have been analysed in further detail in Eurofound (2019). While adopted at EU level and implied in the baseline for the long-term simulations, these policy initiatives require effective implementation and follow-up at the national level, including policy choices with potential impacts on specific sectors, groups or regions over the coming years. These will be discussed in further detail in the next section.

3.4. Short- to medium-term impacts on sectors, skills, tasks and wages

This section builds on the main results of the so-called 'energy scenario' developed under the Future of Manufacturing in Europe (FOME) pilot project (Eurofound, 2019). The scenario projects detailed employment impacts (for EU aggregates and by country and sector) of the implementation of the Paris Agreement, with an additional focus on skills, tasks and wages. These are not available in the long-term scenarios described in section 3.1 or in the individual impact assessments listed in Table 5.4.

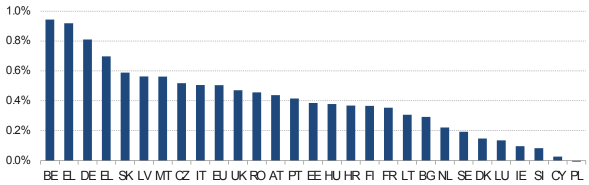
The scenario investigates the employment impacts in the EU of the policies necessary to meet the 2°C limit by 2050. It analyses the impacts across sectors and occupations, with particular focus on manufacturing and industry-related services. The analysis is carried out using the E3ME macro-sectoral model, which provides information on sectoral impacts, in combination with the Warwick Labour Market Extension model for occupational analysis and Eurofound's European Jobs Monitor.

The results show that EU GDP and employment effects in 2030 are expected to be significant and positive (+1.1% employment and +0.5% GDP growth). This amounts to an additional 1.2 million jobs in the EU by 2030, on top of 12 million jobs expected to be created under the baseline (from 2015 to 2030). The positive impact on GDP and the number employed is largely due to the investment activity required to achieve such a transition, together with the impact of lower spending on the import of fossil fuels. Lower consumer prices, notably of solar photovoltaic electricity, further boost disposable incomes, consumer expenditure and consequently the demand for consumer services, which are all generally labour-intensive.

Chart 5.4

Employment implications of the Paris Climate Agreement in EU Member States, 2030

Employment results by country, 2030, % difference from baseline



Note: Deviation in 2030 from the baseline in %

Source: Source: Eurofound (2019)

Click here to download chart.

Employment impacts, however, vary considerably between sectors and countries (see *Chart 5.4* and *Table 5.5*). To give some examples, GDP effects are expected to be highest in Latvia, given its strong dependency on fossil fuel imports, yet employment effects are likely to be moderate. The employment impacts of climate action policies would be positive and substantial in Belgium, Spain and Germany, where employment increases by up to 1% of total employment (equivalent to some 60,000 additional jobs in Belgium, 200,000 in Spain and 350,000 in Germany). By contrast, impacts on GDP and employment are would be insignificant in Denmark as it is already well advanced in the uptake of renewables and energy efficiency, and the additional investment required to meet the CO_2 emissions reduction target is hence small. The impact on Poland's GDP and overall employment growth would also be small but for a different reason, as job losses in the country's substantial coal production sector are expected to offset gains in other sectors.

Employment is expected to increase in manufacturing sectors producing renewable technologies or related to construction and the circular economy, as well as in service sectors. Unsurprisingly, though, employment is projected to decrease in most Member States in mining and oil & gas sectors (as a result of declining activity in the energy extracting sectors) as well as in electricity and gas supply (due to higher energy efficiency measures) and in motor vehicles (because of demand for electric cars). Sectors expected to see increases in employment include: manufacturing sectors producing renewable technologies and those in their supply chains, including basic metals, non-metallic minerals, mechanical engineering, computer, optical and electronic equipment; sectors supplying goods and services to the construction sector; and service sectors generally (benefitting from increased economic activity). The sectoral shift in favour of production of new construction materials and the expected increases in construction activity overall should lead to employment gains among workers in building and related trades and metal, machinery and related trades, while no major changes are expected for other occupational groups.

Table 5.6
Employment implications of the Paris Climate Agreement at sectoral level, 2030
Employment results for the EU by sector, 2030

Sector	percent	thousands
Agriculture	0.5	40
Mining	-16.6	-93
Manufacturing	0.7	209
Utilities	-2.4	-72
Construction	1.1	160
Distribution, retail, horeca	0.6	305
Transport, communications	0.5	64
Business services	0.7	473
Education, health, government	0.3	142
Total	0.5	1228

Note: Deviation in 2030 from the baseline in % and in thousands of persons
Source: Eurofound (2019)
Click here to download table.

Implementing climate action policies will lead to significant labour reallocation across sectors and regions. In the stylised Eurofound modelling, most economic sectors would see net employment gains by 2030, notably business services and distribution as well transport, manufacturing and construction. Two sectors would see net employment reductions overall in the short- to medium-term: mining and extractive industries, and the utilities sectors. In the former, employment would decline as a direct consequence of reduced fossil fuel extraction and coal mining. For the latter, employment is expected to decrease only limitedly, and only temporarily as a consequence of energy efficiency gains. Increased energy efficiency in buildings and households in particular would lead to lower production activity and output in the electricity and gas supply sectors, compared to the baseline. However on the 2050 horizon, (see *Table 5.4*), demand for electricity, and thus employment, is projected to grow strongly, as industry, transport and other services become increasingly electrified leading to employment gains in that sector. Despite these patterns being common across Member States, the extent of job gains and losses in the various sectors and the expected ensuing labour market transitions between sectors may vary across countries.

Job creation due to climate change policies could further mitigate job polarisation in the economy, which is expected to widen under the baseline scenario. Future job creation is expected to increase job polarisation overall, as it will be driven by digitalisation and further integration in global production networks and value chains. Yet job creation due to climate change policies, albeit smaller in volume, is expected to mitigate these tendencies by adding middle-skilled, middle-paying jobs, notably in the construction sector and in services sectors more generally (*Chart 5.5 and Chart 5.6*). Climate action is expected to lead to job gains in all sectors except mining and extraction, and to the creation of middle-skill, middle-paying jobs notably in construction and industry. Overall, much of the expected employment creation is found at the bottom and the middle of the wage distribution. These jobs will be filled by employees with lower levels of education performing less complex tasks, to a greater extent than in the baseline forecast.

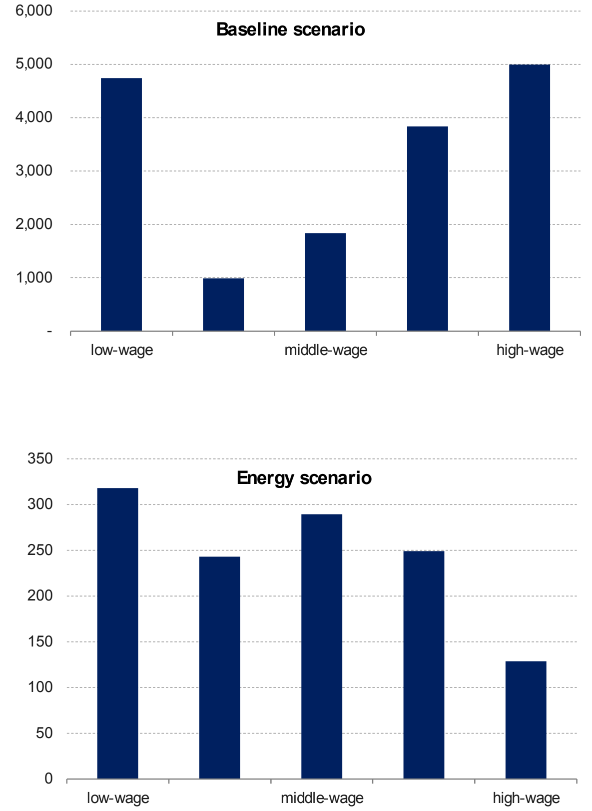
As for employment effects overall, the skill composition of job creation due to climate action, and hence its impact on job polarisation, varies significantly across EU Member States . Overall, climate action favours job creation for all skill groups, notably for middle-skilled and also for low-skilled (see *Chart 5.7*). In Germany, job creation due to climate action is expected to be relatively balanced across job-wage quintiles, against overall very polarised employment projections. In Spain, Ireland, Estonia, Lithuania and Slovakia, climate action is expected to mitigate job polarisation somewhat by creating middle-skilled, middle-paying jobs, though not necessarily large numbers of them. In Cyprus, Greece, Austria, Romania and the UK, on the other hand, climate action is more likely to support low skilled job creation.

The Eurofound simulations above depend on modelling assumptions, some of which have important policy implications. First, the model assumes no labour market frictions. This includes the assumption that the labour force adapts to the structural change in skill requirements associated with the transition to a low-carbon economy. However, the faster the change happens, the more likely it is that there will be frictions that leave some workers unemployed and some demands for new skills unmet, preventing the full potential benefits from being realised. Moreover, it is assumed that there are no barriers to accessing the finance necessary for the investments needed to support the transition. It is also assumed, with a view to modelling future production patterns and trade flows, that countries which currently have a lead in certain sectors will be able to maintain that lead when switching to new technologies. For example, it is assumed that the main manufacturers of conventional cars and trucks become the main manufacturers of electric vehicles.

Chart 5.5

Climate action favours the creation of middle-skilled, middle-paying jobs and mitigates job polarisation

Projected job wage profiles in the baseline and energy scenario , 2015-2030



Note: In thousands; deviations from 2015 for the baseline scenario; from the baseline for the energy scenario, by wage quintile.

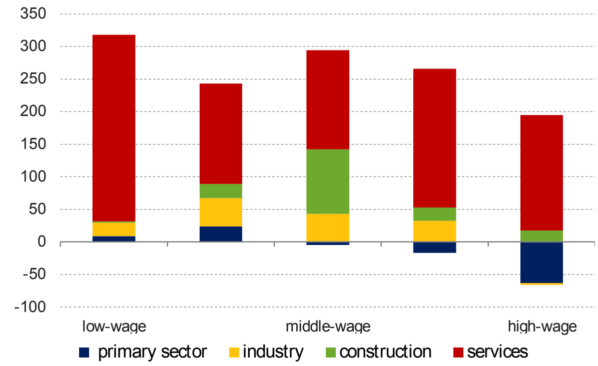
Source: Eurofound (2019)

Click here to download chart.

