A Net Zero workforce

May 2023

Climate Change Committee

Contents

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The Committee

The Rt. Hon John Gummer, Lord Deben,
Chairman

Lord Deben was the UK's longest-serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). Lord Deben also runs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues.

Professor Keith Bell

Keith Bell is a co-Director of the UK Energy Research Centre (UKERC), a Chartered Engineer and a Fellow of the Royal Society of Edinburgh. He has been at the University of Strathclyde since 2005, was appointed to the Scottish Power Chair in Smart Grids in 2013 and has been involved in energy system research in collaboration with many academic and industrial partners.

Professor Michael Davies

Michael Davies is Professor of Building Physics and Environment at the UCL Institute for Environmental Design and Engineering (IEDE). At UCL his research interests relate to the complex relationship between the built environment and human wellbeing. He is also Director of the Complex Built Environment Systems Group at UCL and a member of the Scientific Advisory Committee of 'Healthy Polis'.

Professor Piers Forster

Piers Forster is Director of the Priestley International Centre for Climate and Professor of Physical Climate Change at the University of Leeds. He has played a significant role authoring Intergovernmental Panel on Climate Change (IPCC) reports, and is a coordinating lead author role for the IPCC's sixth assessment report.

Paul Johnson CBE

Paul Johnson is Director of the Institute for Fiscal Studies and a visiting professor at University College London (UCL). He is widely published on the economics of public policy, and he co-wrote the 'Mirrlees review' of tax system design. He was previously Chief Economist at the Department for Education (2000 to 2004).

Professor Corinne Le Quéré FRS

Corinne Le Quéré is a Royal Society Research Professor at the University of East Anglia (UEA), specialising in the interactions between climate change and the carbon cycle. She was lead author of several assessment reports for the UN's Intergovernmental Panel on Climate Change (IPCC) and she currently Chairs the French Haut Conseil pour le Climat.

Nigel Topping CMG

Nigel Topping was appointed by the UK Prime Minister as UN Climate Change High Level Champion for COP26. In this role Nigel mobilised global private sector and local government to take bold action on climate change, launching the Race To Zero and Race To Resilience campaigns and, with Mark Carney, the Glasgow Financial Alliance for Net Zero.

Executive summary

The workforce will be key to delivering Net Zero, but policy is needed to harness the potential opportunities and manage the risks of the transition.

Changes in the UK workforce will enable Net Zero. Workers will create new low-carbon markets and transform processes, products and supply chains from high-carbon to low-carbon. The shift to Net Zero is already underway, with the creation of around 250,000 new jobs in the transition so far, but policy is now required to maximise the employment benefit of Net Zero and manage the risks.

With the right conditions, Net Zero can provide an opportunity for growth in high-quality jobs, distributing opportunities across regions and increasing diversity. However, without active management, there are risks of an inadequate UK skills base to deliver the transition and inequitable or disruptive impacts for the workforce and communities.

This brief provides evidence on the potential impacts of Net Zero for the workforce.

This brief provides an overview of the evidence on the potential impacts of Net Zero for the workforce to inform the Government's **Net Zero and Nature Workforce Action Plan** that is due in early 2024. The key messages are:

- Net Zero will transform the economy but the majority of workers will not see major impacts. Only around a fifth of workers will see the largest impacts – those that are currently employed in sectors that will have a core role in delivering Net Zero, often in the next decade.

- There is potential for the Net Zero transition to create more jobs than will be lost. Between 135,000 and 725,000 net new jobs could be created by 2030 in low-carbon sectors, such as buildings retrofit, renewable energy generation and the manufacture of electric vehicles.*

- The transition provides a range of opportunities, from driving growth in areas with historically low employment to diversifying the workforce of core Net Zero sectors. It also comes with risks that will need to be managed to deliver a just transition, including an inadequate supply of skilled workers, and potentially disruptive impacts to some communities. The risks and opportunities are unique to each sector.

- Government has policy levers at its disposal to support workers during the transition to Net Zero. It does not need to intervene in every sector of the economy, but clearer plans are needed to harness the potential of the transition and to manage its risks. A hands-off approach will not work.

We explore these key messages in more detail in the rest of this summary.

Net Zero takes place in the context of a labour market that is constantly evolving.

1. **The potential impacts of Net Zero for the workforce take place in a labour market that is constantly evolving in response to a changing economy and society. It is a labour market that has undergone deep and sometimes disruptive transitions in the past**.

   – Over the past 60 years, who works, how we work and the type of work we do has changed dramatically, reflecting structural changes in the UK economy and wider society.

   – The UK labour market has gone through significant transitions in the past, including the decline of coal and steel in the 1970s and 1980s and the shift to a service-based economy over the past 100 years. These differ from the Net Zero transition, which is an explicitly stated

* While the range for job creation we present is net job creation (so factors in potential job losses), the range of potential job losses we present are potential gross job losses. We show a wide range: there is much uncertainty in these estimates and there are different ways to calculate changes in job numbers.

government goal and so offers the opportunity for greater certainty to businesses and workers.

– Net Zero takes place in the context of a shifting labour market driven by trends such as automation, digitalisation, a changing immigration system and an ageing workforce. These trends will shape Net Zero impacts on the workforce.

Only a fifth workers will have a core role in delivering Net Zero, with a further fifth helping enable the transition.

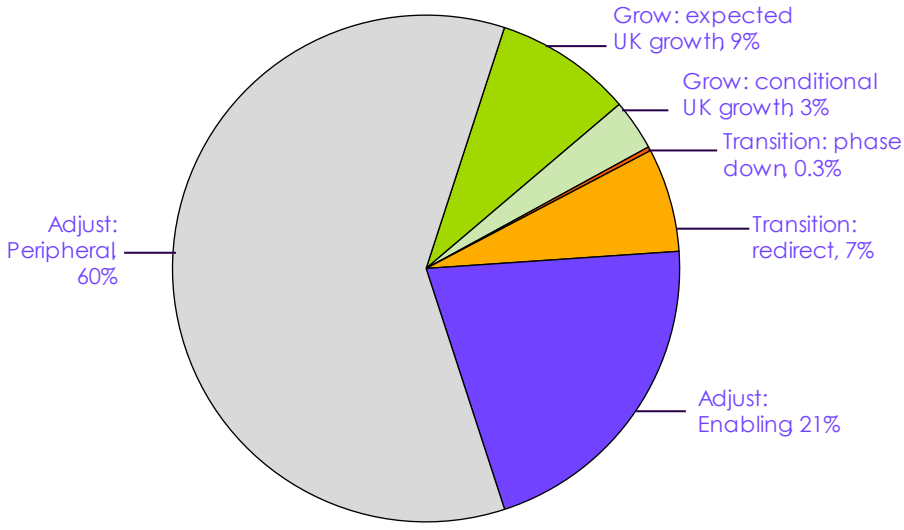
2. **Net Zero will transform the economy but its impacts for the workforce will be mostly felt by only a fifth of today's workers – those that are currently employed in sectors that will have a core role in delivering Net Zero (Figure 1).**

   – A fifth of workers will have a core role to play in delivering Net Zero. Out of these, two-thirds are in sectors that may grow as a result of the transition, such as buildings construction and retrofit and electric battery manufacturing. Less than 1% of UK workers are in sectors that will need to phase down as a result of the transition, and around 7% of UK workers are in sectors that will need to redirect their products and services (Table 1).

   – A further fifth of workers are in sectors that will play an enabling role in the transition, such as financial services and education.

   – The majority of workers (60%) will only experience indirect impacts from the changes across sectors. As such, changes to their sector, skills and knowledge are likely to be peripheral.

Figure 1 Share of currently employed workers by type of Net Zero impact



Source: ONS (2019) *Industry (two, three and five-digit Standard Industrial Classification) – Business Register and Employment Survey (BRES): Table 2*; CCC analysis.

Table 1
Economic sectors by category of Net Zero impact

Sectors	Grow		Transition		Adjust
	Expected UK Growth	Conditional UK Growth	Phase Down	Redirect	Enabling
Agriculture and land use	Forestry, silviculture, and logging Peatland restoration	Agriculture (non-livestock)		Livestock and mixed agriculture Meat and dairy processing	
Built environment	Building construction and retrofit Building construction infrastructure and finishing			Manufacture of central heating radiators and boilers	
Energy supply	Power generation, transmission & distribution	CCS infrastructure* Hydrogen supply*	Coal production Oil & gas production Refining	Gas distribution	
Manufacturing	Construction of industrial facilities			Energy-intensive industry (e.g. steel, cement, glass)	
Transport	Rail operation Construction of roads and railways	Battery manufacturing Vehicle manufacturing Sustainable aviation fuels*	Retail sale of automotive fuel	Aviation Shipping ICE vehicle manufacturing Vehicle maintenance Waste	
Services					Education services Legal and accounting services Financial and insurance activities Architectural and engineering activities and related technical consultancy

Notes: This is a high-level summary of how we allocated sectors against Net Zero impacts. Each sub-sector is composed of economic activities as defined in the Standard Industrial Classification. The table shows the dominant impact for each sub-sector. At a more disaggregated level, a sub-sector can spread across multiple categories of Net Zero impacts. A more detailed breakdown of how we allocated sub-sectors to Net Zero impacts is provided in the Annex. *Sectors that do not currently have a unique Standard Industrial Classification as they depend on the development or scaling of new economic activities within the UK.

3. **There is potential for the Net Zero transition to create more jobs than will be lost. Between 135,000 and 725,000 net new jobs could be created in low-carbon sectors, such as buildings retrofit, renewable energy generation and the manufacture of electric vehicles. This growth is not guaranteed, particularly in the context of international competition, and it would require active reskilling and upskilling of the workforce, which carries some costs. The extent to which new jobs are beneficial to the economy overall depends on the tightness of the labour market, and whether they are additional or displacing jobs elsewhere.**

The transition could bring 135,000 to 725,000 net new jobs, including 8,000 to 75,000 job losses.

The range of future employment estimates is significant according to the existing literature (Figure 2).

- Our review of the literature suggests that the phase-down of high-emitting sectors and redirection of sectors, which will need to transform processes, could lead to the transition of 8,000 to 75,000 workers whose jobs cannot continue in their current form in a Net Zero economy.

- There could be extensive job creation, with estimates suggesting between 135,000 to 725,000 net new jobs created by Net Zero, in sectors such as buildings retrofit, renewable energy generation and electric vehicles.

- However, these estimates are based on external literature, which is limited and may be positively skewed, and are not official CCC estimates.

The potential employment growth in certain sectors is not guaranteed, and can come with an opportunity cost.

There is potential for employment growth in certain sectors, but it is not guaranteed, and may not always boost the economy. The UK must capture a lead in key markets and ensure workers with the right skills can be attracted.

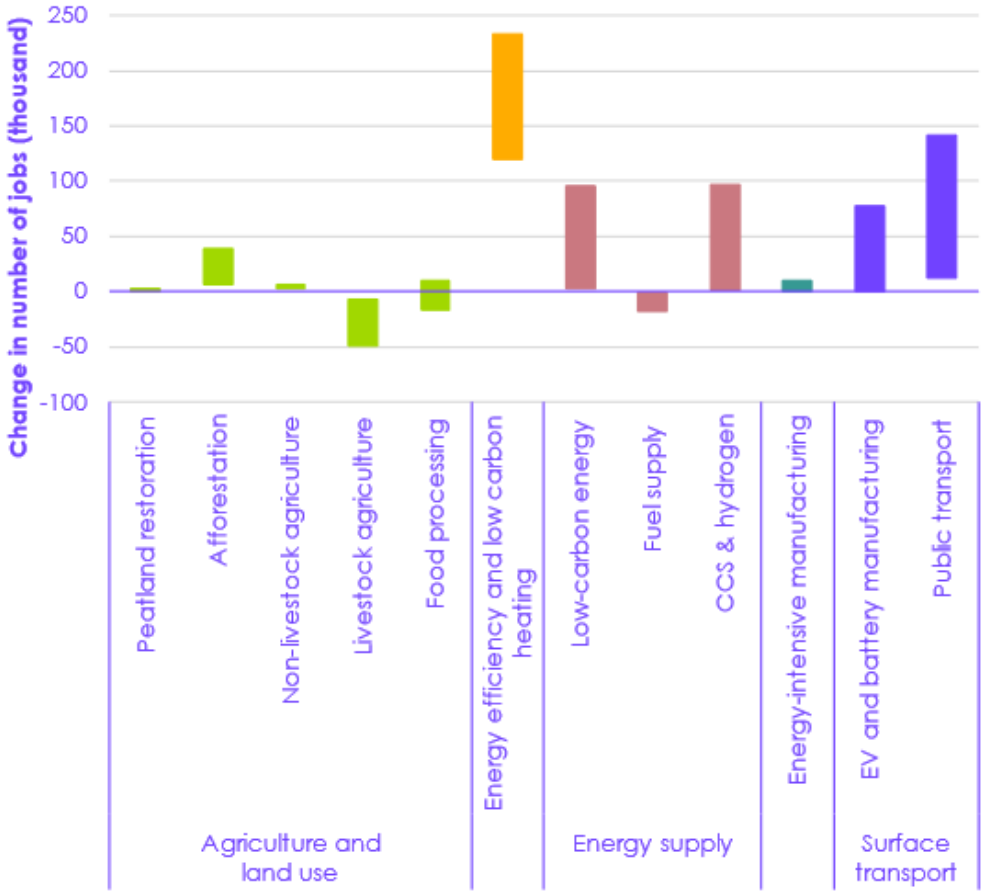
- Nine percent of the UK workforce are in sectors expected to grow and which are not exposed to international competition. For example, buildings construction and retrofit is expected to grow significantly, and is relatively geographically dispersed across the UK. Growth in these sectors is not guaranteed and relies, alongside long-term policy certainty and regulations, on the availability of skilled workers in the right place at the right time.

- Although 12% of the UK workforce are in sectors expected to grow, about a quarter of them (3% of total workers) are in sectors which will only grow if the low-carbon supply chains are based in the UK as opposed to abroad. Failure to provide clear signals and strong incentives to industry and to support an appropriate skills base in the workforce could lead to this growth opportunity being lost.

- While employment growth in a particular sector can bring benefits to regions and workers, if the labour market is tight and skilled workers are taken away from other productive sectors, it carries an opportunity cost.

External estimates of job losses and gains are highly uncertain, but still indicate the potential for significant job gains in areas such as home retrofit and energy supply.

Figure 2 Range of estimates of direct employment impacts of decarbonisation in 2030



Source: CCC analysis based on literature review.[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28]
Notes: This analysis looked across close to 30 reports. While these estimates consider Net Zero impacts across a wide range of sectors, the assessment is not exhaustive so Net Zero impacts on certain sectors will not be included (e.g. impacts on vehicle maintenance). In addition, in combining external estimates for each sector we take a conservative approach, not summing estimates within sectors of job gains unless it is clear the additional jobs would be distinct. Areas where we do sum external estimates include new jobs linked to public buses and to trains, new jobs from energy efficiency and from low-carbon heating, and job losses in the oil and gas sector and in coal mining. In some cases, meeting the UK's climate commitments is contingent on the development of a Net Zero skilled workforce. In others, the potential for job creation will be determined by policy choices. For example, the development of a circular economy would benefit Net Zero and might impact on jobs, however this is not strictly necessary to meet our targets. As such, we cannot draw conclusions on the total impact of Net Zero from the ranges we identify, which instead indicate the potential scale of change. Due to these complexities the numbers in this chart do not align exactly to our headline range for potential net job creation and losses discussed in the report.

4. **The transition provides a range of opportunities, from creating jobs where they are most needed to diversifying the workforce of sectors core to Net Zero. It also comes with risks that will need to be managed to deliver a just transition. These are unique to each sector.**

We have identified four dimensions that shape how a transition impacts the workforce.

   – Other transitions provide us with insights into the drivers of the impacts of transitions. These drivers are useful dimensions to consider in assessing the potential impact of the Net Zero transition for the workforce and communities: (1) the geographical distribution of jobs and regional economic dependencies, (2) the pace of change, (3) the characteristics of the workforce and (4) the policy response to mitigate or address these impacts.

– Sectors that are expected to see the largest growth in employment, such as buildings construction and retrofit, transport, and low-carbon energy supply, are also the sectors that will see some of the fastest transitions, driven by the need to roll out low-carbon technology at pace.

  - Where a sector is predominantly comprised of Small and Medium Enterprises (SMEs), such as in buildings construction and retrofit, the transition is likely to require coordination. The development of a skilled workforce in buildings construction and retrofit is pressing given the pace of decarbonisation needed in the sector.

The UK may be missing out on opportunities to develop low-carbon market domestically by not supporting Net Zero skills.

  - The UK may be missing out on opportunities to capture low-carbon market shares domestically by not supporting the skills that could help attract investment into the UK. This is notably the case for EV and battery manufacturing, an area that is seeing consumer subsidies for inland manufacturing being put in place abroad, such as in the United States and European Union. In other sectors like hydrogen or CCS, the UK currently benefits from a competitive advantage supported by a pool of skilled workers from the oil and gas industry.

– Relatively few workers are in sectors expected to Phase Down (less than 1%) or Redirect (7%) in the Net Zero transition. They can be expected to see a gradual pace of change.

Around 7% of workers are in sectors expected to redirect or phase down, which are expected to see a gradual pace of change.

  - Most of these workers are in the fossil fuel sector where changes in employment are expected to be gradual, if adequately planned for. However, given the geographical concentration of workers there may be a risk of disruptive localised impacts, notably in Scotland where these jobs are mostly concentrated, without targeted intervention.

  - Livestock agriculture is a Redirect sector, but could also potentially see job losses, depending how the required shift in land use towards greater forests and peatlands occurs. Although the shift in land use would be gradual and livestock agriculture represents a relatively small proportion of regional employment at a local authority level, potential job losses could still be sizeable relative to total livestock agriculture jobs, and carry socio-cultural significance.

If managed well, the transition could bring opportunities to diversify the workforce and benefit regions that have historically had low employment levels.

– Net Zero impacts will be distributed differently across socio-demographic groups. Energy supply and construction have historically had an under-representation of women or ethnic minorities. With targeted support, Net Zero offers an opportunity to increase diversity in these sectors. At the same time, in several sectors that are expected to phase down or redirect, people aged over 55, those who identify as men, and those who identify as white, are disproportionally represented. Older workers, who are particularly represented in farming and oil and gas, may need tailored support to transition to alternative low-carbon sectors.

– Decarbonisation could create opportunities in areas that have historically had lower growth or employment. In particular, the creation of industrial clusters within the manufacturing sector or the

development of afforestation could create opportunities across the UK, including in areas with historically low employment levels.

5. **The Government already has policy levers at its disposal to support workers during the transition to Net Zero. While it need not intervene in every sector of the economy, it should develop clear plans that identify when and where policy responses are needed. Policy must be put in place if it is to harness the potential of the transition and manage its risks.**

The Government must identify when and where workforce-targeted interventions might be needed.

Clear policy direction for each sector, combined with a responsive education and skill system, is a fundamental requirement across all sectors. However, in some areas, a workforce-targeted intervention will also be needed.

With this in mind, we have set out a Framework to show the key dimensions to consider for identifying priority or high-risk sectors (Figure 1.1), and have illustrated how this can be used (Figure 3).

We have set out a framework to help identify sectors that may be a priority for intervention.

- For minimising disruptive impacts on workers, key risk areas are sectors which are phasing down or transitioning, where there is a rapid pace of change, and jobs are geographically concentrated, resulting in strong local impacts if workers relocate or lose employment.

- For ensuring Net Zero is delivered, key risk areas would include sectors where the transition would entail rapid growth and where businesses are predominantly SMEs.

- For harnessing opportunities, priority sectors include where growth is conditional (i.e. it is exposed to international competition), where sectors would grow and could be focussed in lower-income regions, or sectors that will grow and where historically there has been limited diversity.

The Framework (Figure 1.1) also highlights the key role of businesses. Where businesses are larger, they may be able to drive much of the needed intervention, although coordination with government may still be needed.

- A predominantly government or business-led response will depend on the concentration of ownership of businesses in the sector. In sectors where employment is concentrated with a few large businesses (e.g. oil and gas, vehicle manufacturing) the responsibility and cost of retraining can generally be taken on by these businesses with some government support and monitoring of progress. In sectors where small businesses largely operate (e.g. vehicle maintenance, buildings retrofit) government should work with the skills system to ensure opportunities for training are available throughout the country.

- A public-private partnership with a clear definition of responsibilities could help to coordinate action across government, businesses, local authorities, education providers and workers.

We will build on this analysis to develop specific recommendations for Government in our 2023 Progress Report.

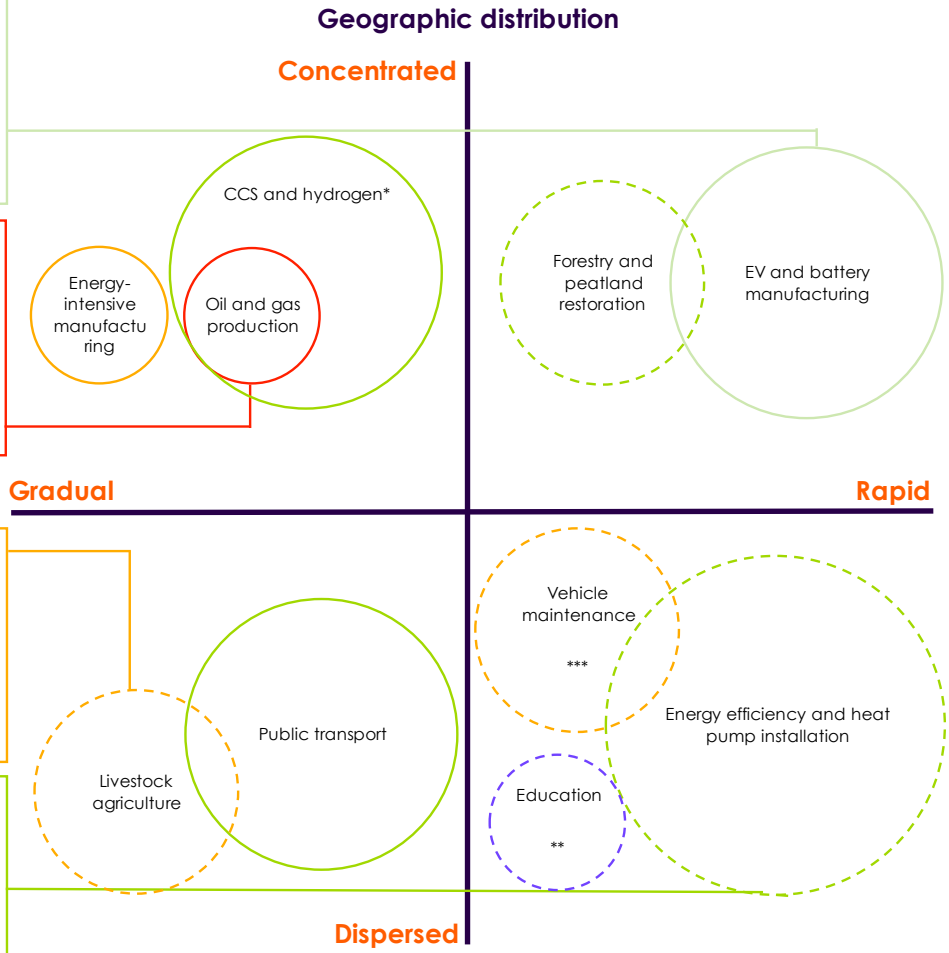
Figure 3 Illustrative policy responses based on transition characteristics

- **Reskilling** will be necessary to **attract investment** in the UK.
- **Large firms should use resources** to invest in workers accompanied by a clear **industrial policy** from Government.

- Oil and gas workers **have sought-after skills** in CCS and hydrogen.
- If the transition were to lead workers to relocate, **regeneration policies** at the local level might be needed.

- Farmers may need support to transition skills towards low-carbon farming or reforestation.
- Given strong social and cultural ties, **place-based strategies** and support may be needed.

- SMEs will need the guidance and support of **Government for reskilling**.
- The implementation of **education and skills policy** should align with the end of gas boiler sales by 2035.



Legend

Size of most employers:

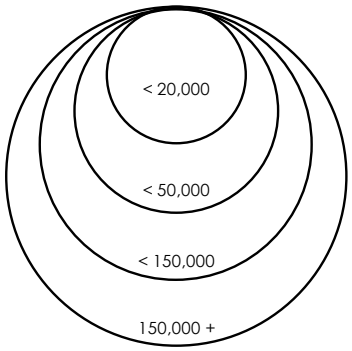
——— Large businesses

- - - - - Small and medium businesses

Net Zero impact:

- Expected UK Growth
- Conditional UK Growth
- Redirect
- Phase Down
- Enabling

Potential scale of change in jobs (according to external estimates)



Notes: *We assume for CCS and hydrogen employers are likely to be large, due to the level of technical and financial investment required. **Our Sixth Carbon Budget does not have a pathway for changes to education, so we have assessed the pace of change based on the need to rapidly upskill the workforce. ***We did not find estimates for the potential scale of employment change in vehicle maintenance, so have based our assessment on the current size of the sector, and the potential changes in vehicle type and ownership.

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Chapter 1

Introduction

This brief builds the evidence base on risks and opportunities Net Zero is likely to present to the workforce.

This brief builds the evidence base on the risks and opportunities that workers are likely to experience as a result of the transition to Net Zero. In doing so, we have identified three broad policy questions that Net Zero poses for the UK labour market:

- What is needed to ensure the workforce are equipped to deliver Net Zero?
- What is needed to protect workers and communities from potential disruptive impacts?
- How can wider opportunities presented by this economic and labour market transition be harnessed?

Our work has been guided by an Expert Advisory Group and the available evidence, but evidence is limited, and numbers mentioned in relation to changes to jobs are only indicative. Our approach to building the evidence base is set out in Figure 1.1.

- In developing this analysis, we convened an Expert Advisory Group to support and critically evaluate our analysis (Box 1.1).
- To assess the proportion of UK workers likely to be impacted by the Net Zero transition, rather than taking a narrow definition of a 'green job', we used our Sixth Carbon Budget Balanced pathway to identify key sectors that are likely to Grow, Phase Down, Redirect or Adjust in the Net Zero transition. We then considered the proportion of workers currently in each of these sectors. This approach has methodological limitations, in particular due to its grounding in current workforce size.
- We also summarise estimates from published literature on the potential future job gains and losses from Net Zero. As these are based on a limited evidence base, and are dependent on policy action, these should be treated as indicative and not the CCC's own estimates.

An Expert Advisory Group helped inform the analysis in this brief.

Box 1.1
Expert Advisory Group on Workers and Skills

To inform this brief, the CCC convened an Expert Advisory Group on workers and skills to support and critically evaluate our analysis of the impacts of Net Zero on workers and skills needs in the UK. Members of the group have expertise across labour markets, green jobs, education and skills, and also on specific sectors (i.e. construction and retrofit, renewables, oil and gas, land use and agriculture, surface transport, manufacturing). They are representatives from academia, think tanks and business (including trade bodies and unions).

Several members of the CCC's Expert Advisory Group were also part of the Government's Green Jobs Taskforce (Box 2.1), allowing us to build on the work started by that group rather than replicate it. The group will continue to provide advice to the CCC on skills policy into 2023, with a report written by the chair, Professor Dave Reay, with contributions from the wider group, published in mid-2023. The group's Terms of Reference have been published alongside this brief.

Notes: Expert Advisory Group members: Professor Dave Reay* (Chair & University of Edinburgh), Julia Barrett (Willmot Dixon), Dustin Benton (Green Alliance), Sue Ferns* (Prospect), Yvonne Kelly* (Barking and Dagenham College), Professor Stephen Machin (London School of Economics), Anna Markova and Mika Minio (Trade Union Congress), Nick Molho* (Aldersgate Group), Mary Thorogood (Net Zero Technology Centre).

* Member of the Government's Green Jobs Taskforce.

Government can draw on this analysis and other evidence to inform the Net Zero and Nature Workforce Action Plan.

The evidence set out in this brief has been gathered with the intention to inform a Net Zero Skills Action Plan and identify where further policy responses are needed. The Government should do this as part of the Net Zero and Nature Workforce Action Plan due at the beginning of 2024.

This brief has chapters covering the expected scale and nature of employment impacts of Net Zero, the labour market context and next steps.