Chart 5.6

Climate action favours job creation in services, as well as middle-paying jobs in construction and industry

Projected job wage profiles in the in the energy scenario by sector, 2015-2030

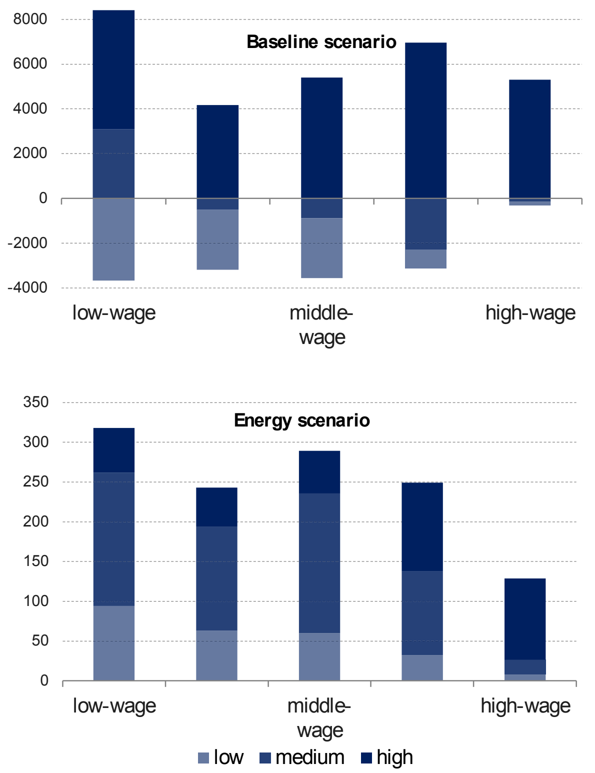


Note: In thousands; deviations from the baseline by wage quintile

Source: Eurofound (2019)

Click here to download chart.

Chart 5.7
Climate action favours job creation for all skill groups, notably for middle-skilled and also for low-skilled
Projected job wage profiles in the baseline and energy scenarios, 2015-2030



Note: In thousands; deviations from 2015 for the baseline scenario; from the baseline for the energy scenario, by wage quintile.
Source: Eurofound (2019)

Click here to download chart.

Finally, the modelling results assume implementation of certain policy measures affecting household expenditure, production costs and/or fiscal sustainability. These measures include:

- a carbon emission price set at global level but applied on a national bases through cap-and-trade systems and/or carbon taxes;
- public programmes to fund improvements in the efficiency of energy consumption in households, industry and commerce and support for the uptake of electric vehicles in the public sector;
- direct subsidies to cover significant parts of the additional investment cost and to incentivise the uptake of renewables across a range of technologies;
- subsidies and feed-in-tariffs (FiTs) to guarantee the price received by renewable electricity producers;
- taxes on the registration of vehicles related to their carbon emissions per kilometre, plus higher road fuel taxes; and
- regulation from 2018 to phase out the least fuel-efficient vehicles as they reach the end of their natural life.

All of these measures have impacts and costs for the public budget and potentially for households, and may require accompanying or compensatory measures. They also presuppose effective uptake and behavioural changes by a range of stakeholders, including firms, investors, households, consumers and local administrations. Additional tax revenues stemming from the implementation of some of the measures could be used to mitigate the effects on stakeholders and compensate them where necessary.

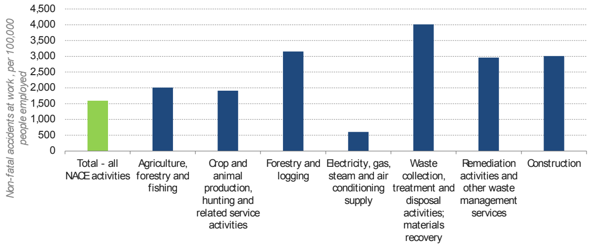
3.5. Health and safety risks in growing green sectors and the circular economy

Care must be taken to ensure that the necessary sectoral shifts are accompanied by policies to ensure high job quality in a climate-neutral circular economy. While some high-risk sectors such as fossil fuel extraction will decrease in size, others will increase, necessitating new occupational health and safety policy priorities (see *Chart 5.8*). A recent report by EU-OSHA notes that the accelerating pace of technology change and potential moves towards a green economy mean it is increasingly important to anticipate new and emerging risks. However, the transition also provides an opportunity to anticipate risks, improve standards and build workers' health and safety into the design of green jobs, including in sectors with currently high risk exposure such as waste management and construction.

Chart 5.8

Importance of anticipating new and emerging health and safety at work risks

Non-fatal accidents at work: incidence rates for 2016



Note: Categories correspond to NACE REV 2 (Statistical classification of economic activities). "All NACE activities" refers to the average across all categories shown. Non-fatal accidents are defined as those that imply at least four full calendar days of absence from work. Statistics on accidents at work can reflect under-coverage (the appropriate population is not covered by the data source i.e. a sector is excluded) or under-reporting (an accident that took place is not reported despite the sector being included).

Source: Eurostat [hsw_n2_03]

Click here to download chart.

3.6. Recycling carbon revenues

Another important aspect of managing the transition to a green, climate-neutral economy is the use of revenues generated from climate policy measures. Carbon taxes and the revenue from auctioning emission permits (as under the ETS) generate resources which enable governments to fund programmes to support upskilling and reallocation of the workforce or to mitigate some of the negative impacts of higher energy prices. The design of such programmes needs to take into account equity and efficiency considerations, and also the interplay between economic inequality and other forms of inequality, including environmental injustice, at both global and EU levels. From the efficiency point of view, what needs to be mitigated is the negative impact of higher energy prices on production, including its employment aspects. Equity considerations focus on the impact of higher energy prices on consumer budgets. As explained below, the two considerations motivate diverging policy measures.

The two main types of carbon-revenue-funded expenditure programmes discussed in the literature are lump-sum transfers and cuts in labour taxation. The main advantage of lump-sum transfers is that they can compensate for the losses suffered by lower-income households as they face higher energy prices (Bruegel 2018). On a per-income basis, the transfer could be proportionately larger for low-income households than for high-income ones. In that way it can be seen as a measure to address equity concerns. Such measures could be means-tested in order to concentrate the subsidy on households that need that form of compensation, and not to 'waste' the funds on wealthier households.

Labour tax cuts, by contrast, may provide higher efficiency gains. While they may be problematic in terms of equity considerations, labour tax cuts are accompanied by efficiency gains, according to a range of simulation exercises. Lowering taxes on labour improves work incentives in general, and particularly for low wage earners. In the particular case of a compensating measure that accompanies raising carbon revenue, it can be thought of as a way to enhance employers' incentives to maintain their workforce while production costs increase. As noted above, the incentive effect of labour tax cuts is the reason why two of the four JRC-GEM-E3 scenarios show positive employment outcomes even though the GDP impact of climate policies is slightly negative.

Other simulation exercises have confirmed this effect. Chateau et al. (2018) directly compared various revenue recycling policies in their study analysing the introduction of a hypothetical worldwide carbon tax. They find that the best total employment outcomes are achieved in the case of wage income tax cuts, whereas from a distributional standpoint disadvantaged categories of workers fare relatively better under a lump-sum programme. Barrios et al. (2013) compare the efficiency impacts of raising funds through green taxes and labour taxes, and find that green taxes produce fewer distortions. That result also suggests that efficiency gains can be achieved by spending carbon revenue on labour tax cuts, taking into account that carbon unit price is adjustable. A group of leading economists, by contrast, argue for returning carbon tax revenue to the public in the form of a lump-sum transfer, which would constitute a 'carbon dividend' (Climate leadership council, 2019). Their argument rests on 'fairness and political viability' considerations, noting that the majority of US families would get more from the transfer than they would lose in increased energy prices.

Last, evidence from behavioural science indicates that increasing the salience of benefits from carbon taxation can enhance its acceptability. For example, a design feature underlying public support for a carbon tax in the Canadian province of British Columbia is that part of the revenue is redistributed to taxpayers in the form of cheques, instead of tax cuts which would be less visible.

Under EU legislation, part of the revenue from ETS is spent on just transition measures. In the period of 2021-2030, a Modernisation Fund will operate in the EU, supporting low-carbon investments in 10 lower income EU Member States. The size of the Fund is 2% of the total allowances for the period. Priority areas covered under the Fund, collectively benefitting from at least 70% of subsidies, include support of just transition by redeployment, re-skilling and up-skilling programmes (alongside green energy-specific items such as renewable electricity generation, improvement of energy efficiency and modernisation of energy networks). Additionally, according to the European Commission's legislative proposal, assistance in the case of unexpected major restructuring events caused by the transition to a climate-neutral economy will be a specific objective of the European Globalisation Adjustment Fund in the 2021-2027 period.

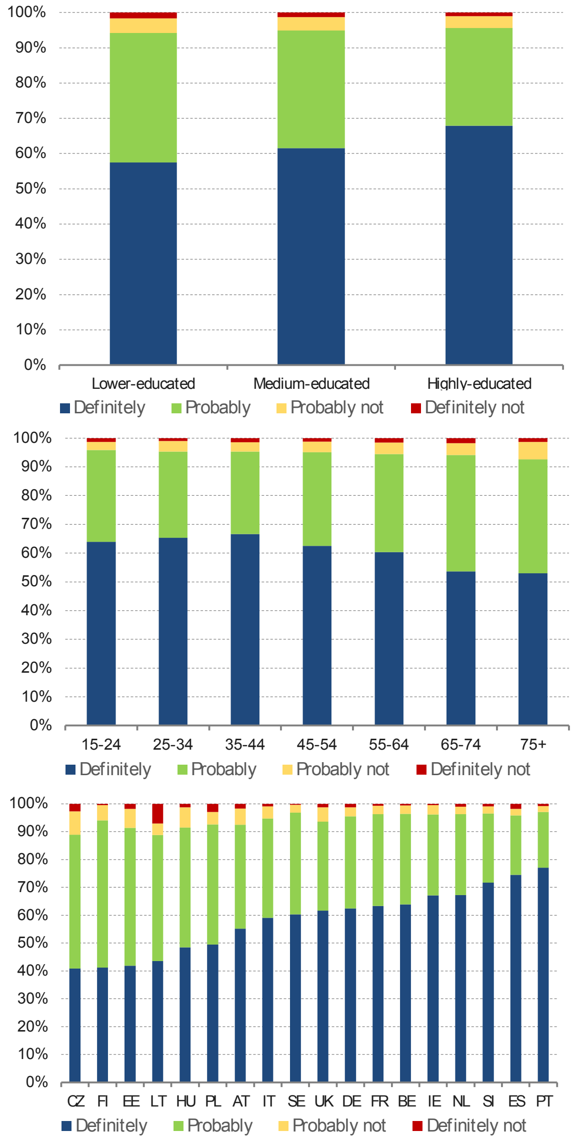
3.7. Public perceptions of climate change and the social acceptance of climate action

Achieving EU climate targets presents a significant challenge and social acceptance of climate action is crucial to its success. Tensions are rising on this topic across urban and rural divides, high and low-income groups, and younger and older generations. A younger generation of climate strikers is pushing policy-makers to further climate action. Their message is driven by a narrative of sustainability: climate action is seen as an urgent global imperative for a world fit for future generations. This view is increasingly gaining acceptance among all EU citizens.