The rest of this brief is set out in four chapters and an accompanying Annex:

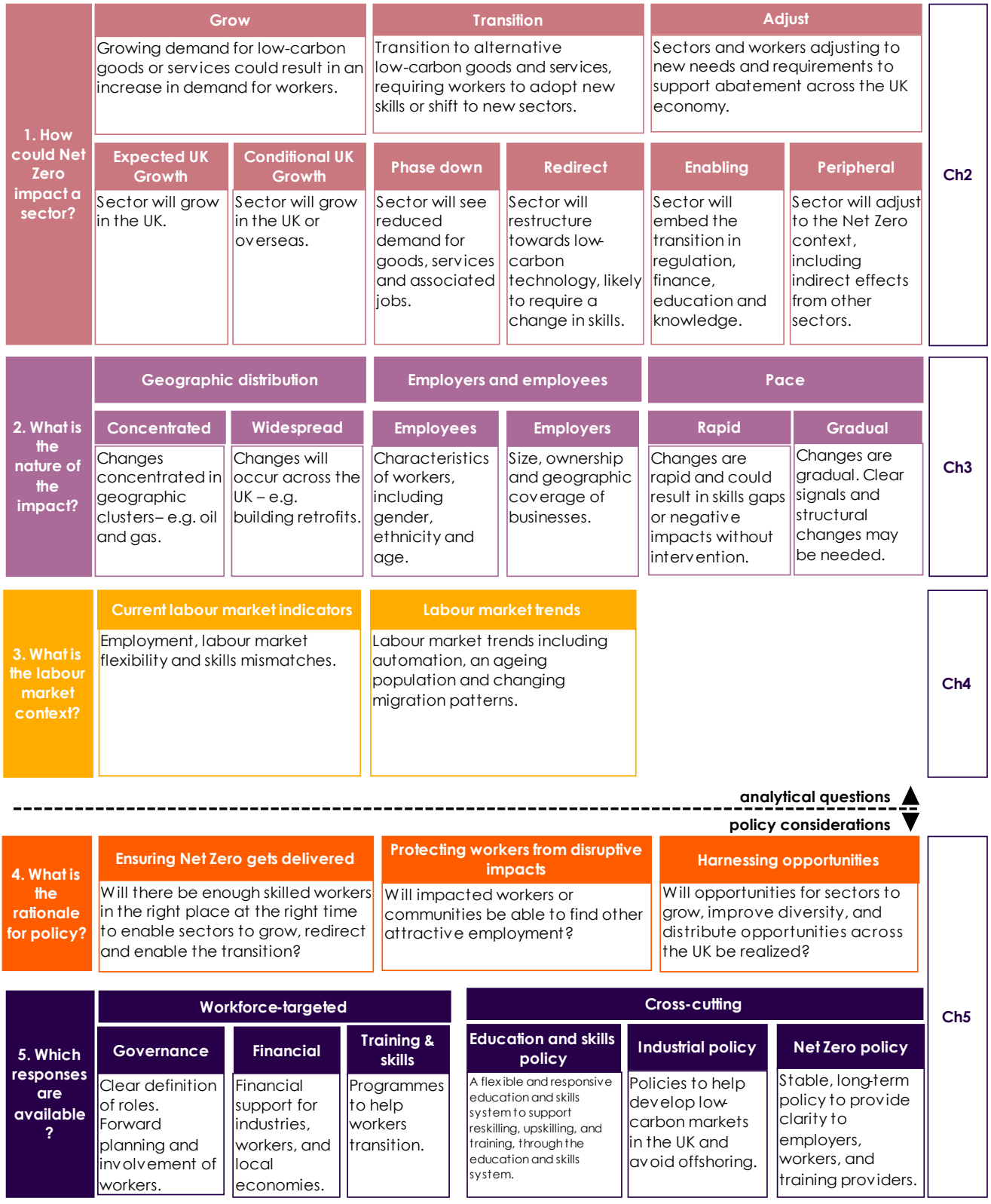
- **Chapter 2 – Employment impacts of Net Zero: type and scale**. We assess the different roles sectors of the economy will play in Net Zero, considering the expected scale of shifts in sector size and employment.

- **Chapter 3 – Employment impacts of Net Zero: distribution and pace.** We review other transitions and identify several factors that affect the impact of a transition for the workforce. Based on these factors, we assess the expected pace of change, geography, and workforce characteristics associated with each sector in the Net Zero transition.

- **Chapter 4 – Labour market context.** We consider future trends that could interact with Net Zero such as automation, digitisation and an aging population, and summarise the labour market context in which the Net Zero transition will take place, considering current employment, wages and labour market composition.

- **Chapter 5 – Conclusions and next steps.** We outline how Government can use this evidence to identify the key risks and opportunities of the Net Zero labour market, to inform a Net Zero Skills Action Plan and priorities for a policy response. We also note key next steps for business and the CCC.

Figure 1.1 Analytical framework for policy considerations



Chapter 2

Employment impacts of Net Zero: Type and scale

In this Chapter we identify the most relevant sectors of the transition to Net Zero and assess how each sector is likely to change.

In this Chapter, we explore the type and scale of impacts of the transition to Net Zero on employment, assessing:

- What are the most relevant sectors for the transition, and how will they be affected?
- What is the potential scale of changes to future employment in different sectors?

Around two fifths of workers are employed in a sector with a Core or Enabling role to play in Net Zero.

Several key messages emerge from our analysis:

- The Net Zero transition has already started, and progress made towards Net Zero has created around 250,000 jobs in the low-carbon and renewable energy economy sectors. However, this is a narrow definition of a 'green job' as most sectors and workers will have some role to play in the Net Zero transition. Instead of estimating green jobs, we focus our analysis on the different impacts Net Zero will have on sectors and their workers.
- The transition to Net Zero cuts across the whole economy and will therefore affect the entire UK workforce to some extent, but the degree to which workers will be affected will vary significantly across sectors.
- The majority of workers will not see major impacts. Only around a fifth of workers will see the largest impacts – those that are currently employed in sectors that will have a Core role in delivering Net Zero.
- We find that around 40% of workers are employed in sectors with a Core or Enabling role to play in delivering Net Zero. The remaining workers are in sectors that will still need to make important shifts, but these will be less direct and will be in the context of a work environment that will progressively adjust to Net Zero.

While there are limited estimates of potential job gains or losses, Net Zero could result in more job creation than job losses.

- There are currently limited estimates of potential job losses and gains, but those available indicate that Net Zero could result in more job creation than job losses with potential for 135,000 to 725,000 net new jobs, including job losses of around 8,000 to 75,000 workers from sectors that will likely Phase Down or Redirect.* While employment growth in a particular sector can bring benefits to regions and workers, if the labour market is tight and skilled workers are taken away from other productive sectors, it carries an opportunity cost.

The rest of this Chapter is set out in three sections:

1. Net Zero employment today
2. The pathway to Net Zero
3. The type and scale of Net Zero impacts on the workforce

* While the range for job creation we present is net job creation (so factors in potential job losses), the range of potential job losses we present are potential gross job losses. We show a wide range: there is much uncertainty in these estimates and there are different ways to calculate changes in job numbers.

1. Net Zero employment today

The transition to Net Zero has already begun. UK emissions have fallen by nearly 50% since 1990, with progress to date coming from the power and manufacturing sectors.

There are 247,000 people employed in LCREE sectors today.

The shift to a lower-carbon energy supply has led to 'green' jobs, which ONS has estimated as being at around a quarter of a million since 2015.

- The Office for National Statistics (ONS) estimates that 247,400 people are employed in the Low Carbon and Renewable Energy Economy (LCREE) sectors in the UK,[1] a relatively stable number since estimates started in 2015 (Figure 2.1).
- LCREE jobs represent less than 1% of all UK jobs. That share is highest in the energy sector at 11%, followed by the manufacturing and construction sectors at 3% and 4% respectively.

Jobs outside of the LCREE sectors should also be considered relevant to Net Zero.

While estimates of LCREE jobs have helped track low-carbon employment to date, the definition is narrow, as jobs outside of the LCREE sectors could also be considered 'green'. There is no agreed definition of what a 'green' job consists of.

- LCREE estimates only account for the energy and renewable sectors such as offshore wind, nuclear or energy-efficient lighting. This leaves out other sectors such as land use, which also have an important role to play in the Net Zero transition.
- The Green Jobs Taskforce defined green jobs as 'employment in an activity that directly contributes to – or indirectly supports – the achievement of the UK's Net Zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks'.[2]
- The ONS recently published a definition of green jobs as 'employment in an activity that contributes to protecting or restoring the environment, including those that mitigate or adapt to climate change.[3] It plans to publish experimental statistics on green jobs in 2023, building on the LCREE employment estimates.[4]

Rather than defining a 'green' job, in this brief we consider each of the sectors impacted by Net Zero.

In our analysis, rather than defining a 'green' job, we consider the different ways all sectors of the economy will be impacted by Net Zero.

- We do not seek to define or identify 'green' jobs as we accept the Green Jobs Taskforce's conclusion that 'every job has the potential to become 'green' as the world moves to combat climate change' (Box 2.1).
- The approach we have taken in this brief aims to navigate the definitional challenges by examining the potential impacts of Net Zero (both positive and negative) on all sectors of the UK economy.

Although there is not robust data, it is unlikely there have been significant job losses as a result of decarbonisation in the UK.

There is not robust data on whether significant job losses have resulted from the UK's decarbonisation to date. However, this is unlikely to be the case, as most decarbonisation has occurred in sectors where employment declined for other reasons.

- Decarbonisation to date has in large part come from decarbonising the energy system.

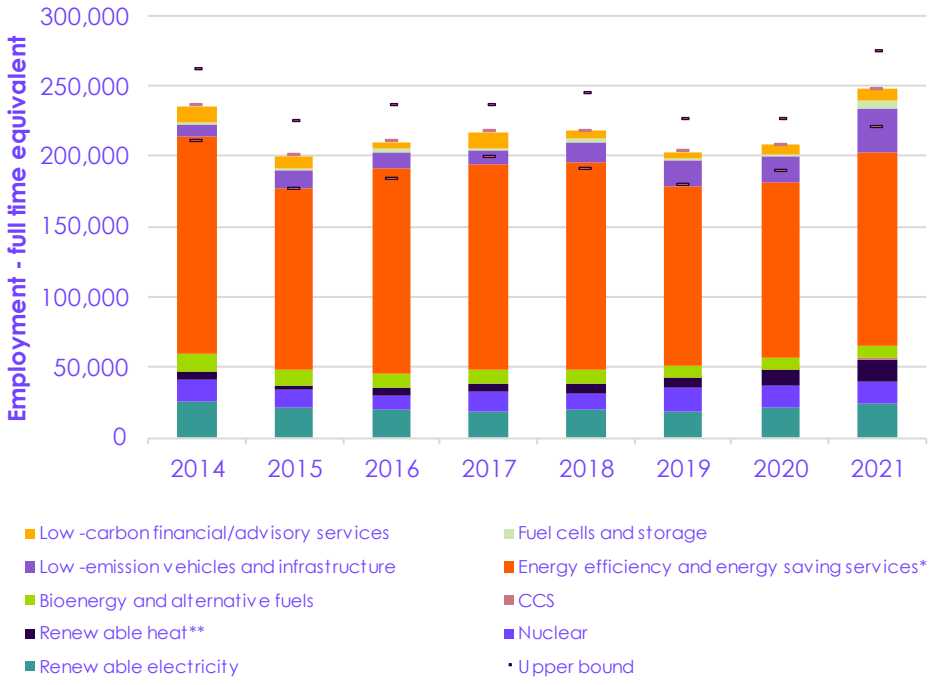
- Declining coal employment has been largely driven by the growing competitiveness of natural gas and renewables. The downturn in employment in oil and gas sectors was largely driven by volatile oil prices that reduced oil and gas output rather than climate ambitions.[5]

In our Fifth Carbon Budget advice we found no risk of a loss of competitiveness to UK industry as a result of decarbonisation.[6] While the direct impacts of carbon policy have been largely mitigated, the UK Government's decision to raise electricity costs to cover the costs of renewables may, in principle, have contributed to job losses by raising energy costs to businesses. However, these rising costs can be avoided by shifting policy costs off energy or by creating more far-reaching exemptions for businesses, as has been the case in other European countries. In addition, energy prices have not been the only cause of industrial decline with increasing international competition playing a pivotal role.

Our analysis considers changes to employment relative to 2019.

In our analysis, we assume that changes to employment are relative to employment in 2019. This means we do not take into account any impacts on employment that may result from the UK's decarbonisation to date.

Figure 2.1 Low Carbon and Renewable Energy Economy (LCREE) employment



Source: ONS (2023) *Low carbon and renewable energy economy, UK: 2021.*
Notes: *Includes lighting, products and energy monitoring and saving services. The figures collected by the ONS are survey-based estimates and gather information from a sample rather than the whole population. Confidence intervals are included to account for uncertainty; **Includes combined heat and power.

The Green Jobs Taskforce produced a report recommending how the UK can support a green industrial revolution and workers in high-carbon sectors.

Box 2.1
Green Jobs Taskforce

The Green Jobs Taskforce was convened by the Department for Business, Energy and Industrial Strategy and the Department for Education in 2021 with the aim to advise the Government, industry and skills sector on how to deliver green jobs in the UK.

The Taskforce developed a report which made 15 recommendations emphasising the need to deliver skills to both recover from the COVID-19 pandemic and meet the UK's climate targets, all the while providing high-quality green jobs and supporting the reskilling of workers in high emitting sectors. The report stated that:

- Clear signals are needed from the UK Government on market demand for low-carbon goods and services in order to inspire confidence in the need to unlock investment from businesses. This included a call for the publication of a Net Zero Strategy, which the Government met in 2021. The Taskforce also recommended a UK-wide body supported by local transition organisations be developed to coordinate and implement effective place-based strategies.
- Creating sustainable high-quality jobs will require all levels of education and training provision to embed Net Zero and deliver the skills and knowledge needed for green jobs. The UK Government needs to map, review, and enhance training pathways to support an inclusive and diverse workforce that is aligned to Net Zero commitments.
- Support for workers in high-carbon sectors is necessary for a just transition. Employers and sector bodies should develop business and skills plans for Net Zero. The adult skills system will also need to respond to local demand, removing barriers to retraining and upskilling. Where necessary, the Government, employers and workers will need to work together to directly support communities in diversifying their local economies.

Following the publication of Taskforce's report in November 2021 a Green Jobs Delivery Group was launched to facilitate coordination between the Government, industry and other key stakeholders and to ensure the UK has a skilled workforce to deliver Net Zero.

Source: Green Jobs Taskforce (2021) *Report to Government, Industry, and the Skills Sector.*

2. The pathway to Net Zero

There is a clear path to Net Zero, set out in our Sixth Carbon Budget report and the UK Government's Net Zero Strategy.

The UK's path to Net Zero is clear. In the majority of sectors, we know the detailed steps to ensure we meet our climate objectives.

In the CCC's Sixth Carbon Budget advice, we set out a pathway to Net Zero by 2050 based on a balanced combination of measures that can credibly reduce emissions across the economy – the 'Balanced Net Zero Pathway' (Figure 2.2).[7]

The UK Government's vision for a low-carbon economy, set out in its Net Zero Strategy in 2021, included overall and sectoral ambitions that have many similarities with our scenarios including: prioritisation of known technologies, improvements in efficiency, electrification as the backbone of the transition with hydrogen supplementing efforts and transformational changes in the UK's land use.[8]

There is general consensus that the route to Net Zero will include reduced demand, adoption of low-carbon technologies, a shift to low-carbon energy and offsetting residual emissions.

Many other organisations have undertaken scenario and pathway analysis for the UK and abroad, and while different analyses may result in a different mix of technologies, demand reduction and land use assumptions, most agree that Net Zero will require:

- **Reduced demand and improved efficiency.** This means reducing demand for goods and services that generate greenhouse gas emissions and making more efficient use of energy and resources. Our Balanced Pathway limits growth in flights and reduces car miles, sees millions of energy efficiency upgrades in homes and businesses, and includes improvements to industrial energy efficiency.

- **Adopting low-carbon technologies.** This includes transitioning to electric cars and heat pumps for households and hydrogen and carbon capture and storage for industry. Electrification makes the largest contribution as it is generally the most efficient and lowest-cost option. Where electrification is not possible or prohibitively expensive (e.g. in some industrial processes), alternatives such as low-carbon hydrogen can be used.

- **Low-carbon energy supplies.** We will need to greatly expand our domestic supplies of low-carbon electricity (largely from offshore wind but also from other renewables and nuclear) and low-carbon hydrogen (itself potentially produced from electricity). This is necessary in order to decarbonise existing generation and also accommodate increasing demand (e.g. to power electric vehicles and heat pumps). Low-carbon electricity generation doubles by 2050 in the Balanced Pathway.

- **Offsetting residual emissions.** Some sources of emissions, in particular from agriculture and aviation, cannot be fully eliminated and need to be balanced by actively removing CO_2 from the atmosphere. This happens in the Balanced Pathway by preserving and expanding our tree cover, restoring our peatlands to return them to carbon sinks and planting energy crops that can be used with carbon capture and storage to permanently bury emissions. Freeing up land for these uses is necessary. There is also the potential for some limited direct air capture of CO_2.

We use CCC's Balanced Pathway to Net Zero to identify the changes that will be required to different sectors of the economy.

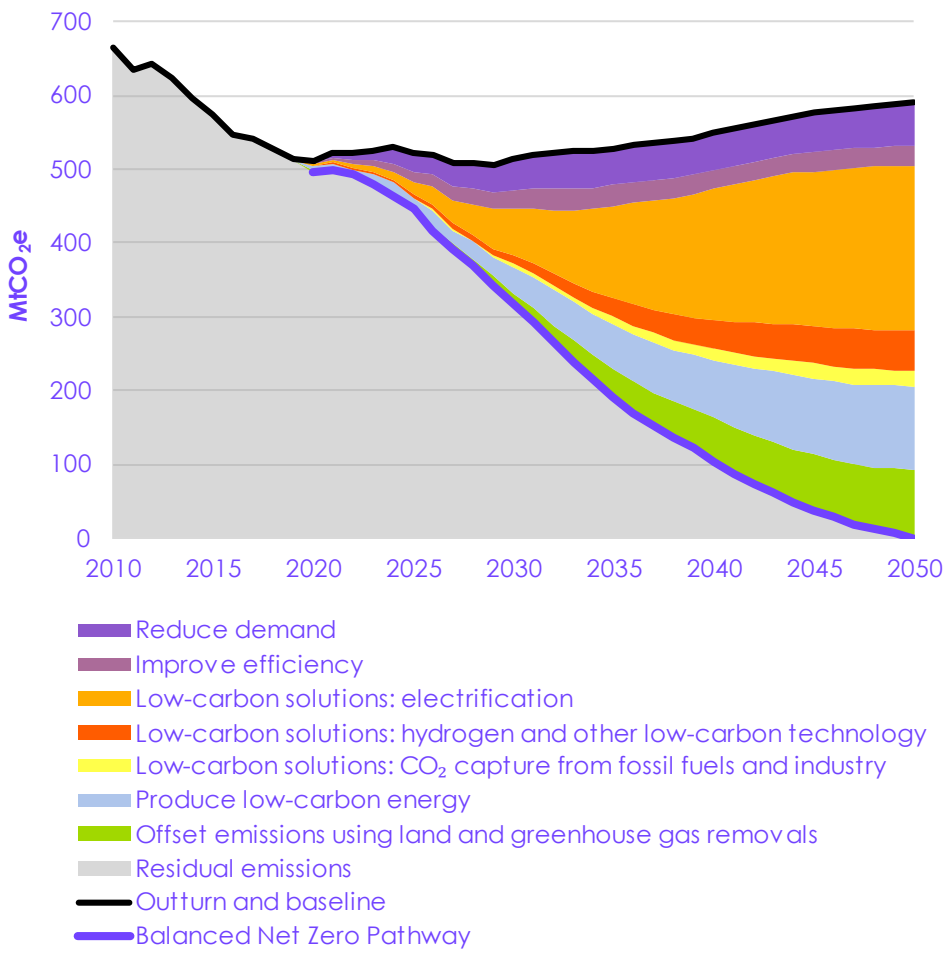
The CCC's Balanced Net Zero Pathway is our starting point to assess the impacts of the transition for the workforce, as the pathway lays out the technological and behavioural changes that must occur in each sector to deliver emissions reductions. These changes inform the pace, scale and nature of the Net Zero transition in each sector, and consequently shape the role and experience of workers employed in each sector.

Where our analysis encounters limitations, which we set out in Box 2.2, we have drawn from external research. This additional evidence helps inform our conclusions of the impacts of Net Zero on employment.

While this brief focuses on the impacts of action to mitigate against the worst effects of climate change as we transition to a Net Zero economy, workers and businesses are also likely to experience the direct impacts of climate change and hazards, including loss of productivity from exposure to more extreme temperatures. We explore these issues briefly in Box 2.3.

Our Sixth Carbon Budget report sets out a pathway to Net Zero, highlighting the role of reduction in demand, adoption of low-carbon technology, low-carbon energy and emissions removals.

Figure 2.2 Types of emissions reductions in the CCC's Balanced Net Zero Pathway



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019*; CCC analysis.
Notes: 'Other low-carbon technology' includes use of bioenergy and waste treatment measures. 'Producing low-carbo energy' requires the use of carbon capture and storage (CCS) in electricity generation.

We used the CCC's Sixth Carbon Budget's Balanced Net Zero Pathway as the basis for our analysis, supplementing this with external literature. There are important limitations to this approach.

Box 2.2
Analytical methodology and limitations

The Annex provides a detailed description of the methodology that was used to assess the impacts of Net Zero on workers. Our approach comes with limitations that should be taken into account when considering the conclusions of the analysis.

Identifying sectors affected by the Net Zero transition based on the CCC's Balanced Pathway. We identified each UK economic sector based on a review of all Standard Industrial Classification codes. At this level of disaggregation, we considered the number of workers employed in each sector before the COVID-19 pandemic in 2019 and the sectoral contribution to UK emissions. We used the Balanced Net Zero Pathway from the CCC's Sixth Carbon Budget analysis as the basis for identifying the labour impacts of Net Zero and the pathway to decarbonisation for each sector.

This approach has multiple advantages:

- We developed an analysis that extends to the whole economy, while maintaining a detailed understanding of the drivers for emissions reductions in each sector.
- Our Sixth Carbon Budget analysis combines a wide range of abatement measures in the 2020s that keep options open for subsequent deployment in the 2030s. This results in a mix of demand-side action, electrification, hydrogen and natural and engineered greenhouse gas removals that allow us to assess various potential impacts of Net Zero for the workforce.
- The pace of the transition to Net Zero is not uniform across sectors. The analysis from the Sixth Carbon Budget provides a detailed pathway from 2020 to 2050 for each sector, which accounts for the level of maturity of decarbonisation options, the policy frameworks in place, and sector specific dynamics, such as supply chain constraints, infrastructure requirements, and the rate of behaviour change. From these sectoral pathways, we are able to infer the pace of the transition for workers.

At the same time, there are limitations to our approach:

- Our assessment does not consider the impacts of Net Zero on occupations within each sector. For example, the offshore wind industry could see growing demand for engineers while maintaining demand for corporate workers. At the same time, demand for corporate workers could be growing in proportion to the size of the sector. It remains highly uncertain how Net Zero will impact different workers within each sector. The methodology we have used means that our analysis will tend to overestimate the number of people affected by the transition.
- The analysis does not provide a forecast of the impact of the Net Zero transition on future employment, rather a snapshot of current employment in sectors likely to be impacted.
- Our analysis is based on a qualitative assessment that allocates economic sectors into categories of Net Zero impacts, which can be challenging. Identifying these impacts, defining them, and carrying out the allocation involved an iterative process with experts, allowing us to distil the factors driving changes for workers. Given the uncertainty of some of these impacts we relied on the judgement of our Expert Advisory Group (Box 1.1).

Estimating Net Zero employment impacts based on published external evidence. To allow us to estimate future Net Zero employment impacts, we undertook a review of the published evidence in this space and collated the range of employment impacts found. In collating estimates of changes in employment we only considered direct employment, to avoid double-counting indirect jobs from multiple sectors (Figure 2.5).

However, we encountered multiple challenges with this approach:

- Our assessment is not based on a comprehensive literature review. We focused on publications which covered the sectors identified as most likely to be affected by Net Zero, based on changes occurring in our Balanced Pathway (as described above). We were unable to find figures for some of these sectors, such as vehicle maintenance. We have also not actively searched for estimates on some of the smaller emitting sectors such as F-gases, waste and shipping. We have also not

included how deeper transformations to the economy, such as the creation of a circular economy could affect workers.

- Not all estimates were produced with Net Zero in mind. Certain studies were based on the UK's previous emissions reduction target, of reducing emissions by 80% by 2050, relative to 1990. Where possible, we adjusted the estimate number of jobs by the same degree of difference between deployment assumptions within the study and within our Sixth Carbon Budget pathway.
- Details of the methodologies to estimate jobs created or lost due to the transition to Net Zero are sometimes vague and methodological approaches are not always consistent. While we focused on estimates in the literature that we could assess with more transparency, there remains uncertainty on the extent to which all estimates are comparable. The distinction between sustained and short-term employment is particularly challenging. For these reasons the external potential range of job losses and gains presented should be taken as indicative and not official CCC estimates.

Climate change will impact on workers through extreme heat affecting working conditions, and businesses being affected by extreme weather events.

Box 2.3
The impact of climate change on workers and businesses

The Intergovernmental Panel on Climate Change (IPCC) has already warned of the impacts that climate change, and particularly increased heat, will have on workers as the number of days with 'climatically stressful conditions' will increase across the globe.

The CCC's Independent Assessment of UK Climate Risk has also previously identified areas of concern for UK workers and businesses:

Workers' health and productivity. Extreme heat can expose workers to heat stress, heat exhaustion, heat stroke and even fatality, which would contribute to heat-related excess mortality in the UK.

- Outdoor workers are likely to be most exposed to high temperatures. These are workers that tend to be low-skilled and low-waged in industries like agriculture or construction and manufacturing industries.
- Indoor workers who are not in a temperature-controlled environment could also suffer from overheating. That includes employees that work from home, which represent 31% of UK workers.
- Employees with existing health conditions will be more vulnerable during extreme heat events.
- The impact of extreme heat on workers is very likely to affect employee productivity, which is defined as output per worker, per job and per hour. These health-related impacts on workers could in turn prevent workers from working, or working effectively.

Business impacts. Extreme weather will impact businesses across the UK, both directly and indirectly through their supply chains and reliance on infrastructure. These impacts could in turn affect workers that depend on businesses for their earnings.

- Businesses are at risk from flooding, coastal erosion, extreme weather and water scarcity. Present day expected annual damages to non-residential properties across the UK from flooding averages around £670 million.
- Extreme weather can cause disruption to infrastructure, having a further impact on businesses. A survey showed that disruptions to infrastructure caused by extreme climate events could prevent workers to access work sites and thus increase costs for businesses. Employees that live furthest away from their workplaces, such as in the renewable energy and services sectors are likely to be most affected.
- Given the criticality of power supply for most businesses, extreme weather affecting energy infrastructure can have widespread implications for business operations and cause cascading impacts across other crucial networks including transport, telecommunications and ICT. Telecommunications and ICT outages can lead to reduced capacity across a wide range of business services, and will increasingly do so as more and more business functions become digitalised.
- Businesses will also be at risk from disruption to domestic and international supply chains. Some supply chains may be at higher risk due to more vulnerable logistics or production processes. These risks are summarised in the CCC's Resilient Supply Chains brief.

Source: IPCC (2022) *Climate Change 2022: Impacts, Adaptation and Vulnerability*; CCC (2021) *Independent Assessment of UK Climate Risk;* ILO (2019) *Working on a warmer planet: The effect of heat stress on productivity and decent work;* ONS (2022) *Homeworking in the UK – regional patterns: 2019 to 2022;* LSE (2020) *LSE Climate Risk Business Survey – synopsis;* CCC (2022) *Just transition and climate change adaptation,* CCC (2022) *Resilient supply chains.*

(a) Types of Net Zero impacts

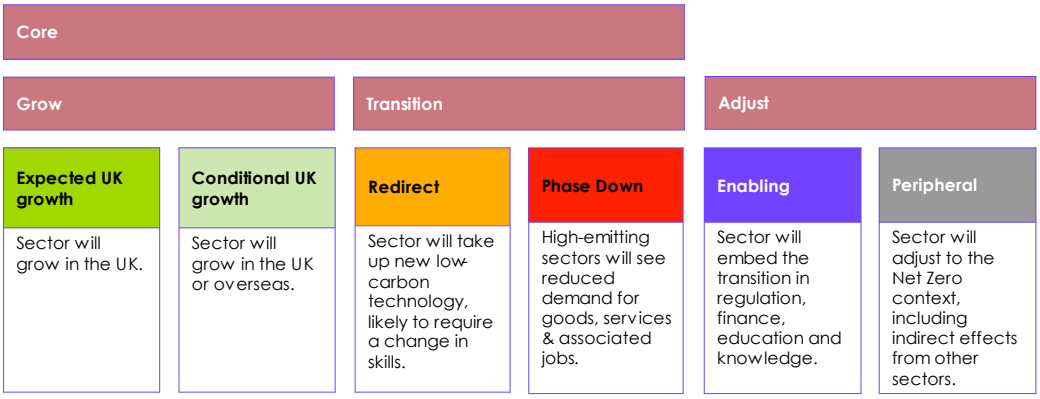
We have grouped the UK's economic sectors into six categories, based on how the CCC's Balanced Pathway would affect sector demand and employment.

As set out above, the transition to Net Zero will require fundamental shifts in our economy across every sector of the UK economy. It will result in growing demand for certain goods and services and shrinking demand for others. It will also require means of production to change so that all goods are produced in a low-carbon way. This will result in a range of impacts on the total demand for labour, the occupations of that labour force, and the types of skills they require.

For each of the UK's economic sectors, we have assessed the changes resulting from the uptake of decarbonisation options in the Balanced Pathway which could in turn affect sector employment. We consider three high-level categories of impact and assign one to each sector: Grow, Transition and Adjust. Each of these three impact categories is further divided into two types of impacts, as described in Figure 2.3. We refer to Grow and Transition sectors as Core sectors, given their central role in the Net Zero transition.

We assign each sector to one of six categories: Expected UK Growth, Conditional UK Growth, Phase Down, Redirect, Enabling and Peripheral.

Figure 2.3 Definition of Net Zero impacts



Source: CCC analysis.

Our approach to allocating economic sectors into the categories above was largely qualitative and based on four key factors: 1) the sector's contribution to emissions and emissions reductions; 2) the availability of low-carbon alternatives and need for demand reduction in the sector; 3) whether the goods and services in the sector can be imported; and 4) whether the sector has an indirect role in delivering Net Zero. Box 2.2 and the Annex to this brief lay out our methodology in further detail.

A fifth of the workforce are employed in sectors that will have a Core role to play in delivering Net Zero, rising to two fifths if we include sectors with an Enabling role.