Across the EU, the vast majority of the public accept that climate change is happening (*Chart 5.9***).** In EU countries for which survey data are available, 95% of respondents believe climate change is happening either 'definitely' or 'probably'; 61% believe this 'definitely'. This belief is held across all education levels (*Chart 5.9* Panel A) and age groups (Panel B), and in most countries (Panel C).

Furthermore, many feel a high level of personal responsibility to reduce climate change across EU countries (*Chart 5.10*). 40% of respondents rank their sense of responsibility as at least 7 on a scale of 0 (not at all) to 10 (a great deal). The highest levels of personal responsibility to reduce climate change were obtained in France, where 64% ranked this at at 7 or above and 13% at 10.

Chart 5.9
The vast majority believe climate change is taking place, across education levels, age groups and countries
Responses to the question "Do you think the world's climate is changing?" by education level (Panel A), by age group (Panel B) and by country (Panel C).

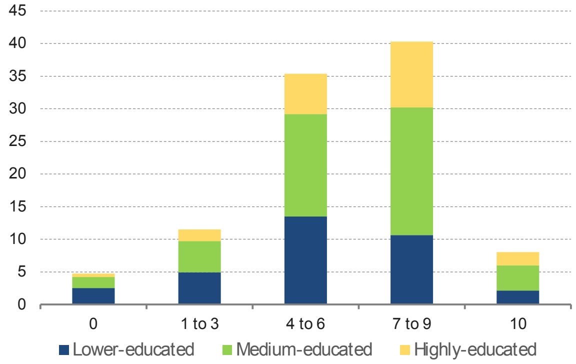


Note: Categories "Refusal to answer" and "Don't know" excluded.
Source: European Social Survey data (2016)
Click here to download chart.

Chart 5.10

Many feel a strong sense of personal responsibility to tackle climate change, with the more educated tending to display a greater sense of this

Responses to the question "To what extent do you feel a personal responsibility to try to reduce climate change?" on a scale of 0 (not at all) to 10 (a great deal).



Note: Categories "Refusal to answer" and "Don't know" excluded

Source: European Social Survey data (2016).

Click here to download chart.

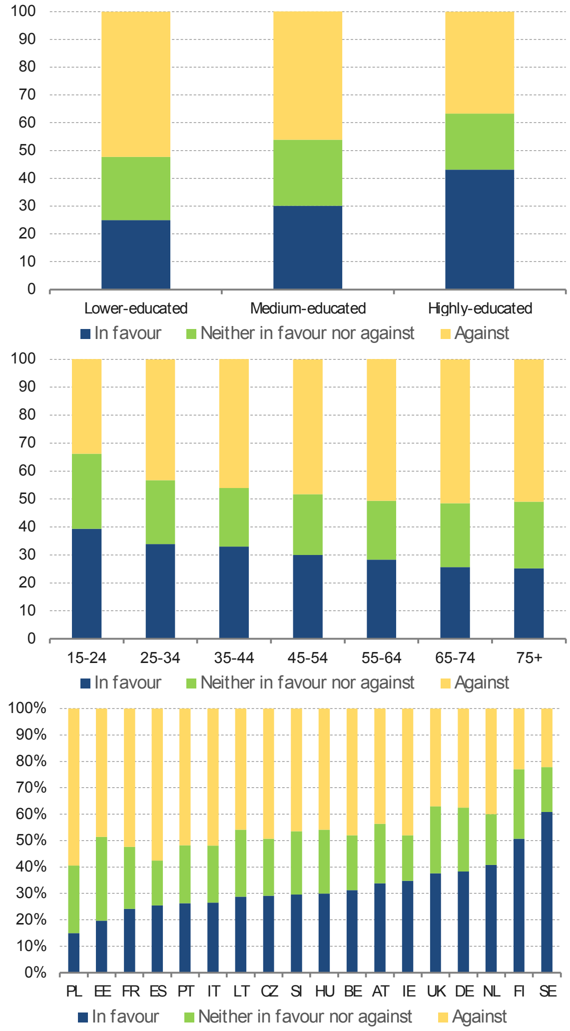
Despite widespread awareness of climate change and of the responsibility and urgency to act, support for climate action is mixed, and stronger for standards than taxation. On average, only 31% of respondents are strongly or somewhat in favour of taxes on fossil fuels to reduce climate change. Those with higher levels of education display higher levels of support (*Chart 5.11* Panel A) as do younger cohorts (*Chart 5.11* Panel B). While these can be interpreted only as correlations, literature on the topic suggests that such traits play an important role in climate action support (see below). Across countries, the picture is mixed, with those in favour of such taxes ranging from 15% in Poland to 61% in Sweden (*Chart 5.11* Panel C). Citizens in western and northern Europe, with the exception of France, are more in favour of such taxes than Southern and Eastern Member States.

Energy prices present a challenge for achieving a just transition and citizens are concerned that these costs are too high *(Chart 5.12)*. The proportion of people extremely or very worried amounts to 71% in Spain and 68% in Portugal,. Energy costs impact people's ability to heat their homes (see Section 4) and to to incur the transport costs necessary to work and participate in society. When such costs become unaffordable, they may have a strong adverse impact on public support for climate action.

Chart 5.11

Support for fossil fuel taxes exists but varies across different groups

Responses to the question "To what extent are you in favour of or against taxes on fossil fuels to reduce climate change?" by education level (Panel A), by age group (Panel B) and by country (Panel C).



Note: "In favour" refers to those who responded either strongly or somewhat in favour, "against" refers to either strongly or somewhat against. Categories "Refusal to answer" and "Don't know" excluded.

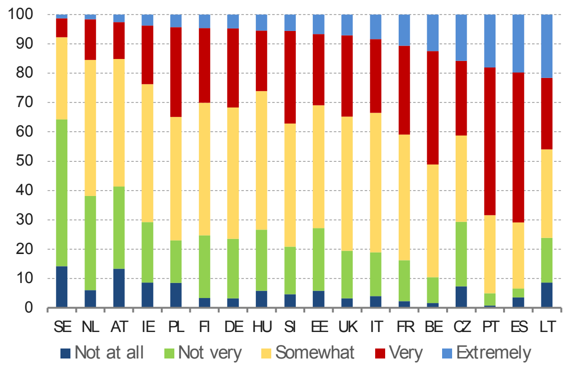
Source: European Social Survey data (2016).

Click here to download chart.

Chart 5.12

Citizens are concerned about high energy prices

Responses to the question "How worried are you that energy may be too expensive for many people in [country]?"



Note: Categories "Refusal to answer" and "Don't know" excluded

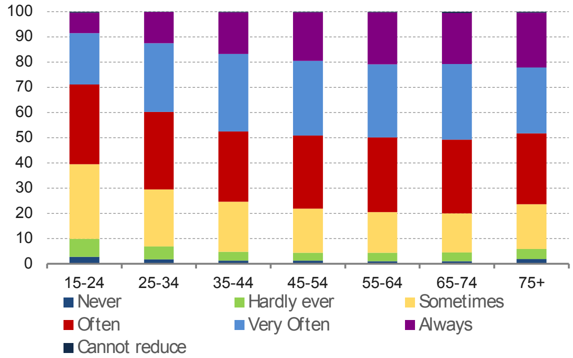
Source: European Social Survey data (2016)

Click here to download chart.

Evidence on the determinants of support for climate action is complex and country-specific. Some research suggests that perceived costs and perceived climate benefits are the strongest predictors of support for climate action, but that political affiliation also plays an important role. Other research finds that, in the Norwegian context, support for fuel taxation is in fact best predicted by beliefs about environmental consequences, not by self-interest. There is evidence of a strong impact of culture on policy support as well as complex, non-linear relationships between information, beliefs and public policy opinion formation. Understanding the reasons for support for and resistance to climate action will be crucial to policy formation.

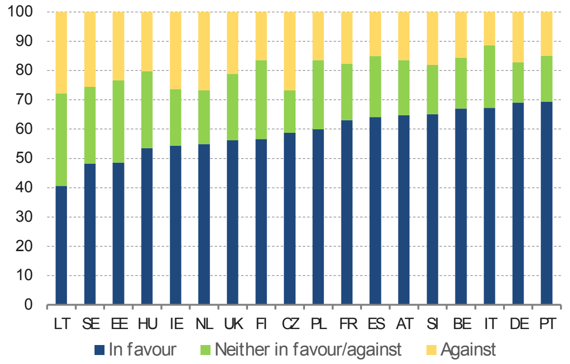
There is also a growing movement calling for changes to consumption patterns and consumer behaviour. In a list of the most effective climate change mitigation actions, a move towards plant-based diets is ranked at number four out of 80, with potential to reduce emissions by over 66 gigatons. Initiatives such as 'Meatless Mondays' and 'VB6' (Vegan before six pm) are helping to challenge norms and habits around meat and protein consumption. A significant shift towards plant-based foods is occurring, driven by younger generations. However, all age groups are making considerable efforts to reduce energy consumption, with greater efforts among older cohorts (*Chart 5.13*). Support for banning sales of inefficient household appliances and increasing the likelihood of buying efficient appliances is also strong across countries (*Chart 5.14* and *Chart 5.15*), although hypothetical situations may reflect aspirations more than actual behaviour.