Figure 2.4 shows the share of workers currently employed within each category of impact. We find that a fifth of the workforce is currently employed in sectors that will have a Core role to play in delivering Net Zero by either directly or indirectly contributing to emissions reductions – this includes all workers currently employed in Grow and Transition sectors. If we include Enabling sectors, this rises to around two fifths of the workforce.

Over 10% of the workforce is employed in a sector expected to see demand growth, including heat pump installation and battery manufacturing.

- **Grow.** These are sectors that will see growing demand for their goods or services, which could result in an increase in demand for workers. Over 10% of the current workforce is employed in sectors that are expected to see demand growth. These figures only tell us how many workers are currently employed in sectors with potential for growth and not how much employment in these sectors could grow by. We explore this further through additional analysis in section (b). Within Grow sectors there is the potential for:

  - **Expected UK Growth.** Sector and employment growth are expected to happen in the UK. This mostly relates to services that cannot be imported. Examples of this include workers providing services that contribute to Net Zero such as heat pump installers and bus drivers. Around 9% of workers are currently employed in these sectors.

  - **Conditional UK Growth.** Markets for low-carbon products will grow, but goods and services could be imported, so sector and employment growth may occur abroad. National sector growth and job creation will depend on building a comparative advantage and capturing opportunities for domestic economic activity. Examples of this include battery and heat pump manufacturing. Around 3% of current workers are employed in these sectors.

Around 7% of the workforce is employed in sectors which will need to transition, including vehicles manufacturing and oil and gas extraction.

- **Transition.** These sectors will need to transition to low-carbon goods and services or different means of production, which will require workers to adopt new skills within their sector or shift towards new sectors. Around 7%* of workers are employed in these sectors. Although these numbers suggest a relatively small aggregate impact, employment in these sectors is often geographically concentrated, so although this is a small proportion of the total UK workforce, it could represent a significant proportion of employment in certain areas. We explore this further in Chapter 3. Within Transition sectors, we further differentiate between:

  - **Redirect.** A restructure of the sector is needed to shift towards low-carbon goods and services and accommodate low-carbon means of production, which could require a change in workers' roles without necessarily shifting to a new sector. Examples of this are vehicle manufacturing, which will need to shift production away from combustion vehicles, towards electric vehicles. Other examples are in cement and steel, where the end product remains the same, but will need to be produced using low-carbon methods, potentially requiring new or additional skills from workers. Those working in livestock agriculture will need to shift the farming and land use management they undertake to increase carbon sequestration and reduce emissions.† About 7% of the workforce is currently employed in these sectors.

  - **Phase Down.** These are high-emitting sectors where decarbonisation requires reducing demand for their goods and services, as well as decarbonising production processes and end-products. In practice these sectors will need to redirect their production, as well as reducing

* The share of currently employed workers in Phase Down and Redirect sectors combined adds up to 7% due to rounding.

† Livestock agriculture is considered a Redirect sector as it is likely that those currently working in livestock agriculture will experience a change in the nature of their work, incorporating reduced herd sizes and reduced-carbon farming. However, it remains possible that the sector will experience job losses, depending how the shift in land use is achieved.

it. Examples of this include oil and gas, where extraction will need to decline, and businesses will need to move into activities consistent with Net Zero, such as offshore wind or carbon capture and storage. Less than 1% of the current workforce is employed in these sectors. Some, but not all, of these workers will have to transition into other sectors as demand for the goods and services produced decline.

- **Adjust.** Sectors where the Net Zero transition will bring about less fundamental change but will still require workers to adjust to a new set of economic and regulatory conditions or provide support to emissions reductions. The majority of the current workforce (81%) is employed in these sectors. Some of these will have a more direct role to play in delivering Net Zero than others:

  – **Enabling.** Sectors that will support the transition by embedding changes aligned with Net Zero to regulation, finance, and knowledge in businesses and society. These include workers in finance or education that could indirectly support emissions reductions. Around 20% of the current workforce is employed in these sectors.

  – **Peripheral.** These are sectors where significant, direct impacts are not expected, but there may still be a need to adjust, for example to changes in regulation, or to indirect effects from other sectors. For example, postal workers could drive electric mail vans, and doctors might prescribe non-F-gas inhalers. While their occupation and skills are likely to remain the same, the context within which they operate will have aligned to Net Zero. Businesses might need to support workers embedding Net Zero into their operations. Around 60% of the UK workforce is currently employed in these sectors.

Around 20% of the current workforce are in sectors that will help embed change to regulation, finance and knowledge.

Around 60% of the population are currently employed in peripheral sectors.

Table 2.1 provides a high-level summary of the key sectors under each category of Net Zero impact. It excludes Peripheral sectors, which, as set out above, will have a less direct role to play and face less fundamental change to their employment or skills needs.

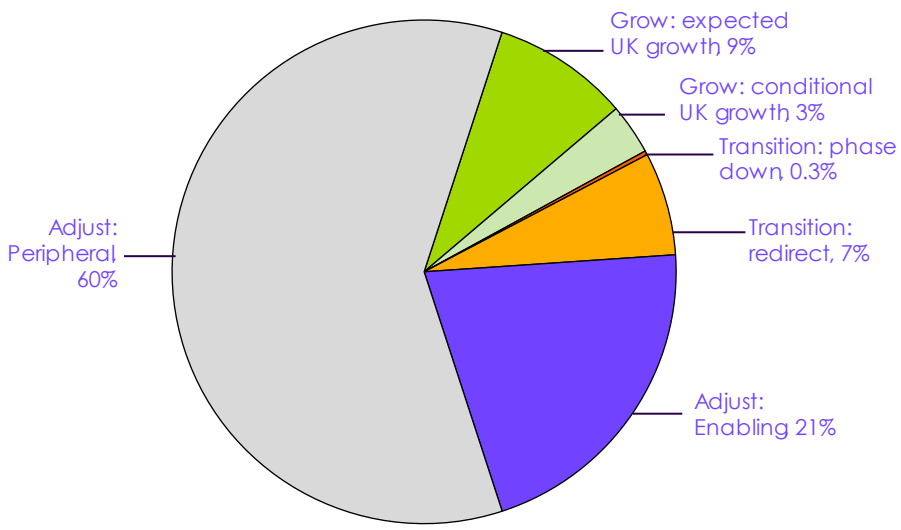
Table 2.1
Economic sectors by category of Net Zero impact

Sectors	Grow		Transition		Adjust
	Expected UK Growth	Conditional UK Growth	Phase Down	Redirect	Enabling
Agriculture and land use	Forestry, silviculture, and logging Peatland restoration	Agriculture (non-livestock)		Livestock and mixed agriculture Meat and dairy processing	
Built environment	Building construction and retrofit Building construction infrastructure and finishing			Manufacture of central heating radiators and boilers	
Energy supply	Power generation, transmission & distribution	CCS infrastructure* Hydrogen supply*	Coal production Oil & gas production Refining	Gas distribution	
Manufacturing	Construction of industrial facilities			Energy-intensive industry (e.g. steel, cement, glass)	
Transport	Rail operation Construction of roads and railways	Battery manufacturing Vehicle manufacturing Sustainable aviation fuels*	Retail sale of automotive fuel	Aviation Shipping ICE vehicle manufacturing Vehicle maintenance Waste	
Services					Education services Legal and accounting services Financial and insurance activities Architectural and engineering activities and related technical consultancy

Notes: This is a high-level summary of how we allocated sectors against Net Zero impacts. Each sub-sector is composed of economic activities as defined in the Standard Industrial Classification. The table shows the dominant impact for each sub-sector. At a more disaggregated level, a sub-sector can spread across multiple categories of Net Zero impacts. A more detailed breakdown of how we allocated sub-sectors to Net Zero impacts is provided in the Annex. *Sectors that do not currently have a unique Standard Industrial Classification as they depend on the development or scaling of new economic activities within the UK.

Over 10% of the current workforce is in a sector expected to grow whereas less than 1% of the workforce is in a sector expected to phase down.

Figure 2.4 Share of currently employed workers by type of Net Zero impact



Source: ONS (2019) *Industry (two, three and five-digit Standard Industrial Classification) – Business Register and Employment Survey (BRES): Table 2*; CCC analysis.

(b) Range of future employment estimates

Based on external research, we have summarised the expected potential impacts of the Net Zero transition on different sectors and sub-sectors.

In this section, we consider the Core sectors identified above in more depth. As the analysis set out in the previous section only provides numbers for *current* employment within each sector and category of impact, we have reviewed estimates produced by other organisations on the potential for future job losses or gains brought about by decarbonisation in these sectors in future.

Government aims to further low-carbon employment to support 480,000 new jobs in the UK by 2030 through its Powering Up Britain plan and accompanying sectoral reports and policy proposals.[9]

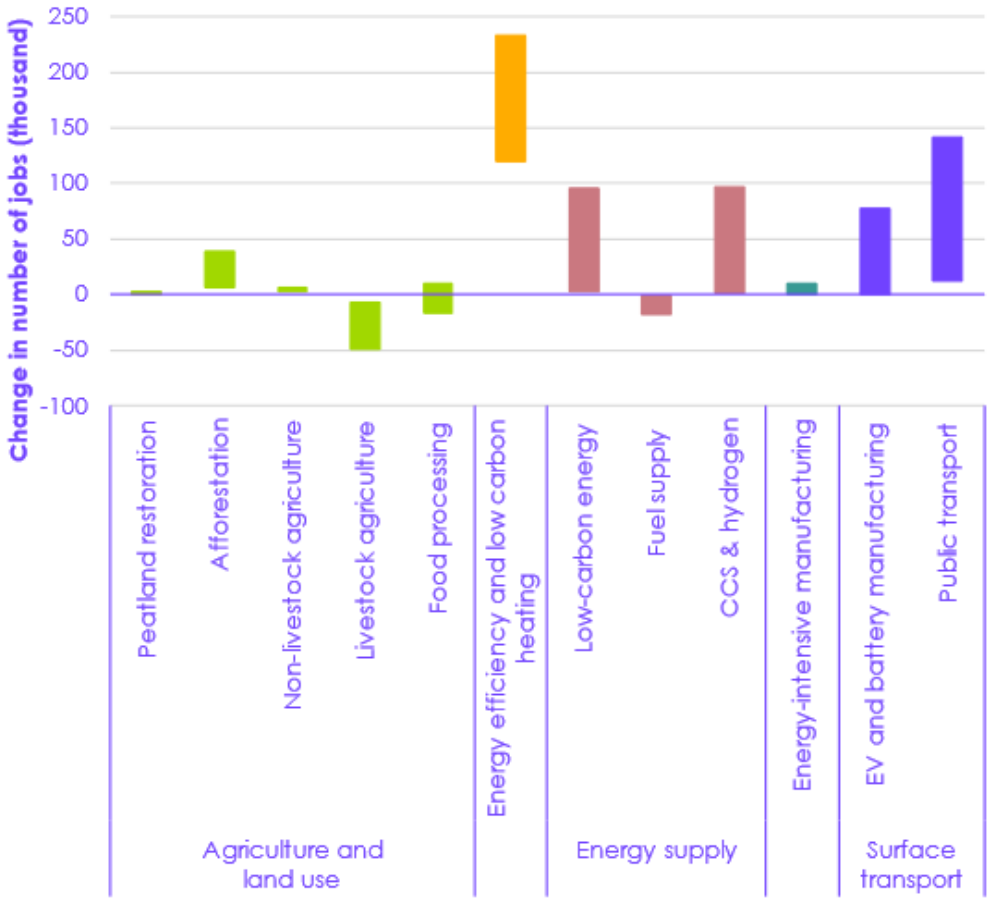
In reviewing the literature, we extracted estimates of job creation and losses from close to 30 reports, aggregated up and summarised in Figure 2.5. This assessment is not exhaustive of all sectors of the economy. In addition, in some cases, meeting the UK's climate commitments is contingent on the development of a Net Zero skilled workforce. In others, the potential for job creation will be determined by policy choices. For example, the development of a circular economy would benefit Net Zero, although this is not absolutely required to meet emissions targets. As such, we cannot draw conclusions on the total impact of Net Zero from the ranges we identify, which instead indicate the potential scale of change.

Finally, there were some sectors, such as vehicle maintenance, for which estimates on job creation or losses were not available. For these, we note factors which could influence the scale of job creation or losses.

Given the limitations, these are not official CCC estimates. We set out the methodology and limitations in more detail in the Annex and in Box 2.2.

External estimates for the impact on jobs are most significant for energy efficiency and low-carbon heating, low-carbon energy, public transport, EV manufacturing and CCS & hydrogen.

Figure 2.5 Range of estimates of direct employment impacts of decarbonisation by 2030



Source: CCC analysis based on literature review.[10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37]
Notes: This analysis looked across close to 30 reports. While these estimates consider Net Zero impacts across a wide range of sectors, the assessment is not exhaustive so Net Zero impacts on certain sectors will not be included (e.g. impacts on vehicle maintenance). In addition, in combining external estimates for each sector we take a conservative approach, not summing estimates within sectors of job gains unless it is clear the additional jobs would be distinct. Areas where we do sum external estimates include new jobs linked to public buses and to trains, new jobs from energy efficiency and from low-carbon heating, and job losses in the oil and gas sector and in coal mining. In some cases, meeting the UK's climate commitments is contingent on the development of a Net Zero skilled workforce. In others, the potential for job creation will be determined by policy choices. For example, the development of a circular economy would benefit Net Zero and might impact on jobs, however this is not strictly necessary to meet our targets. As such, we cannot draw conclusions on the total impact of Net Zero from the ranges we identify, which instead indicate the potential scale of change. Due to these complexities the numbers in this chart do not align exactly to our headline range for potential net job creation and losses discussed in the report.

(i) Grow

The Net Zero transition should see a growth in sectors such as buildings construction and retrofit, forestry and peatland restoration and energy supply. Estimates of net new jobs range from 135,000 to 725,000.

The Net Zero transition could create 135,000 to 725,000 net new jobs.*

Expected UK Growth. Many of the potential new jobs could be seen in UK expected growth sectors such as buildings construction and retrofit, land use and energy supply.

- **Buildings construction and retrofit**. Demand for workers that can install low-carbon heating and carry out energy efficiency improvements is expected to increase substantially to decarbonise the UK's nearly 30 million existing buildings.

* While the range for job creation we present is net job creation (so factors in potential job losses), the range of potential job losses we present are potential gross job losses. We show a wide range: there is much uncertainty in these estimates and there are different ways to calculate changes in job numbers.

This sector could see the most job creation with between 120,000 - 230,000 new jobs by 2030, which would represent an increase of up to 11%in jobs in the sector relative to today. Attracting new workers and upskilling and retraining existing workers at the pace required could pose a challenge. We explore these impacts and risks in more detail in Box 2.4.

- **Forestry and peatland restoration**. Achieving the levels of tree-planting ambition in the CCC's Balanced Pathway could require between 6,600 and 39,000 new workers by 2030 in the UK, while peatland restoration could produce up to 560 and 2,200 additional jobs by 2030. Planting hedgerows could lead to 8,300 new jobs by 2030. It is possible that this work could instead be undertaken by people already employed in the agriculture and land use sectors, as Government plans under the Environmental Land Management Scheme aim to incentivise farmers to contribute to decarbonisation through measures such as afforestation.[38] There is much uncertainty in these estimates and considerable barriers to finding new workers for these sectors, which we explore in Box 2.5.