Chart 5.13
Efforts are made to reduce energy consumption by all age groups, particularly by older respondents
Responses to the question "In your daily life, how often do you do things to reduce your energy use?"



Note: Categories "Refusal to answer" and "Don't know" excluded.
Source: European Social Survey data (2016).
Click here to download chart.

Chart 5.14
There is support for the banning of inefficient appliances to tackle climate change across all countries
Response to the question "To what extent are you in favour of/against banning sales of the least energy-efficient household appliances to reduce climate change?"

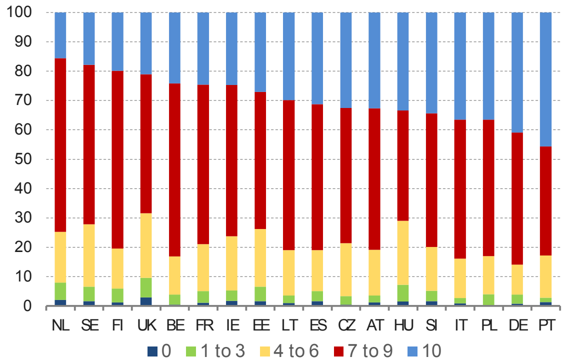


Note: "In favour" refers to those who responded either strongly or somewhat in favour, "against" refers to either strongly or somewhat against. Categories "Refusal to answer" and "Don't know" excluded.
Source: European Social Survey data (2016).
Click here to download chart.

Chart 5.15

A large majority of people are at least somewhat likely to buy energy-efficient appliances, with between 15% and 45% saying they are extremely likely to do so

Response to the question "If you were to buy a large electrical appliance for your home, how likely is it that you would buy one of the most energy-efficient ones?" (On a scale of 0 to 10 where O is not at all likely and 10 is extremely likely).



Note: Categories "Refusal to answer" and "Don't know" omitted.
Source: European Social Survey data (2016).
Click here to download chart.

Citizens are increasingly aware of their power as both consumers and citizens to tackle climate change. Citizens can reduce their individual climate footprint but also pressure business and government through consumption and participation to respond to popular demand. Grassroots initiatives against single-use plastic have led, for example, to fast-food chains abandoning plastic straws, as well as to changes at governmental level such as the EU Single Use Plastics Directive.

The European Commission has been trying for some time to encourage sustainable purchasing and consumption. The 2012 Communication on consumer empowerment included proposals to improve awareness on environmental and sustainability aspects. Housing and transport are other areas where more can be done to encourage consumers to act on their feelings of personal responsibility to address climate change e.g. by insulating their homes, and choosing to walk or cycle to work. Moreover, the 2014 Public Procurement directive enables national and local authorities to make better use of strategic procurement, with particular consideration to social and environmental objectives.

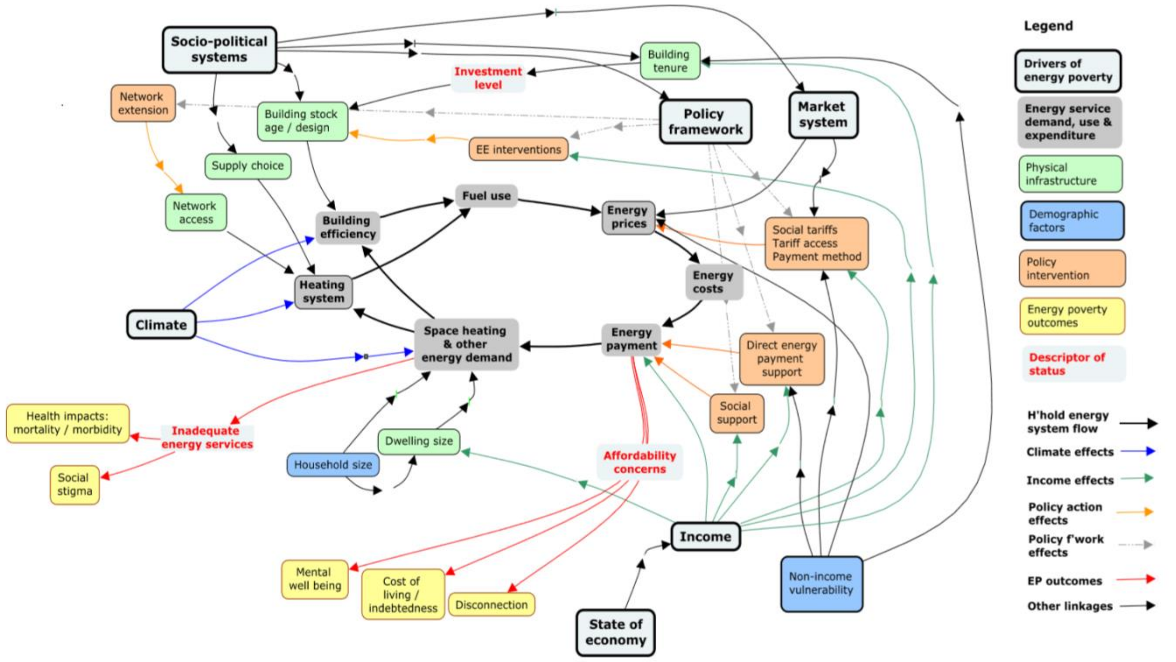
Greener supply is as important as greener demand and the EU is helping to foster this. The Eco-design Directive provides a framework for improving the environmental performance of energy-related goods and for product bans and phase-outs of inefficient products such as incandescent lightbulbs. EU energy labels can increase green demand for energy-related products. For other categories of products, various ecolabelling schemens sometimes coexist and trust in eco-labelling must be maintained. As the "greenwashing" of environmentally or socially irresponsible companies is considered a potential problem, there is a clear rationale for government to regulate and create incentives to ensure that signals and markets operate effectively.

Trends in green consumption and consumers' willingness to alter their behaviour offer much scope for exploration. Research suggests that green consumption and green citizenship are in fact distinct concepts and that their determinants are complex. Many factors play a role, including individuals' habits, trust and values, perceived consumer effectiveness, as well as product availability, social norms, brand image and eco-labelling, with the consumer's environmental concern and the product's functional attributes emerging as the two major determinants. Gaps between attitudes and behaviour and inadequate information can be major barriers to the purchase of eco-friendly products, e.g. the lack of awareness and misunderstandings around refurbished mobile phones.

Behavioural interventions show how consumer habits and defaults can be "nudged" in a green direction and how societal norms can be changed and exploited. Synergies can achieve win-win outcomes in the public and private interest, for example reducing plate sizes and providing social cues can reduce food waste in hotels, with benefits for both the environment and business. Low-cost interventions can exploit social norms to reduce excessive energy consumption.

Reducing food waste is crucial to tackling climate change. One third of food raised or prepared does not make it "from farm or factory to fork", and this food waste contributes 4.4. gigatons of carbon dioxide equivalent into the atmosphere every year. In terms of climate change mitigation, reducing food waste is ranked at number three out of 80, with potential to reduce emissions by over 70 gigatons. This seems a particularly pertinent problem in a world where nearly 800 million people go hungry and resources are increasingly under pressure. The Sustainable Development Goals call for the halving of per capita global food waste at the retail and consumer level by 2030,

Figure 5.2
Energy poverty is a multifaceted phenomenon
Drivers and effects of energy poverty



Source: Rademaekers, K et al (2016).
Click here to download figure.

as well as reducing food losses along production and supply chains. Key to this is firstly pre-empting food waste before it happens, and then reallocating unwanted food. Standardising date labelling to focus on safety as opposed to optimal taste is important, as is consumer education, and campaigns such as "Feeding the 5000". France and Italy have passed laws requiring supermarkets to pass on unsold food to charities, animal feed or composting companies instead. Food waste is one of the horizontal principles that applies to the design and implementation of the Fund for European Aid to the Most Deprived. This Fund supports EU Member States' action to provide food and/or basic material assistance to the most deprived.

Food waste prevention is an integral part of the Commission's Circular Economy Package and it will also foster competitiveness, sustainable growth and employment. The Revised EU Waste Legislation, adopted on May 30th 2018, requires Member States to reduce food waste at each stage of the supply chain, to monitor food waste levels and to report on progress made. An EU methodology to measure food waste and a multi-stakeholder platform (EU Platform on Food Losses and Food Waste) will help with this, which includes a dedicated sub-group working on simplifying and promoting better use and understanding of date-marking.

4. CLIMATE ACTION AND ENERGY POVERTY

Energy poverty is a multi-dimensional concept which lacks a uniform definition. Its measurement poses practical and conceptual challenges. Defining energy poverty needs to take into account the necessary domestic energy services needed to guarantee basic standards of living in the relevant national context, existing social policy and other relevant policies. At a basic level it can be described as conditions where "individuals or households are not able to adequately heat or provide other required energy services in their homes at affordable costs". A limited number of Member States have defined energy poverty at the national level (e.g. the UK, FR, CY, SK, IE) while almost all have identified vulnerable consumers in the context of retail gas and electricity markets with a view to protecting them. In most cases, these are recipients of social benefits (e.g. unemployment benefit or social assistance) or specific socio-economic groups based on income, age and/or health characteristics.

Energy poverty has a number of drivers. Household income is clearly important, but energy prices, and energy efficiency also play a role. Affordability of energy-efficient housing contributes to the reduction of energy poverty and improves environmental outcomes (see

Figure 5.2). Socio-political systems also influence the energy market system, its degree of liberalisation and level of competition, as well as the energy mix, thereby determining energy prices. Another important driver is the local natural environment, which influences the demand for heating or cooling. The local climate also affects the quality of dwelling stock in terms of how insulation and provision of heating systems.

Energy poverty has an indirect effect on many policy areas, including health, environment and productivity. Adequate warmth, cooling, lighting and the energy to power appliances are essential for ensuring a decent standard of living and citizens' health. These services also enable citizens to fulfil their potential and enhance social inclusion. Therefore addressing energy poverty has the potential to bring multiple benefits, including lower spending on health, reduced air pollution (by replacing unfit heating sources), better comfort and wellbeing, improved household budgets and increased economic activity.

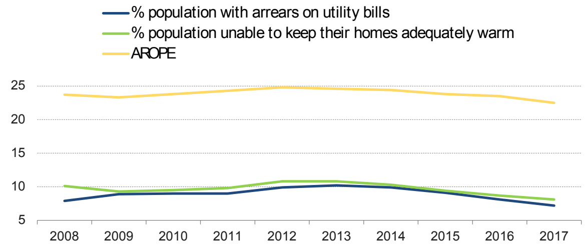
4.1. Trends in energy poverty indicators

It is now widely acknowledged that energy poverty is a distinct form of deprivation. It is estimated to affect almost 50 million people in the EU. Indicators of energy poverty, encompassing the inability to keep a person's home adequately warm and being in arrears on utility bills , has followed a similar trend to being at risk of poverty or social exclusion in the last decade, albeit at a significantly lower level; they were increasing between 2009 and 2013, when they reached their peak. Since the onset of the recovery, they have been decreasing to below pre-crisis levels. Energy poverty has multiple drivers, so it does not fully overlap with monetary poverty or being at risk of poverty or social exclusion (see *Chart 5.16*).

Chart 5.16

Indicators of energy poverty do not fully overlap with being at risk of poverty or social exclusion

Population with arrears on utility bills, unable to keep home adequately warm and being at risk of poverty and social exclusion in the EU, 2008-2017



Source: Eurostat, ilc_mdes07, ilc_mdes01, ilc_peps01.

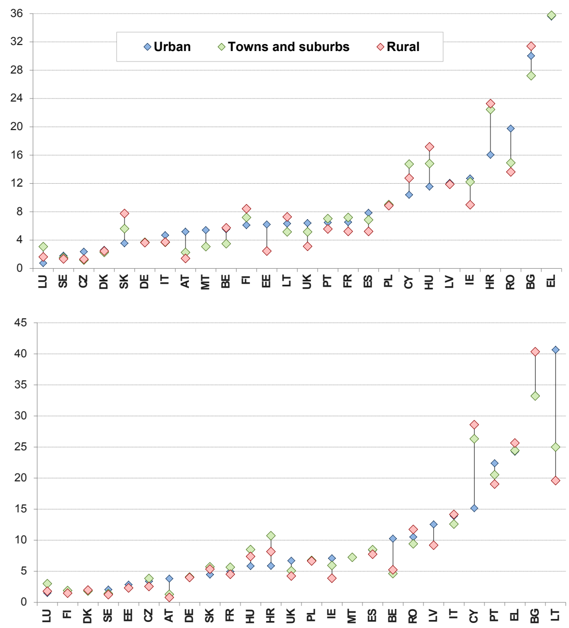
Click here to download chart.

Although decreasing to pre-crisis levels overall, important differences in indicators of energy poverty between Member States remain. Between 2008 and 2017 the proportion of people who found it difficult to warm their homes adequately increased in Greece, Spain, Italy, Lithuania and Malta. Similarly, the proportion of those with arrears in utility bills decreased overall, but increased in Cyprus, Greece, Spain, Portugal, Ireland, Lithuania, Latvia and Slovakia.

Chart 5.17

Indicators of energy poverty in cities less spread than in rural areas and towns in most Member States

Proportion of individuals reporting arrears on utility bills (panel A) and inability to keep home adequately warm (panel B) per degree of urbanisation (2017)



Note: 2014 instead of 2017 for DE, 2017 instead of 2017 for IE and UK. No degree of urbanisation reported for NL and SI

Source: EU-SILC

Click here to download chart.

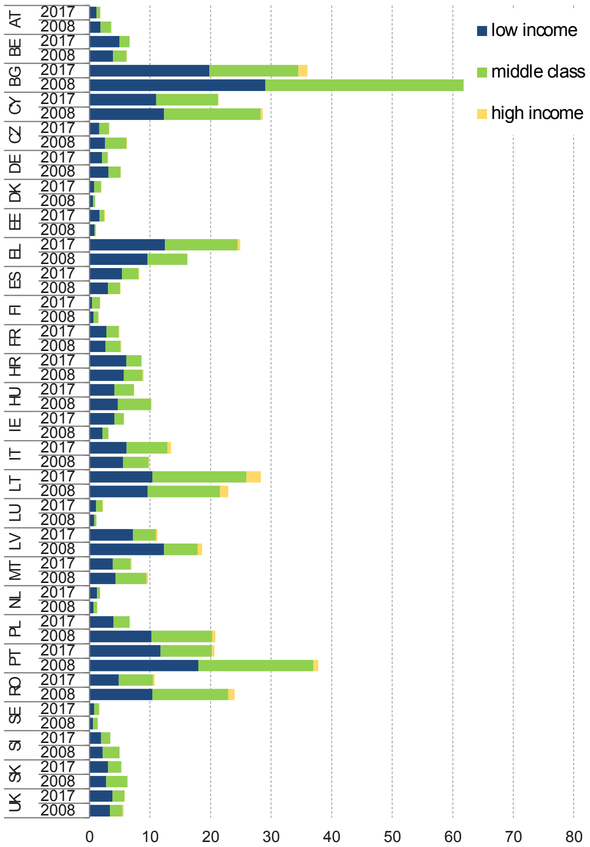
In most Member States, people living in cities show lower indicators of energy poverty, but there are some notable exceptions.

Households in cities are less able to keep their houses warm in Lithuania, Latvia, Belgium, Austria and to some extent in Portugal, Ireland and the UK. In Romania, Estonia, Malta and Austria, households in cities are more likely to be in arrears on utility bills.

Chart 5.18

Significant proportions of those who cannot keep their home adequately warm belong to the middle class

Proportion of individuals reporting inability to keep home adequately warm by income group (2017 and 2008)



Note: 2010 instead of 2008 for HR and 2016 instead of 2017 for the UK and IE

Source: EU-SILC

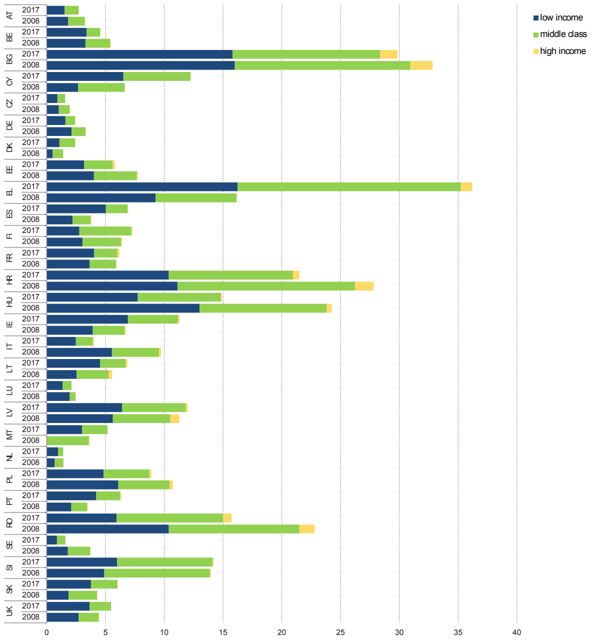
Click here to download chart.

A significant proportion of households unable to keep their homes warm or with arrears in utility bills belong to the middle income group. More than half of those who are unable to keep their home warm in Finland, Romania, Slovenia, Denmark and Greece belong to the middle class , while out of this group Greece (25.7%) and Romania (11.3%) report higher proportions of people unable to keep their homes warm than the EU average of 7.8%. In Greece, Finland, Denmark, Latvia, Romania, Czechia and Italy more than half of households with arrears in utility bills belong to the middle income group. This is an issue particularly in Greece and Romania, which record higher proportions of the total population reporting inability to pay their utility expenses (see *Chart 5.18*).

In more than a quarter of Member States the proportion of people reporting arrears in utility bills has increased over the last decade. Arrears are an increasing problem, both for those on low incomes and for the middle class. This development coincindes with the increase in energy prices over the period (total household electricity prices rose at a 2% annual rate from 2008 to 2017) and to the fall in real household disposable income in some Member States. In Greece the middle class contributed significantly to the rising proportion of people with arrears in utility bills - particularly worrying in a country where the proportion of people unable to keep their house warm was increasing up to 2016. The situation has improved somewhat in the last two years, but remains considerably worse than pre-crisis.

In almost all Member States where the proportion of people reporting they are unable to keep their homes warm increased in the last decade, this has become more of an issue for the middle class. While most Member States recorded a decrease in the proportion of individuals reporting being unable to warm their homes, the proportion has increased in Greece, Italy and Latvia, particularly among the middle income group. In Spain, however, the increase was more significant among people with low incomes.

Chart 5.19
In many Member States the middle class is less troubled by arrears on utility bills than a decade ago
Proportion of individuals reporting as being in arrears on utility bills, per income group (2017 and 2008)



Note: 2010 instead of 2008 for HR, HU, IT, MT and 2016 instead of 2017 for the UK and IE.

Source: EU-SILC.

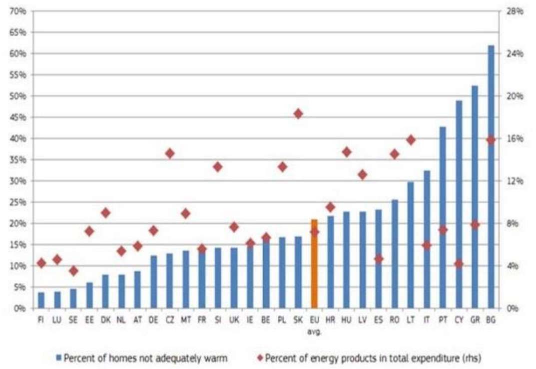
Click here to download chart.

4.2. Energy prices, expenditure and energy poverty

Energy prices, one of the key drivers of energy poverty, have increased substantially over the last two decades, putting additional pressure on those with lower incomes. The price increases were driven by the combined impact of steadily growing network charges and taxes. This development, coupled with unfavourable trends in real gross disposable household income during the crisis, increased the pressure on households in general. Without matching improvements in energy efficiency this reduces available income for consumption on other goods, putting additional pressure in particular on those with lower incomes.