- **Energy supply**. With the doubling to trebling of domestic electricity supply needed to 2050, renewables and nuclear could create around 2,500 to 95,000 direct jobs by 2030.* These emerging industries could benefit from a pool of skilled workers from the oil and gas industry. A study has previously suggested that around 90% of oil and gas workers have skills that are transferable to the offshore, hydrogen and CCS industries.[39] However, with only 39,000 workers in the oil and gas industry today,[40] not all of whom can be expected to transition to low-carbon energy over the period of the transition, additional skilled workers are likely to be needed in these sub-sectors.

- **Electric vehicle infrastructure**. The installation of electric vehicle charging points in homes, businesses, and public spaces is likely to grow demand for trained electricians. While our assessment did not find any estimates for job creation, it is expected that over 300,000 public charging points will be needed by 2030 across the UK.[41]

The Net Zero transition could see a growth in sectors such as hydrogen, CCS, battery manufacturing and food processing, but this is conditional on these growth opportunities being captured domestically.

Conditional UK Growth. As set out in the previous section, in some sectors job creation is not guaranteed to happen in the UK despite growing demand for the goods and services in that sector, as it has the potential to occur abroad. The literature highlights a few sectors where this is particularly relevant, with the potential for job growth of up to 220,000 jobs by 2030 if these opportunities are captured in the UK. Currently the UK is missing out on some opportunities to grow low-carbon markets:

- **Hydrogen and CCS**. The development of a hydrogen and CCS economy in the UK could create 1,500 to 97,000 new jobs by 2030.† While some activity on hydrogen and CCS will have to occur in the UK, there are uncertainties over the UK's ability to become a centre for such activities. The UK is well placed to develop hydrogen and CCS clusters given its potential for CO_2 storage, its market for engineering design, project management, procurement and commissioning activities, and the potential transferability of skills from the oil and gas sector – making it fifth globally in its potential for production of hydrogen.[42]

* The wide range is driven by underlying assumptions about the technology mix and deployment levels. The lower bound represents jobs from the investment into 35 GW of onshore wind while the upper bound represents jobs associated with the generation from 130 GWh.

† This wide range is driven by the level of deployment. The upper range would require more than 20 GW of hydrogen capacity to be developed in less than a decade (more than twice the current Government target) while the lower range only assumes 7 GW of capacity.

However, low-carbon markets are likely also to develop abroad. Although there is likely to be some European cross-border trade in hydrogen and CO2 it is unclear precisely how this will play out. It is possible that the UK could end up relying on hydrogen imports and the export of CO_2 to be stored elsewhere. The competitiveness of international markets will in part determine the role for a UK hydrogen and CCS infrastructure, which is why investment, and the development of a skilled workforce is needed to secure these opportunities.

- **Electric vehicle and battery manufacturing**. Electric vehicle and battery manufacturing could create up to 80,000 to 100,000 jobs, including 20,000 jobs which could come from the development of ten battery gigafactories' in the UK.* Some of the literature suggests that if these gigafactories are not located in the UK, the Net Zero transition could instead result in jobs losses in the vehicle manufacturing sector. It is not yet clear whether the UK will gain a comparative advantage over other countries. The UK has taken steps to capture market shares, and some car manufacturers are investing in electric vehicle manufacturing in the UK. However, there have been challenges and there is a risk manufacturing will find more favourable conditions elsewhere. Subsidies in places such as the United States and the European Union (Box 2.6) are likely to attract investment and secure jobs outside of the UK.

- **Non-livestock agriculture and food processing.** A shift in diets away from emissions-intensive animal products could increase demand for non-livestock agricultural products. It could also grow demand for markets for non-meat-based proteins (Box 2.5), though these measures were not considered as part of the Sixth Carbon Budget analysis. Oxford Economics estimate that the transition could support 16,500 jobs in alternative proteins farming and factories across the UK by 2030. The National Food Strategy estimates that developing and manufacturing alternative proteins in the UK (rather than importing them) would create an estimated 6,500 jobs in farming. This will be dependent on the UK's ability to capture market shares.[43]

(ii) Transition

The Net Zero transition should see shifts in means of production in sectors such as vehicle maintenance and energy-intensive manufacturing. There is limited evidence on the impact on job numbers in these sectors.

Redirect. Outcomes for workers in these sectors will depend on the ability to transform means of production and adapt to low-carbon goods. We have not been able to find evidence on potential employment impacts in some of the sectors in this category, such as vehicle maintenance.

- **Energy-intensive manufacturing**. The manufacturing sector will need to undergo a deep transformation to reduce emissions through fuel switching (e.g. electrification, use of hydrogen), application of CCS and other measures. Without subsidies, this shift could increase costs that will put the competitiveness of UK industry and its associated jobs at risk by relocating production outside of the UK. Employment in energy-intensive manufacturing will therefore largely depend on the maintenance of competitiveness and policies that support that aim. The support of UK industry and its workforce and the decarbonisation of energy-intensive manufacturing could open new opportunities, creating up to 9,500 new jobs, most notably from export opportunities which are potentially larger than domestic business opportunities.[44] However, the introduction of the United States' Inflation Reduction Act and the EU's proposed Green Deal Industrial Plan have increased the risk to industry competitiveness.[45,46]

* External estimates of job creation vary in how much they distinguish between jobs created in EV versus battery manufacturing. For this reason, we present the upper bound as a range.

- **Vehicle maintenance**. Vehicle maintenance has provided stable employment levels for decades with 275,000 workers employed in the sector. Mechanics of internal combustion engine vehicles are likely to be affected by the take-up of electric cars as the difference in engine and transmission systems means mechanics will need a different set of skills. Electric vehicles also require less maintenance overall,[47] although this could be offset by an increase in projected car ownership in our pathways due to population growth - despite demand-side actions to limit projected car ownership growth.

An increase in land used for sequestration could involve a shift in the type of farming and land management which those currently in livestock farming engage in. Depending on how it is delivered, it could see a reduction in jobs.

- **Livestock farming**. An increase in land used for carbon sequestration, and a shift in UK diets to less meat and dairy, as set out in the Sixth Carbon Budget, will result in a change to the way our land is managed. The literature suggests that 7,000 to 42,000 jobs could be lost as a result. However, these studies do not consider the shift in practices that could come from the transition instead of the decline in jobs. While the transition could mean fewer farmers working exclusively on livestock farming, this may not result in an overall decline in the need for agricultural workers – rather a shift in the type of farming and land use management they undertake based on biophysical limitations. The Government's plans for Environment Land Management Schemes will redirect subsidies to support public goods, including carbon sequestration, potentially resulting in reduced herd sizes combined with more reduced-carbon farming (e.g. on-farm woodland creation and management), thus supporting new jobs. We explore the transition for these workers in more detail in Box 2.5.*

Sectors such as oil and gas production and coal mining will need to phase down, which estimates suggest could result in up to 17,000 workers no longer being employed in those sectors.

Phase Down. The reduction in demand for goods and services in high-emitting Phase Down sectors could lead to up to 17,000 workers no longer being employed in the sector. For fossil fuel supply, this shift is occurring in the context of an already shrinking sector. While these sectors will reduce in size, they will continue to exist and will also have to adapt their production processes and products:

- **Oil and gas production and refining**. Employment in the North Sea is already projected to fall as oil and gas reserves and resources decline. Net Zero could accelerate this transition. Up to 15,000 workers in these industries could need to find new employment by 2030. Workers from the oil and gas industry are likely to be in demand as their skills will be valuable to grow new low-carbon markets, such as CCS and hydrogen, as mentioned above.[48] In the next decade, low-carbon energy supply should create more opportunities for work than the fossil fuel industry.

- **Coal mining and coal-fired generation**. Around 1,400 workers are currently employed across a dozen surface mines in the UK. Plans to shut down coal-fired generation by 2024 have further reduced demand for coal mining in the UK which should result in a fall in employment. However, consent was given to a new UK coal mine at the end of 2022. Although it is not clear whether plans will result in the construction of the plant given legal challenges and prevailing economic conditions against it, its development could affect future employment levels, as well as resulting in both stranded assets and stranded workers and communities, due to planning permission beyond 2035 when there should be no domestic use for coking coal.[49]

* Livestock agriculture is considered a Redirect sector as it is likely that those currently working in livestock agriculture will experience a change in the nature of their work, incorporating reduced herd sizes with reduced-carbon farming. However, it remains possible that the sector will experience job losses, depending how the shift in land use is achieved.

- **Retail sale of automotive fuel**. The expansion of electric vehicle infrastructure will likely transform the sale of automotive fuel in petrol stations.[50] Jobs in petrol stations could decline as the majority of electric vehicle charging will be done at home, at work or in public spaces, thus reducing demand for fuel at petrol stations. However, en-route and destination charging stations will also be needed. Some existing petrol stations are well placed to meet these new demands, but it will require some changes to their operations.

The evidence is limited on the scale of potential employment growth (or decline) and the specific changes that will be needed in both Enabling and Peripheral sectors – we have not found estimates to include in Figure 2.5. While these sectors may be less likely to experience significant job creation or loss as a direct result of Net Zero, they have a key role to play in supporting the transition, which we set out in Box 2.7.

To deliver home retrofits at the pace and scale needed will require a larger construction and retrofit workforce. There have been limited efforts to address labour market challenges such as demand uncertainty, financial costs and a decline in workers in the construction industry.

Box 2.4
Grow sector deep-dive: home retrofits

The UK's homes account for 13% of emissions, predominantly from oil and gas boilers. Retrofitting these homes to replace fossil-fuel heating systems with low-carbon alternatives and to reduce their energy consumption through insulation and other efficiency measures is a critical element of the pathway to Net Zero.

To achieve this the UK will need a larger construction and retrofit workforce than it currently has. Demand for new roles such as heat pump engineers, renewables specialists and retrofit coordinators will rise, and there will be an uplift to existing roles such as electricians, window installers, and heating, ventilation and air-conditioning specialists:[51,52]

- The CCC expects that for most homes the transition to low-carbon heating systems (predominantly heat pumps) will occur in line with the natural life cycle of their existing boilers (typically around 15 years). Installing these units is likely to require around 30,000 new heat pump engineers by 2030.
- For energy efficiency retrofits, the bulk of this work – insulating remaining cavity walls and lofts, and solid wall insulation for the poorest homes – needs to happen between now and 2030. Thereafter most remaining demand for these skills post-2030 will come from new-build homes (rather than retrofits).
- During the period of transition, the literature suggests that the buildings construction and retrofit sector will need to grow, adding between 120,000 to 230,000 new jobs between now and 2030.

This labour market transition currently faces some challenges:

- There has been a decline of around 184,000 in workers in the construction industry between 2019 and 2020, driven by a combination of the COVID-19 pandemic and EU exit.[53] Attracting new workers and upskilling and retraining existing workers at the pace required, particularly at present under such a tight labour market, could pose a challenge.
- Ongoing uncertainty about future demand for skills reduces the incentives for workers to upskill or retrain. This is compounded by strong demand for existing skills and the nature of most construction firms being SMEs, often with one or very few employees.
- Training or retraining impose financial costs on both workers and firms, both in terms of the upfront fees for instruction, as well as lost earnings from work not done while in training. These costs compound the issue of uncertainty about future demand.
- The relative lack of certain capabilities (such as heat pump engineers) is limiting the growth of UK-wide supply chains for decarbonised heat. This in turn limits the investment by manufacturers and others which could help drive up demand.

Source: BEIS (2022) *Provisional UK greenhouse gas emissions national statistics 2022*; CITB (2021) *Building Skills for Net Zero*; Construction Industry Training Board (2021) *Migration and UK Construction 2021*; IPPR (2020) *All hands to the pump, a home improvement plan for England.*

The UK will need to free up land for carbon sequestration. Depending on how this is delivered, it could result in a change in farming practices, or a loss of jobs in livestock agriculture, accompanied by an increase in jobs in afforestation and peatland restoration.

Box 2.5
Transition sector deep-dive: agriculture and land use

Net Zero will likely see a shift from people working in high-emitting agricultural practices to lower-carbon agriculture and land use alternatives. The challenge for this sector will lie in the pace of the transition across and within these two areas and the transferability of skills between them. Whether this will occur through changes to existing jobs or a transfer of workers from the former to the latter is very uncertain. The impacts of Net Zero on agricultural workers could also have significant social and cultural implications for wider rural communities.

- The CCC's Sixth Carbon Budget Balanced Pathway requires the UK to free up land for carbon sequestration. With an afforestation rate of 30,000 hectares per year by 2030 and peatland restoration at a rate of 56,000 hectares per year by 2030, an increase in the number of people employed in afforestation and peatland restoration in the UK can be expected.
- It is possible that the change in land use could be achieved through a shift in the type of farming and land use management that livestock agriculture farmers undertake, via a decrease in herd size and an increase in low-carbon farming practices such as afforestation. In such an instance, it is not clear that job losses would occur, so much as a transformation in the nature of the work. For this reason, we label the livestock agriculture sector a Redirect sector.
- However, it is possible that instead there will be a combination of job losses and gains across the livestock agriculture and land use sectors. In such an instance, new jobs in afforestation and peatland restoration could be filled by workers currently employed elsewhere in agriculture. For example, if afforestation occurs on land that is currently used for agriculture, those currently employed on farmland may shift to tree planting.
- There is a wide range of job estimates that are highly uncertain. This is partly due to the varying approaches to estimate the length of employment per hectare in a sector where work is often temporary and seasonal in nature and so does not perfectly represent Full-Time Equivalent (FTE) employment. As a result, our assessment sometime relies on job-years and temporary employment estimates. The upper range of job estimates tend to include long-term employment from nature-based tourism.
- However, CCC analysis based on evidence in the literature indicates that achieving the Balanced Pathway's tree-planting targets could require between 6.600 and 39,000 new workers by 2030 in the UK, while peatland restoration could produce up to 560 and 2,200 additional jobs by 2030. It also indicates that livestock agriculture could see job losses of 7,000 to 42,000.
- Both shifts in farming practices or changes to employment could have significant social and cultural implications for communities with long-running connections to and employment in livestock agriculture.
- The transition also brings opportunities, including the potential for greater demand for highly paid jobs. That is the case for agronomists, ecologists, and arboriculture officers that tend to earn within, or above, the UK average salary.

While some skills are expected to be transferrable, barriers remain:

- **Economics**. Farmers are unlikely to change their practices unless it is economically attractive to do so. Therefore, adapting their land to alternative uses will likely only occur in response to changing consumer demand or policy measures. In addition, switching to low-carbon alternatives, such as agroforestry requires investment over long-term horizons that make it particularly challenging to incentivise the shift, given upfront costs (e.g. ground preparation and tree planting) and the timing of returns.
- **Age**. The median age of a farm-holder in the UK is 60. Fewer than 20% of surveyed farmers plan on retiring fully and those who intend to will be past the age of 70. To address this, Defra has committed to pay £50,000-100,000 lump sums to farmers to encourage retirement and bring about changes in land use, however these payments were only made available for a short period of time and applications for the scheme have now closed.