While spending more in absolute terms, higher income households use a smaller proportion of their income on energy. In 2015 , households in the lowest income decile spent 10.4% of their total consumption expenditure on energy. For low-income households, the proportion of energy costs in total consumption expenditure varies between Member States from 3% in Sweden to 23% in Slovakia, with almost all Central and Eastern Member States displaying significantly higher shares than others. Middle-income households spend more in absolute terms but use proportionately less of their total expenditure on energy products (7.1% compared to 10.4%). Middle-income households in Central and Eastern Member States spend much more of their total consumption expenditure on energy than middle-income households in North and Western Member States (10-15% compared to 4-8%). Large variations across Member States are driven mostly by the variations in household disposable income, but energy prices and energy efficiency, particularly of buildings, also play a role.

Chart 5.20
Complex picture when comparing ability to warm home to the proportion of energy expenditure in total expenditure
% of households at risk of poverty whose homes are not being kept adequately warm; energy expenditure as % of total expenditure for households in the third decile



Source: European Commission (2019).

Click here to download chart.

For households below the poverty threshold, there is no strong correlation between the proportion of their total spending on energy, and their perception of their ability to keep their homes warm. In most Mediterranean Member States, with their warmer climates, the share of energy expenditure in total consumer expenditure is lower than the average (see *Chart 5.20*). However, this is not reflected in people's perception of their ability to keep their homes adequately warm. In part this is because energy performance standards in the warmer Member States tend to be lower than in those with colder weather. This, coupled with often inadequate heating systems in dwellings in warmer climates, results in the exposure of households to cold during those months when the temperatures fall below the level considered comfortable.

Although transport fuel use and expenditure are not captured by energy poverty indicators, they have important implications for the transition to a climate-neutral society

and its social acceptance. Unlike household energy use, the proportion of expenditure on transport fuels within total expenditure increases as household income increases. In 2015, households in the first income decile spent 3.1% of their total expenditure on transport fuel, while households in the fifth decile spent 4.3%. Higher income households rely more on private transport and therefore they spend proportionately more on diesel than low income households. However, diminishing differences in excise duties on petrol and diesel, environmental legislation and public acceptance (see *Chart 5.13*) are expected to reverse this trend in the future.

Both social policy measures and energy policy measures can help mitigate energy poverty. The first type of policy measures tackle energy poverty indirectly through social protection systems. Social benefits in different forms (e.g. unemployment benefit, minimum income support) can contribute to tackling energy poverty indirectly by increasing the disposable income of low-income households. Social housing systems in some countries in Northern and Western Europe often provide low-income households with relatively energy-efficient housing, thereby decreasing their energy bills. Energy bill support and social tariffs providing (targeted) financial support to households to pay their energy bills also reduce immediate pressures on the energy poor. However, they do not address the underlying drivers of energy poverty in the same manner as measures to improve building insulation of housing or replace heating systems.

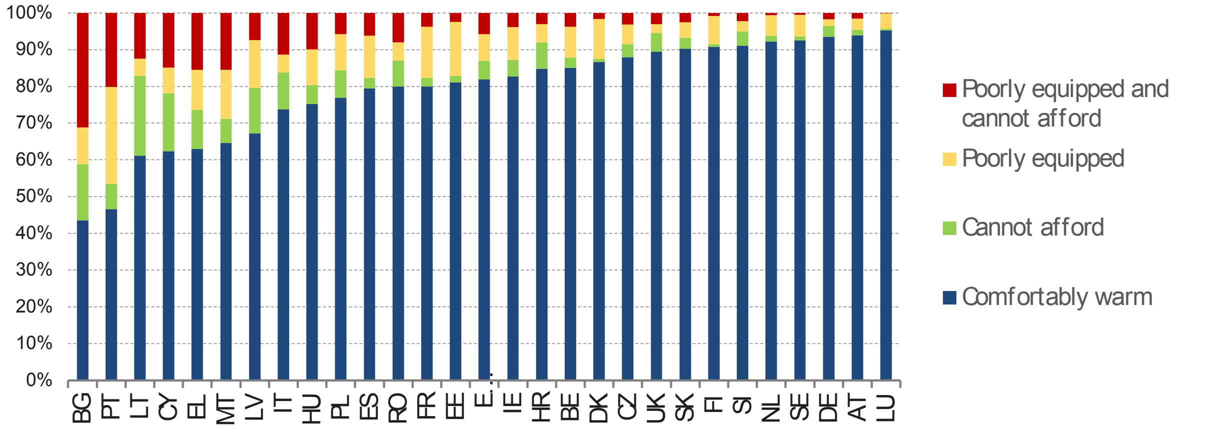
4.3. Energy efficiency measures

Measures to improve the energy efficiency of buildings and appliances can decrease total residential energy consumption. Lower consumption levels result in reduced energy import dependence, which makes households more resilient and less vulnerable to oil and gas price fluctuations, particularly in winter. Heating-related energy use represents approximately two thirds of the total energy consumption of households. In the period up to 2015 significant decreases could be observed in EU household energy consumption (a 5.7% fall between 2008 and 2016). This was largely due to decreasing heating-related consumption through building refurbishments and more efficient heating systems (e.g. replacing boilers which had low energy efficiency).

Bringing residential buildings up to energy-efficiency norms requires investment in renovation. In 2012 (latest data available) poorly equipped or insulated homes were still identified as a major reason for households facing difficulties to keep their homes warm during wintertime (see *Chart 5.21*). According to the High-Level Task Force on Investing in Social Infrastructure in Europe , the funding gap for social infrastructure in housing is approximately 450,000-500,000 new homes plus 800,000 homes requiring renovation. Belgium has relatively old building stock, and major needs for renovation and retro-fitting of dwellings to improve energy efficiency. Reaching the targets of the 2030 Climate and Energy Framework and a low-carbon economy by 2050 would require a doubling of the current annual renovation rate, from 0.7% to 1.3%. In Ireland, the cost of upgrading the housing stock to energy rating B3 would require an investment of EUR 35 billion. Hungary (despite recent improvements), Lithuania and Romania face similar issues of low energy efficiency in residential buildings. France has introduced ambitious plans to retro-fit social and private housing, but unlocking private investment remains a major challenge. Seeking new sources of efficiency improvements in other areas, such as the use of electricity appliances, will also be crucial to reaching the targets.

Several factors hold back investment in the energy efficiency of homes, including informational barriers, financial constraints and misaligned incentives. Many households remain unaware of the return on investment from greater energy efficiency. Some may find it difficult to access information on the improvements needed for their specific dwelling. Households may also lack understanding of the grants or loans they could access to support their investment. Other important impediments to investments in energy efficiency and renewable energy are low income, limited wealth or lack of access to credit. Among home-owners there is a consistent pattern across Member States of those on lower incomes being less likely to adopt retro-fitting improvements to the energy efficiency of their homes, despite government support measures. For rented homes, the costs and benefits of energy efficiency measures are often split between landlords and tenants. Whereas the cost of renovation or improvements in energy efficiency are typically financed by landlords (at least initially), the benefits in terms of reduced energy

Chart 5.21
In addition to the cost of energy, another major reason for households experiencing cold in winter is poorly equipped homes
Proportion of the population living in homes that are not comfortably warm during wintertime, by reason, 2012



Note: 'Cannot afford' refers to a lack of financial resources to keep the home adequately warm during wintertime. 'Poorly equipped' refers to a dwelling where the heating system is insufficiently effective, or where the home is insufficiently insulated against the cold.

Source: Authors' calculations based on EU-SILC 2012 User Database, ad hoc module 2012 on housing conditions.

Click here to download chart.

bills typically go to the tenant. Proliferation of rentals may hold back investment in energy efficiency in old buildings in city centres where it is most needed. Improving energy efficiency for vulnerable households may therefore require policies that are adapted to the specific situations of private tenants, social tenants or precarious homeowners.

In the medium run, energy poverty may increase in the absence of policy change, if energy costs rise faster than total disposable household income. Long-term simulations confirm that, regardless of the scenario chosen, energy expenditure (including fuel costs and energy equipment expenditure) is projected to increase in the medium term (with an increase between 2015 and 2030 of 21%). Given expected increases in household income, overall energy expenditure is projected to stay at a similar share of household disposable income in 2015 and 2030, amounting to 7.3%. After 2030 energy expenditure tend to continue to increase in absolute terms but varies considerably between the scenarios (see section 3.1.), with some of the lowest levels of increase under the energy efficiency scenario and the highest in the scenarios based on the implementation of high tech solutions with focus on an increased circular economy or changes in consumer preferences. But more important these scenarios see energy expenditure increase less fast after 2030 than household income, resulting in a decreasing share of household disposable income after 2030, underlining the long term benefits of a transition to a more resource and energy efficient economy.

5. Climate change and air pollution: air quality impacts on local health

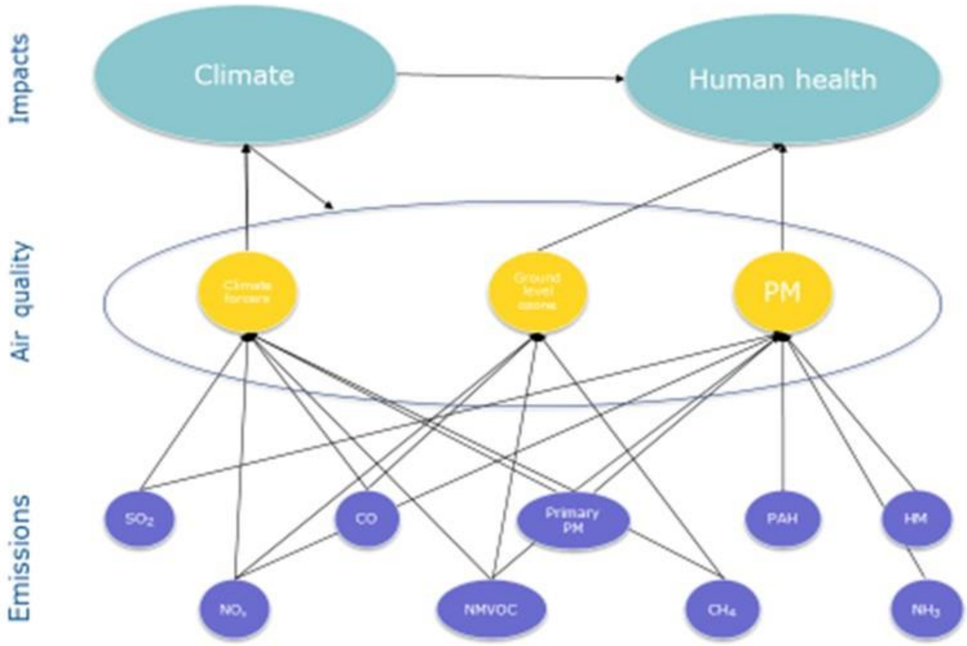
Climate change and air pollution are intrinsically related. Carbon dioxide is the largest driver of climate change but other non-CO_2 'climate forcers' also contribute to global warming (see *Figure 5.3*). Ground level ozone (O_3), one of the key air pollutants that has a significant impact on human health, can also be worsened by global warming. Fine particulate matter (PM), another major air pollutant, contains black carbon, which has a warming effect, while sulphur oxydes may, in some cases, contribute to cooling the climate. While most of the measures to cut emissions have the win-win effect of reducing air pollution and contributing to climate change mitigation, certain measures lead to trade-off effects between air quality and climate change.