- **Skills**. Improvements in efficiency and land use will require new technology such as the use of GPS mapping, soil testing and data management. Around 65% of farm managers have no formal agricultural education, so less formal routes to upskilling may be required. In addition, farmers need skills support and place-based strategies now to put in place the measures that will reap the benefits from trees, agroforestry, and hedges over the next few decades.

Source: CCC (2020) *Sixth Carbon Budget: The UK's path to Net Zero;* ONS (2021) *Annual Population Survey;* The Countryside Charity (2021) *Hedge Fund: investing in hedgerows for climate, nature, and the economy;* CCC Calculations based on WPI economics, RSPB Scotland, Scottish Wildlife Trust and WWF Scotland (2021) *A Nature Recover Plan;* Philippidis, G., Sartori, M., Ferrari, E., M'Barek, R (2019) *Waste not, want not: A bio-economic impact assessment of household food waste reductions in the EU;* Newton, A., Evans P., Watson S., Ridding L., Brand S., McCracken M, et al. (2021) *Ecological restoration of agricultural land can improve its contribution to economic development;* The Landworkers Alliance (2019) *Supporting the Next Generation of Farmers;* Edgar, J., Weir, G., Bovill Rose (2021) *Green Renewal – The economics of enhancing the Natural Environment;* Green Alliance/WPI Economics (2021) *The National Food Strategy: The Plan;* Oxford Economics (2021) *The Socio-economic impact of cultivated meat in the UK;* Defra (2016) *Agricultural labour in England and the UK Farm Structure Survey 2016 ;* Nyman, M., Plummer, A., Murphy, L (2021) *IPPR: A fair transition for farming;* Wheeler, R., Lobley, M., Soffe, R., (2020). *Farm Succession and Inheritance in England, Scotland, and Northern Ireland;* National Careers Service (2021) *National Careers Service: Explore Careers;* NFU (2021) *Doing our bit for Net Zero;* Proveg International (2022) *Amplifying farmers' voices;* Rewilding Britain (2021) *Rewilding the Rural Economy;* Woodland Carbon Code *(2022) Woodland Carbon Code: Requirements for voluntary carbon sequestration projects;* CCC analysis.

New UK employment as a result of the transition to electric vehicles will be contingent on gigafactories and manufacturing being located in the UK, with promising early commitments from car manufacturers.

Box 2.6
Conditional Growth sector deep dive: vehicle and battery manufacturing

Electric vehicle (EV) and battery manufacturing offer relatively high potential for job creation. However, employment in the UK will depend on whether manufacturers choose to remain or locate in the UK, as EVs and batteries could also be manufactured abroad and imported.

Research by the Faraday institute suggests that opportunities for job creation in vehicle and battery manufacturing are conditional on the development of gigafactories (battery factories), components manufacture, Original Equipment Manufacturer (OEM) investment, and manufacture in the UK in order to capture key shares of export markets.

Their research finds that around 10-40% of job creation in the surface transport sector is dependent on up to ten gigafactories being located in the UK, due to post-Brexit rules of origin. In the absence of gigafactories the vehicle manufacturing sub-sector could see overall job losses instead. The report highlights that securing gigafactories in the UK will require policy support in line with that seen in the EU.

Although some efforts have been made by Government to secure these opportunities, and several announcements regarding investments into EV and battery manufacturing by car manufacturers have been made, the future direction of the sector is not yet clear.

Positive developments include:

- Vauxhall announced in 2021 that it would invest £100 million for EV production in its Ellesmere Port (Cheshire) site in the Northwest, safeguarding 1,000 factory jobs.
- Nissan made an announcement in 2021, investing £1 billion for the expansion of EV production and opening the Envision Gigafactory. Production of a new EV model, the Nissan Leaf, will create nearly 1,000 new direct jobs and more than 4,500 in the UK supply chain. The new Gigafactory is planned to be operational by 2024 and will create 750 new jobs and secure 300 existing roles.
- Aston Martin pledged, in 2021, to manufacture all their electric cars in the UK from 2025. All battery sports cars will be made in the Gaydon (Warwickshire) plant, whilst all electric SUV models will be made in Glamorgan (Wales). These plants employ approximately 2,500 people, but the future job impact is not currently clear.

Risks include:

- The Government offered £100 million in grant funding to start-up Britishvolt towards setting up a prospective £3.8 billion Gigafactory, with the promise of generating 3,000 skilled jobs. Public funding was based on key milestones being met, including private sector investment commitments. Britishvolt went into administration in early 2023, with the majority of its 232 employees made redundant.[54] Recharge Industries subsequently entered into agreement to purchase the company's existing business and assets, although little detail has so far emerged on its plans for the business.[55]
- Ford announced that it would cut 1,300 jobs in the UK, or a fifth of its workforce, out of 3,800 job cuts across Europe. In addition to economic uncertainty, the manufacturer's shift towards electric vehicles was cited as a reason.[56]

Source: Faraday Institute (2020) *UK electric vehicle and battery production to 2040*; BBC (2021) *Vauxhall owner Stellantis to invest €30bn in electric vehicles*; BBC (2021) *Nissan announces major UK electric car expansion*; BBC (2021) *Aston Martin's electric sports models to be made at Gaydon plant*; BBC (2023) *Britishvolt: UK battery start-up collapses into administration*; Sky News (2023) *Ford job cuts: More than a thousand jobs to go in the UK*; BBC (2023) *Ford to cut one in five jobs in the UK.*

The Net Zero transition should see sectors such as education, training and finance playing an enabling role. While Peripheral sectors won't see significant changes to the skills required in day-to-day jobs, some, such as real estate and advertising, will require an understanding of Net Zero to actively support the transition.

Box 2.7
Peripheral and Enabling sectors

Enabling sectors will support the transition by embedding changes to regulation, finance and knowledge in businesses and society in line with Net Zero. While there is limited evidence on shifts in employment as a result of the Net Zero transition, they have a key role to play in ensuring people and systems are aligned with and able to deliver the transition.

- **Education and training**. Without educators and skills providers, the shifts needed in Grow and Transition sectors will not be possible. The skills and education systems will need to evolve to ensure workers have the right skills and knowledge to effectively transition to Grow and Redirect sectors while also creating opportunities for new entrants. Educators will also play a role in offering an understanding of climate change to children, young people and adults in a way that translates into action and skills for Net Zero. The Government has started to embed this though the Department for Education's Sustainability and climate change: a strategy for the education and children's services systems.
- **Finance**. The finance sector will have a role in bolstering green finance and updating market structures with strong standards for investment that aligns to Net Zero targets. The UK Government has already recognized how crucial this sector will be as it stated its ambition for being a world leader in green finance.
- **Research.** Innovation is a fundamental component in the transition to Net Zero, which will require advances in the development and scale-up of new methods, services and technologies. Research into how Net Zero can be delivered effectively and fairly will play a role in informing how the transition is achieved.
- **Accounting services.** The accountancy sector will have a role in ensuring robust emissions accounting and practices by organisations.

Although Peripheral sectors may not grow or phase down as a result of the transition, and workers may not need to adjust their core work, these sectors have a role in shaping the Net Zero transition.

For some Peripheral sectors, this will be a relatively passive adaptation to the Net Zero context, for example postal workers could drive electric mail vans, and nurses might work in hospitals that have shifted to electric heating and non-F-gas anaesthetics.

Workers in some Peripheral sectors also have the potential to play a more proactive role in supporting the Net Zero transition, through their influence on other organisations and society in general. For example:

- **Real estate.** The real estate sector can influence the level of investment and pace at which new and existing buildings are decarbonised. Those working in real estate will also need to adjust the information they consider in relation to properties and their valuations, to reflect any new regulations or policies relating to low-carbon heating and insulation.
- **Employment placement agencies** can play a role by directing people to Net Zero opportunities and helping to meet the demand for skilled workers in low-carbon industries. Recruiters will need an understanding of Net Zero skills requirements.
- **The advertising sector** has the potential to shape consumer behaviour and influence demand for both high and low-carbon products. Firms will need to understand the commercial and consumer opportunities that Net Zero can offer.
- **The media** has a role to play in informing and educating the public on what the Net Zero transition will involve and why it is necessary. Journalists and editors will therefore need a strong grasp of issues related to Net Zero.

Source: DfE (2022) *Sustainability and climate change strategy*; HMG (2023) *Green Finance Strategy;* University of Birmingham (2021) *Net Zero Accounting for a Net Zero UK.*

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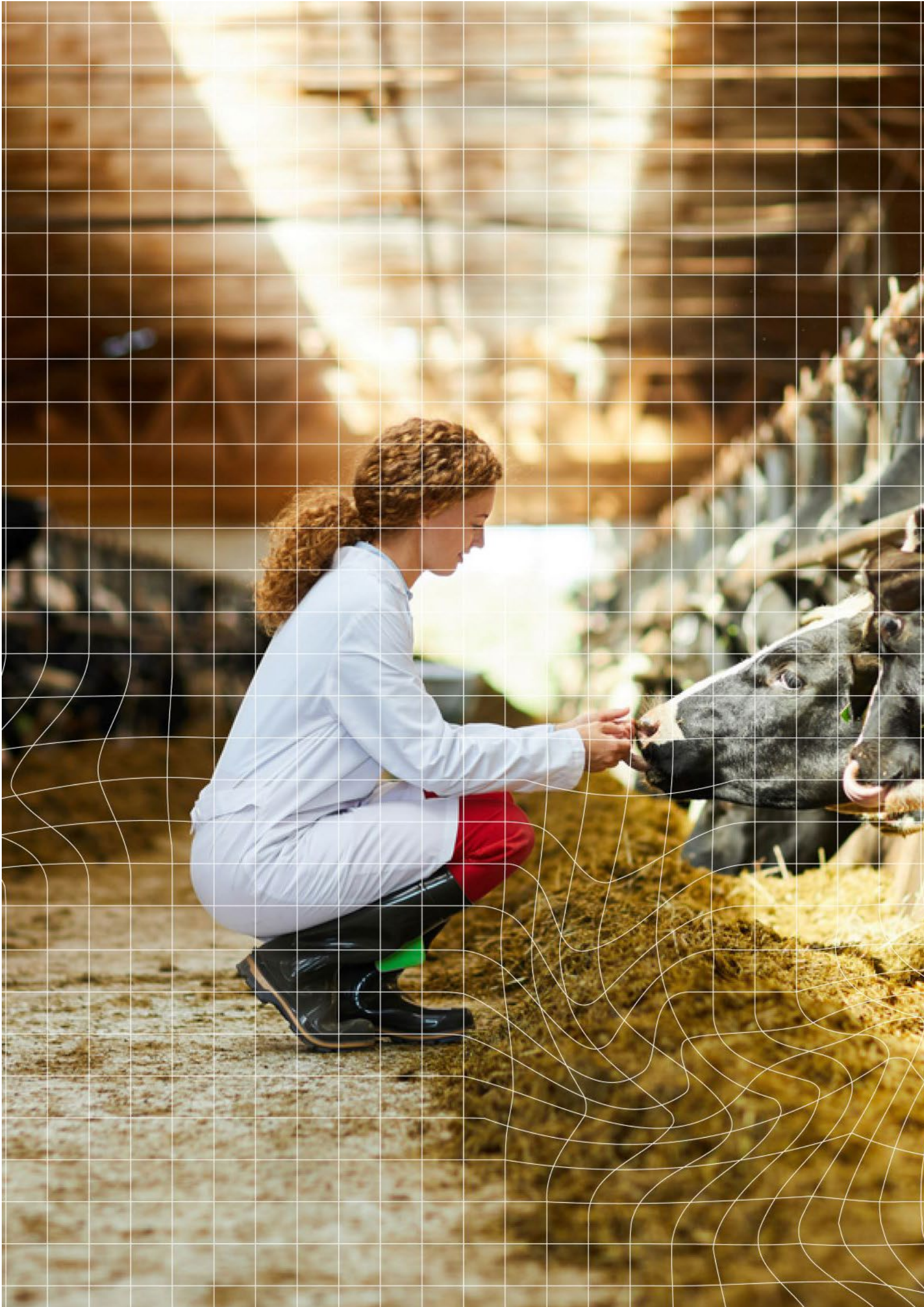


Chapter 3

Employment impacts of Net Zero: Distribution and pace

This Chapter considers the expected distribution and pace of the employment impacts of the Net Zero transition.

In this Chapter we explore the nature of employment impacts of the transition to Net Zero. We review lessons from other transitions, to identify key characteristics of a transition that shape how workers are impacts. Based on this, in terms of the Net Zero transition, we consider:

- What is the current economic dependency of UK regions and local authorities on different sectors, and the business composition?
- What is the expected pace of the transition in different sectors?
- What are the characteristics of current workers in different sectors?

Our key messages are:

Past transitions show that the geographic distribution of jobs, pace of change, workforce characteristics and policy response shape the impact of a transition for the workforce

- The UK labour market has gone through significant transitions in the past, including the decline of coal and steel in the 1970s and 1980s and the shift to a service-based economy over the past 100 years. The past transitions in the UK provide us with insights into factors that shape the impact of a transition for the workforce: (1) the geographic distribution of jobs and regional economic dependencies; (2) the pace of change; (3) the characteristics of the workforce; and (4) the policy response.

The earliest and most rapid shifts in employment will be in sectors that are expected to grow, while sectors that may see job losses tend to employ relatively few people and can change gradually.

- Sectors that offer the most potential for new jobs, such as buildings construction and retrofit, should offer employment opportunities across the UK. There is also an opportunity to harness the Net Zero transition to invest in skills and jobs in areas with lower employment, including for sectors that are location-specific, such as forestry, CCS and hydrogen.
- At UK level, sectors that will need to phase down such as oil and gas, or sectors that will redirect but may also experience some job losses, such as livestock agriculture, tend to employ a relatively small number of people and involve a gradual decline. However, employment in these sectors is relatively concentrated in certain regions or local authorities, which could risk greater disruption for workers if the transition is not managed well.
- The earliest and most rapid shifts should occur in sectors that will be growing low-carbon markets to deliver technologies that can abate emissions, such as heat pumps or offshore wind. While this highlights the potential for growth, it also presents a risk that if policy does not ensure there are sufficient skilled workers, progress to Net Zero will be delayed. Sectors which will require more gradual shifts still require prompt action, given the lead-times required for skills and structural changes.
- In many Core Net Zero sectors people aged over 55, those who identify as men and those who identify as white, are disproportionally represented. Sectors that could grow as a result of the transition have an opportunity to diversify.

The rest of this Chapter is set out in two sections:

1. Lessons from other transitions
2. The distribution and pace of Net Zero impacts on the workforce

1. Lessons from other transitions

Transitions from the past and from other countries highlight factors that determine the impacts of a transition for the workforce and communities.