Air pollution is the greatest environmental health risk in the EU and it has a direct impact on individuals' quality of life. Chronic exposure to air pollutants increases the risk of heart disease, stroke and pulmonary and respiratory diseases, including lung cancer. Each year, air pollutants such as particulate matter, nitrogen dioxide and ground level ozone are responsible for around 400,000 premature deaths in the EU. Air pollution also has a considerable economic impact, cutting lives short, increasing medical costs and reducing productivity across the economy through working days lost due to ill health or dragging down the productivity of those working. The

Figure 5.3

Air pollution affects human health and climate change

Interaction between emissions, quality of air and impacts on human health and climate



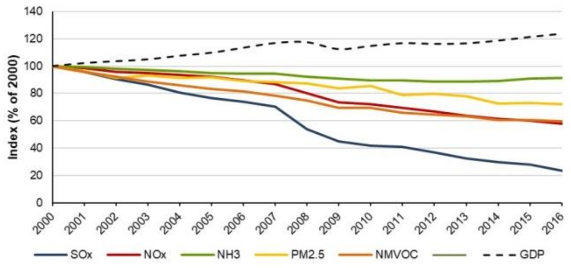
Source: Based on European Environment Agency – Air quality in Europe 2010. For illustration purposes only.
Click here to download figure.

related total health costs of air pollution have been estimated at EUR 330 - 940 billion annually, including EUR 15 billion in lost workdays. Air pollution also has a negative impact on ecosystems, damaging soil, forests, lakes and rivers and reducing agricultural yields.

People from lower socio-economic backgrounds, children, older people and those with pre-existing health problems are the most vulnerable to the negative effects of air pollution. People from lower socio-economic backgrounds tend to be more affected by air pollution than the general population, as the negative effects of pollution aggravate the effects of poor diet, unhealthy lifestyles and inadequate healthcare. Air pollution can also have a detrimental effect on children's development and health. The occurrence of bronchitis, pneumonia and sinusitis in children has been linked to air pollution. Children's delayed neural and cognitive development can sometimes be attributed to air pollution. It can have a negative impact on their early school performance and subsequently their educational attainment, employability and income. Long-term exposure to air pollution is associated with stress, anxiety, cardiovascular and respiratory diseases in older people, who are also more likely to suffer from frailty and reduced lung function. Finally, air pollution can exacerbate the already poor health of those with a pre-existing health condition.

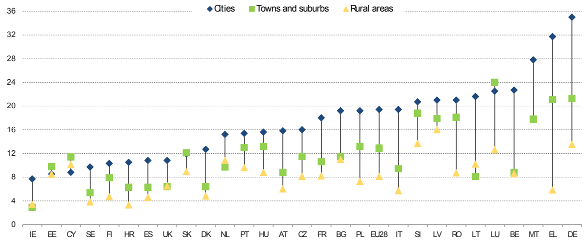
Emissions of the main air pollutants have been decreasing in the EU, showing a significant absolute decoupling from economic activity. Despite this positive trend (see *Chart 5.22*), the levels of air pollution still exceed the EU limits in zones and agglomerations across the EU. Road transport is one of Europe's main sources of air pollution, especially for harmful pollutants such as nitrogen dioxide and particulate matter. Emissions from agriculture, energy production, industry and households also contribute to air pollution.

Chart 5.22
Emissions in the EU have been decreasing…
Development in EU28 emissions, 2000-2016 (% of 2000 levels), main air pollutants



Note: GDP expressed in chain-linked volumes (2010), % of 2000 level
Source: EEA: Air Quality in Europe 2018
Click here to download chart.

Chart 5.23
People in cities report being more exposed to pollution and other environmental problems than those living in rural areas
Proportion of people living in an area with problems related to pollution, grime or other environmental problems, by degree of urbanisation, 2017



Note: Low reliability of data for MT rural areas; 2016 for the UK.
Source: Eurostat, ilc_mddw05.
Click here to download chart.

Those living in cities are more exposed to the detrimental effects of air pollution on health. Although emissions of air pollutants have decreased considerably since 1990, air pollutant concentrations in specific localities still remain high, with urban areas being the most affected. Up to 96% of EU citizens living in urban areas were exposed to O_3 concentrations above the levels set in the World Health Organisation guidelines in the 2014-2016 period. The proportion of the EU-28 urban population exposed to $PM_{2.5}$ and PM_{10} levels above WHO guidelines was the lowest since 2000, but still reached 42-52% and 74-85% respectively.

Urban dwellers also report to suffer more than others from air pollution and other environmental problems. In 2017, almost one fifth of the EU 28 population living in cities reported suffering from pollution, grime or other environmental problems. This problem was most severe in German and Greek cities, while less than 10% of city dwellers in Sweden, Cyprus, Ireland and Estonia reported suffering from these conditions. People living in towns and suburbs (12.9%) and those living in rural areas (8.1%) are less likely to report this problem (see *Chart 5.23*). Air pollutants tend to concentrate more in urban areas due to factors such as higher density of economic activity, population and the built environment.

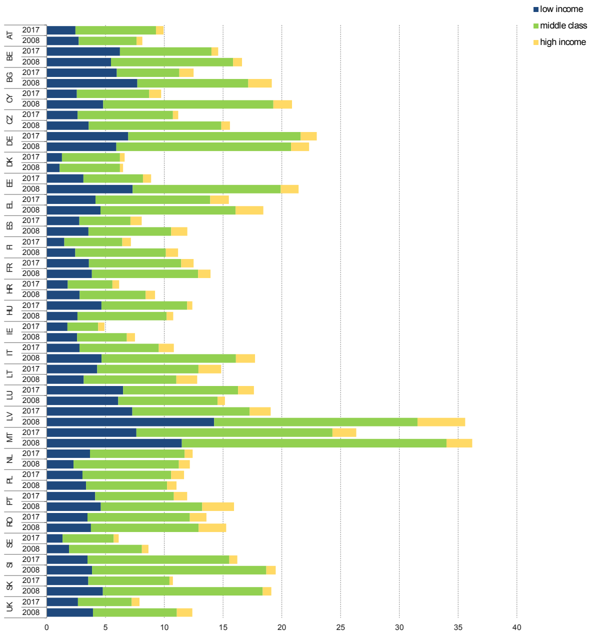
The proportion of people who report being exposed to problems related to pollution, grime and other environmental problems has been decreasing, although it varies widely across Member States. This encouraging trend, in line with the overall reduction in air pollution, can be observed in most Member States, with the exception of Austria, Germany, Hungary, Lithuania and Luxembourg. However the proportion of those reporting environmental problems in areas where they live is still above 20% in Germany and Malta.

The evidence on vulnerable groups being more exposed to air pollution is mixed. Social, economic, political and environmental factors contribute to how environmental risks are distributed in a society. People from lower socio-economic backgrounds are more likely to live in more affordable, densely built-up and populated city centres with higher traffic concentration and thus suffer higher exposure to air pollution than those living in suburbs, for example. A number of local studies confirm that people from less privileged socio-economic backgrounds live in areas more exposed to air pollutants. These studies were conducted in Germany, Czechia, France, Belgium and the Netherlands. However, *Chart 5.24* shows that, despite a decrease in the last decade in most Member States, a relatively high proportion of those reporting environmental problems in areas where they live belong to the middle class (the proportion with high income is relatively small.) Evidence is similarly mixed as regards specific age groups, such as the elderly and children.

Chart 5.24

A relatively high proportion of individuals reporting pollution, grime and other environmental problems belong to the middle class

Proportion of people living in an area with problems related to pollution, grime or other environmental problems by income group, 2008 and 2017



Note: 2010 instead of 2008 for HR, 2016 instead of 2017 for IE and the UK.

Source: EU-SILC.

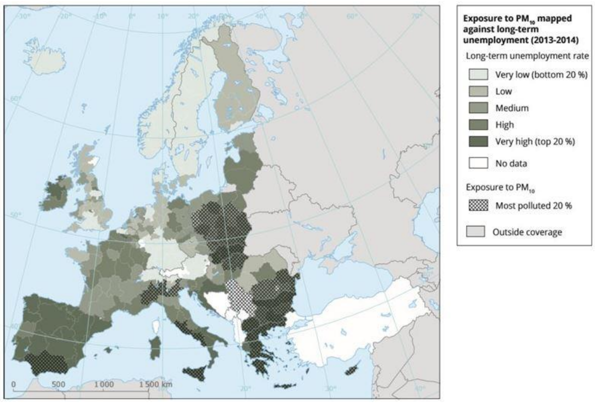
Click here to download chart.

The correlation between the level of regional development and air pollution is not straightforward. In general, less developed regions, as measured in terms of unemployment, educational level and household income, are more exposed to pollutants such as PM2.5 and PM10 (see *Figure 5.4*). More densely populated areas or those with higher levels of industrialisation such as those in northern Italy, western Germany and the UK suffer more from NO2 pollution (see *Figure 5.5*). However, a more granular assessment shows that within these regions, those with lower socio-economic status are often more exposed.

Figure 5.4

Less developed regions tend to be more exposed to pollutants

Exposure to fine particulate matter mapped against long-term unemployment



Note: Exposure is expressed as population-weighted concentrations; mapped for NUTS 2 regions

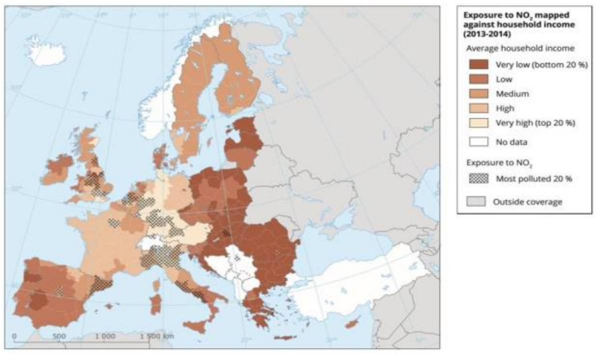
Source: EEA (2018)

Click here to download figure.

Figure 5.5

The link between regional development and air pollution is weak

Exposure to NO2 mapped against household income (2013-2014)



Note: Exposure is expressed as population-weighted concentrations; mapped for NUTS 2 regions

Source: EEA (2018)

Click here to download figure.

Climate change action has the potential to improve air quality (and therefore human health) and vice versa. Policies aimed at mitigating climate change reduce greenhouse gases and local air pollutants when these have the same underlying source, which is often the case. Transition to the energy systems necessary to reach the targets agreed in the context of the Paris Agreement on climate change can help to improve air quality and consequently human health through reduced use of fossil fuels. The impact can be even stronger if more ambitious policies than those limiting global warming to 2.0 degrees Celsius are implemented, and accompanied by gradual diffusion of air pollution control measures or even full adoption of the best available air pollution abatement technologies by 2030. Compared with 2010, pollution-related premature mortality in the EU is projected to increase by roughly a quarter by 2050 if additional climate change mitigation measures and air pollution measures are not taken. Under the most ambitious scenario in terms of climate and air pollution action, roughly one third of premature deaths can be avoided.

Climate action therefore has the potential to gather further political support by focusing on the co-benefits of air pollution reduction and avoiding the few trade-offs. This is the case because the benefits of air pollution are local and visible in the short term, compared with the longer term and global effects of climate mitigation action.

6. Conclusions and eco-social policy choices

The transition to a low-carbon economy is expected to have small but positive effects on GDP, and employment. GDP and employment effects by 2030 are expected to be respectively up to 1.1% and 0.5% higher than they would be without climate action necessary for meeting the 2 degrees target under the Paris Agreement. This amounts to an additional 1.2 million jobs in the EU by 2030, on top of the 12 million additional jobs expected to be created on the baseline scenario. Simulations of pathways towards a climate-neutral (i.e. net zero greenhouse gas emissions) EU economy by 2050, consistent with the EU contribution to limiting global warming to 1.5 degrees, also show a positive net overall employment impact of 1.5 to 2 million extra jobs by 2050, with a small GDP impact which is either positive or negative, depending on modelling specifications.

The transition to a climate-neutral economy is expected to provide additional jobs in growing, green(ing) sectors both in industry and services, including construction, waste management and sustainable finance. The positive impact on GDP and employment is largely due to the investment activity required to achieve such a transition, together with the impact of lower spending on the import of fossil fuels. Furthermore, lower consumer prices, notably of solar photovoltaic electricity, boost disposable incomes, consumer expenditure and consequently the demand for consumer services, which are generally labour- intensive. The design of revenue recycling is a major driver of economic and employment outcomes. The impacts, however, will vary considerably between sectors and countries, ranging from slightly negative employment impacts in Poland to additional job creation of up to 1% of the total workforce in Belgium, Spain and Germany.

Moving to a climate-neutral economy may also help to mitigate further job polarisation resulting from digitalisation, by creating jobs in the middle of the wage and skill distributions. Targeted support is needed for retraining and upskilling of the workforce, in response to new emerging tasks and skill requirements. The costs for these measures need to be shared fairly. The positive health effects of reduced pollution in general, and of changed sourcing and production processes relating to the circular economy, should also be borne in mind.

However, the transition will require significant reskilling and labour reallocation, and hence raises questions about potential costs and risks in the employment and social domain and their distribution. The measures and reforms necessary to reach the climate targets will have substantial impacts on people and regions, including significant labour reallocation across sectors and occupations. They will particularly affect workers and families whose livelihoods have so far been dependent on work in energy-intensive sectors: these workers will need support for the transition, including retraining, reskilling and possible job search, as well as income support and compensatory measures where appropriate.

The measures and reforms will further affect those lower and middle-income households already at greater risk of disproportionately high spending on energy and mobility and even energy poverty. Their hardship would be deepened by regulatory or fiscal measures which potentially have regressive effects, whereas progressive measures could help to mitigate these negative effects.

Careful design and adequate funding sources to support the necessary accompanying or compensatory measures are essential for a just transition. Options include tax shifts from labour to energy consumption, waste and pollution, as well as the use of revenues from climate policies to finance social transfers ensuring a fair burden sharing. Revenue recycling schemes which use revenues from carbon taxation for the financing of subsidies to taxpayers have been shown toenhance the acceptability of climate action measures overall. Climate action has also potential to gather further social acceptance by bringing forward the co-benefits with air quality.

Progress towards Sustainable Europe 2030 and the ambitious vision defined in the Communication "A Clean Planet for All" of November 2018 entails a broad policy mix. It requires effective and timely implementation of a whole range of policy measures and fundamental reforms at EU, national and regional levels, including in areas such as energy and transport, taxation, research, industrial and competition policy as well as employment and social policies.

The Commission has put in place an enabling framework of policies and programmes that are of key relevance in this context. In addition to the many energy- and climate-related initiatives , and the overall commitment for climate mainstreaming across all EU programme, with a target of 25% of EU expendicure comtributing to climate objectives, they include in particular:

- the European Pillar of Social Rights, which declares among other things a right of access to good quality essential services such as water, sanitation, energy and transport, and indicates that support for access to such services should be available for those in need. It also declares a right to quality and inclusive education, training and life-long learning and a right to adequate social protection – all crucial elements of a fair and just transition.
- the European Structural and Investment Funds, notably the European Social Fund and the European Regional Development Fund, which offer financial support for infrastructure investments and for reskilling, upskilling, retraining and transition support.
- the European Globalisation Adjustment Fund, which supports workers made redundant as a result of major structural change caused by globalisation, the continuation of the crisis, or the transition to low-carbon economy.
- the InvestEU programme, which provides an EU budget guarantee to support investment and access to finance in the EU for sustainable infrastructure, research, innovation and digitalisation, SMEs and social investment and skills.
- economic policy coordination under the European Semester which, among other things, helps to promote progress towards the Europe 2020 targets. These include lifting Europeans out of energy poverty, identifying investment needs and promoting reforms in support of a more circular, low-carbon economy, including tax shifts away from labour towards environmental taxes.
- the Initiative for Coal and Carbon-Intensive Regions in Transition, which helps to mitigate the social consequences of the low carbon transition and assists the regions concerned to define low-carbon transition strategies and address potential negative socio-economic impacts.
- the Modernisation Fund, which supports low-carbon investments in 10 lower income EU Member States, including support of just transition by redeployment, re-skilling and up-skilling programmes.

the involvement of stakeholders, notably social partners, in the design and implementation of these policies and initiatives.

For the EU's climate and energy strategy to succeed, it is of key importance to integrate the social dimension from the outset and not as an afterthought. As indicated in the long-term strategy for a climate neutral EU economy by 2050, this will help to ensure a socially fair, just transition and, eventually, social acceptance and public support for reform. Social concerns and impacts need to be taken into account from the outset in policy design and implementation. Where needed, mitigating or compensatory measures need to be part of the reforms. This approach reflects the importance of the environmental-social nexus in the EU development model.

Annex 1: Studies on the 'greenness' of occupations

Despite the generally accepted view on the significant effects that the transition to a climate-neutral economy would bring for skills and tasks, only relatively few studies have assessed this issue in detail. There are surprisingly few reliable statistics on the nature, number, and sectoral concentration of the jobs affected and relatively less effort has been expended on assessing the 'greenness' of different occupations. Among the few exceptions in the literature are Ast and Margontier (2012) and Eurofound (2012) for France, Bowen et al. (2018) for the US and Marin and Vona (2018) for the EU:([1])

Ast and Margontier (2012) and **Eurofound (2012)** provide a taxonomy of green and 'greenable' occupations in France. They estimate the number of people in green occupations in France in 2008 at 136 000, and that of people in 'greenable' occupations at 3.5 million. They find that green occupations are concentrated in traditional activities such as waste management, treatment of pollution, energy production and distribution, and protection of the environment, and predominantly held by male employees in stable jobs. By contrast, they found 'greenable' occupations to be much more diverse, with two thirds of them in activities unrelated to the environment.

In a study for the US Department of Labor, **Bowen et al. (2018)** identify occupations subject to 'greening' on the basis of the tasks that the workers in these occupations performed, and identified the ensuing skills needs for the main economic sectors. Based on this typology, they estimate the share of jobs in the US that would benefit from a transition to the green economy, and present different measures for the ease with which workers are likely to be able to move from non-green to green jobs. Using the US O*NET database and its definition of green jobs,([2]) they find that 19.4% of US workers can be considered being part of the green economy in a broad sense. A large proportion of this 'green employment', however, would be 'indirectly' green, comprising existing jobs that are expected to be in high demand due to greening but do not require significant changes in tasks, skills, or knowledge. They further analyse the task content of jobs and conclude that green jobs vary in their degree of 'greenness,' with very few jobs consisting of green tasks only. They find that non-green jobs generally differ from their green counterparts in only a few skill-specific aspects, suggesting that most re-training can happen on-the-job and that greening of the economy holds important growth potential.

In **Bowen and Hancké (forthcoming)**, the authors are exploring the results when transferring the taxonomy to the EU economy. This is ongoing work the results of which are presented below.

Marin and Vona (2018), by contrast, examine the impact of different climate change policies on skills in 15 industrial sectors in 14 European countries, based on a taxonomy of economic sectors according to their exposure to climate policies. They conclude that climate policies, proxied by energy prices, have a very small negative impact on total employment, while favouring skilled workers (e.g. technicians and managers) against manual workers. Climate policies also have a pronounced bias towards technical occupations (e.g. physical and engineering science technicians, process control technicians).

([1]) Jacob et al. (2015) further provide a sector-based typology and analysis of green jobs and their impacts with particular focus on emerging and developing economies.

([2]) See Rivkin et al (2009) and https://www.onetcenter.org/overview.html.

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