Transitions from the past and from other countries offer insights into the factors that can determine the extent of their impact on individual workers, local communities, and the economy as a whole.

- The UK's transition from manufacturing towards a services economy is an example of a gradual transition which was accompanied by economic growth across the UK and for a range of workers (Box 3.1).
- The UK's transitions away from coal and steel are examples of disruptive transitions which negatively impacted workers and communities (Box 3.2).
- Although these shifts were unrelated to climate policy, they offer lessons and insights which can help to inform the Net Zero transition.
- The ongoing transition away from coal in Germany and the Netherlands offer insights into similar transitions which provided strategies to enable a more orderly transition (Box 3.3).

The pace of change, geographic distribution of employment, labour market characteristics and policy response have shaped the impact of previous transitions for workers and communities.

By looking into other transitions, we have identified key factors that determine the extent to which labour market shifts can affect workers.

- **Pace of change**. Past transitions have seen economic sectors shrink or grow as they adjust to changing markets and global dynamics. Where businesses don't gradually close down, these impacts can be abrupt and, without intervention, can risk workers being left stranded and unprepared to move to other jobs and sectors. This was the case in the transition away from coal and steel, where employment reduced dramatically within a decade (Box 3.2). On the other hand, transitions that are more gradual, such as the shift to a service-based economy (Box 3.1) can give workers time to respond to the shift.
- **Geographic distribution of employment and regional economic dependency.** Regions and local areas that are particularly dependent on a specific sector tend to be disproportionately affected by any negative (or positive) changes in that sector. For example, in the transition away from steel, the high regional concentration of steel employment in Yorkshire and the Humber, the West Midlands, the North of England and in Wales (Box 3.2) made it particularly challenging for workers in those regions to find alternative sources of employment locally and meant some communities were more heavily impacted. In contrast, the transition to the services-based economy created opportunities across much of the UK (Box 3.1).
- **Characteristics and state of the labour market**. The availability and access to alternative job opportunities shape the impact for the workforce. Whether replacement jobs provide similar wages and status, and the option to remain in the same region, determine the incentives for workers to transition and the employment outcomes for those workers. For example, in the transition away from steel, the limited alternative employment options with comparable wages made it challenging for workers to find attractive alternative employment (Box 3.2).

The governance, financial support and skills training provided by policy shape the impact of a transition for workers and communities.

- **Policy response**. Policy responses to past transitions in the UK and abroad have varied, from little intervention to more managed approaches. Even where transitions are similar in nature (e.g. within-sector shifts that are most felt at the local level) the policy response can result in very different outcomes. We have identified three broad aspects of policy responses to past transitions that have influenced their outcomes:

  - **Governance.** The structured dialogue between governments and workers can lead to differing outcomes. The German transition away from coal (Box 3.3) offers an example of two different approaches to multi-stakeholder negotiations. Germany's approach focused on engaging with workers and unions and involving them in the decision-making processes, which saw large numbers of workers utilise the support.

  - **Financial support.** Government funding for reskilling, accessible career advice and the availability of alternative employment can support a successful transition. Subsidies and financial support to build alternative community projects can revive local economies, as has been the case outside of the UK (Box 3.3). However, these measures take time to implement, which is why a timely strategy for delivery is essential. Lump-sum redundancy payments also offer direct one-off compensation for workers, although these have not been found not to be adequate to address the challenges faced by workers.

  - **Skills.** Delivering effective skills and training can play a key role in supporting workers to transition to alternative jobs or sectors. The Netherlands and Germany both delivered social programming and vocational training to support workers transitioning into new roles outside the coal sector. This support was put in place to prevent long-term unemployment. The UK Government's steel industry policies of the 1980s saw little to no social programming and vocational training and saw both short and long-term generational unemployment in areas with high levels of job losses (Box 3.2).

In the UK transitions away from coal and steel for much of the time period considered, many of the steelworks and coal mines were nationalised. Many workers in sectors relevant to Net Zero today are employed by companies that are not nationally owned. This opens up wider opportunities for employers in how the transition could be managed, depending on the size and geographic coverage of the business.

In the next section for sectors affected by Net Zero, we assess the expected pace of change, geographic distribution of employment, profile of employers and workforce characteristics.

Since the mid-nineteenth century the UK has shifted from a manufacturing to a service-based economy, creating opportunities across the UK for different workers.

Box 3.1
Lessons from the past: the shift to a service economy

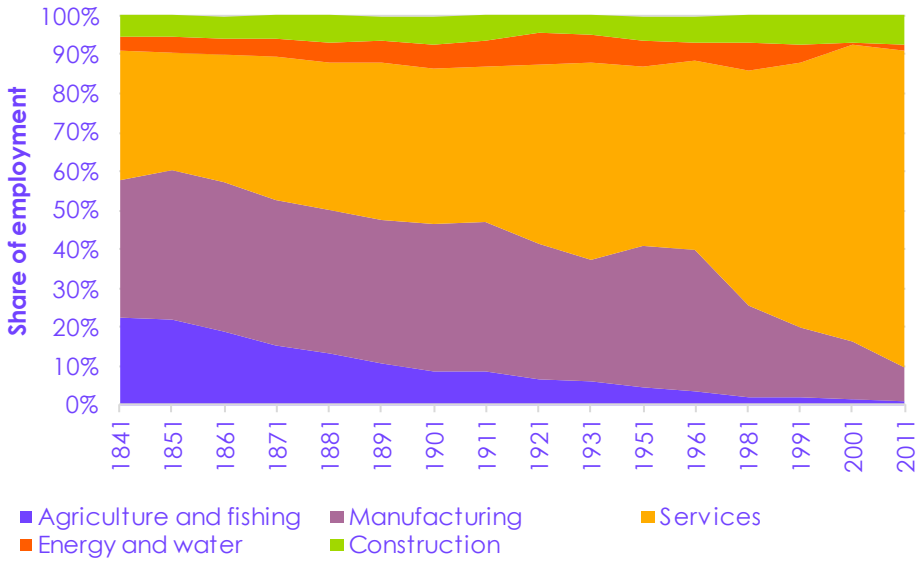
One of the most significant structural changes to the UK economy has been the shift from a mixed manufacturing-service economy towards an ever-greater share of services, driven in part by automation. The shift has been gradual in pace as it has been taking place since the middle of the 19th century (Figure B3.1).

- In 1850, manufacturing and service jobs provided a similar share of employment in England and Wales, each employing around 35% of workers. Between the 1910s and 1960s, employment in manufacturing grew at a similar rate than service jobs with 30% growth in employment.
- After 1960, the gap between services and manufacturing widened and the pace of the transition accelerated. On average around 110,000 workers moved away from manufacturing every year from 1961 to 2016, with 25% of the decline happening in those last 16 years. In the same period, on average 267,000 workers entered the service economy every year.

The UK's service economy has created opportunities across the UK.

- The shift to a service economy has increasingly resulted in economic growth. The service economy now contributes 78% of the UK's Gross Value Added (GVA), representing £1.5 trillion in real terms. Of these, over 20% come from finance and professional services such as engineering, research or consultancy work, which contribute to important exports for the UK.
- The proportion of service jobs across the UK is higher relative to other sectors. At the local authority level, an average of 82% of those economically active are employed in the service industry. The proportion is much smaller for energy-intensive manufacturing jobs (maximum 3%).
- Towards the end of the 19th century only 27% of women were economically active. Women's participation in the labour force grew substantially from the 1950s onwards, in part as the growing service economy offered them jobs. Today 92% of all working women are in the service industries, relative to 74% of men.

Figure B3.1 The employment shift to a service-based economy in England and Wales



Source: ONS (2015) *Transition from a manufacturing to service led labour market over past 170 years.*

Source: PwC (2018) *The services powerhouse: Increasingly vital to world economic growth*; ONS (2013) *Women in the labour market: 2013*; ONS (2022) *Employment by industry*; ONS (2019) *Long-term trends in UK employment: 1861 to 2018.*

Both steel manufacturing and coal sectors saw a rapid decline in employment in a matter of decades, with disruptive impacts for workers and local communities.

Box 3.2
Lessons from the past: disruptive sectoral transitions

The decline in the UK's coal mining and steel manufacturing sectors, particularly from the late 1970s onwards, led to profound negative effects for workers and local communities some of which persist to this day.

Coal

- **Rapid declining output and employment.** From the 1920s, prior to consideration of emissions reductions, the coal industry started experiencing a decline in output driven by low demand and offshore competition. This shift was most abrupt between 1980 and 1990 (Figure B3.2), when the workforce shrank from 241,600 to 56,000 workers, representing an average annual decline in employment of 13%.
- **High regional dependency on coal employment.** The regions most affected by declining coal jobs were either remote, had small surrounding economies, or both. Coal miners were often transferred to surviving mines, most of which eventually closed as well.
- **Limited alternative employment.** This was compounded by regions' struggle to grow and absorb an additional labour supply, due to an increasing working-age population and rising labour market participation among women. As a result, coal workers were simply made redundant.
- **Limited support and lower earnings.** Financial packages were made available to some former miners that included redundancy payments, welfare benefits and pensions.[1] Regeneration policies aimed to support workers by providing retraining and finance for infrastructure and business support. However, recent evidence suggests that in the year following job loss, the earnings of miners that had found work fell by 40%. Fifteen years on, these wages remained 20% lower.
- **Wider social impacts.** The loss of employment and the absence of replacement jobs had knock-on effects for local communities. There was significant social disruption, particularly in 1984 during long-held strikes that resulted in 27 million of working days lost. The costs to communities were also considerable given that households relied on the wages of these workers, 80% of which were men, at a time where only half of women were economically active.
- **Varied long-lasting effects.** In over 20 years, the loss of coal-mining jobs was only offset in smaller coal mining regions like North Wales that saw job opportunities come from the manufacturing and service sectors. Other areas such as Northumberland, North Staffordshire and Lancashire have not yet replaced all lost jobs. Former mining communities remain some of the poorest in the UK.

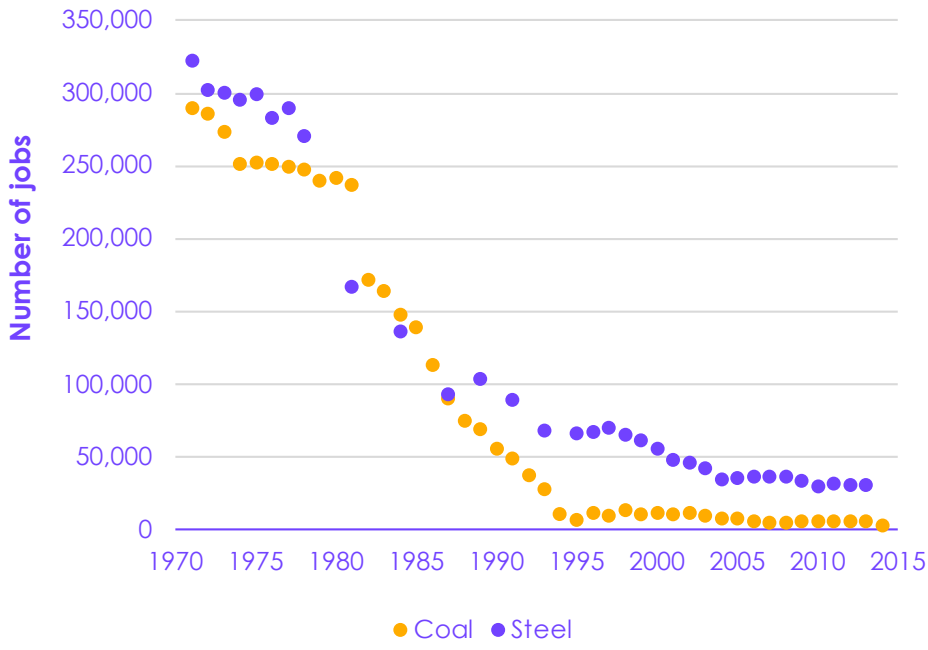
Steel

- **Rapid declining output and employment.** From the late 1960s, the steel industry saw production fall sharply. The steel industry provided around 320,000 jobs in 1971. In a decade, the steel manufacturing sector saw a loss of 156,000 jobs,* 67% of which were lost in just three years, between 1978 and 1981.
- **High regional dependency on steel employment.** Although steel employment only made up around 1% of total UK employment in 1971, it represented a much higher proportion of employment in Yorkshire and the Humber, the West Midlands, the North of England and Wales. Some communities, such as the former Cleveland county, suffered unemployment rate of 14% in 1980, almost twice as much as the UK average, due to plant closures.*
- **Limited attractive alternative employment**. The rapid pace of this decline came with difficulties in finding replacement jobs, despite a slight increase in the number of jobs in the UK in that period. In addition, in a sector with wages higher than the UK average, it was difficult to find alternative jobs that could provide a similar job quality.

* Excluding those from steel processing and in supply chains

- **Wider social impacts.** Factors other than wages – including cultural and personal identities tied to the sector – meant that many workers did not want to move into alternative sectors or to other regions.[2]

Figure B3.2 Employment in coal and steel from 1970 to 2015 in Great Britain



Source: ONS (2016) *Updated: The British steel industry since the 1970s,* BEIS (2022) *Historical Coal Data: Coal Production, 1853 to 2021.*

Source: Stockholm Environment Institute (2021) *Decline of the United Kingdom's steel industry: lessons from industrial transitions;* Hutton Georgina (2021) *UK Steel Industry: Statistics and policy*, House of Commons Library; Institute for Fiscal Studies (2022) *Job displacement costs of phasing out coal;* Beatty, C., S. Fothergill, and R. Powell (2007) *Twenty years on: has the economy of the UK coalfields recovered?* Environment and Planning, 39(7), p.1654; ONS (2023) *Labour Force Survey Summary: Women by economic activity for those aged 16 and over and those aged from 16 to 64 (seasonally adjusted);* ONS (2018) *Labour disputes in the UK: 2018;;* Sheffield Hallam (2017) *An historical case study for the project "Coal Transitions: Research and Dialogue on the Future of Coal;* Bennett, K., H. Beynon, and R. Hudson (2000) *Coalfields regeneration: Dealing with the consequences of industrial decline*, The Policy Press; National Archives, *Interwar coal mining;* BEIS (2012) *Historical coal data: coal production, availability and consumption 1853 to 2021.*
Notes: Working days lost are defined as the number of days not worked by people as a result of their involvement in a dispute at their place of work. In measuring the number of working days lost, account is taken only of the time lost in the basic working week.

The approaches to phasing out coal in the Netherlands and Germany offer examples of Governments providing support for workers to transition, and establishing inclusive engagement between stakeholders.

Box 3.3
Lessons from abroad: transitions away from coal

Other European countries – like Germany and the Netherlands – have also experienced declining coal industries at different points in time, which offer different approaches to address the impacts of sectoral transitions on workers.

Netherlands. In 1965, the Netherlands committed to phasing out twelve mines in the region of Limburg. Closely managed closures and a plan to assist workers with the transition to alternative employment streams were put in place to ensure the transition was fair, with research validating the positive impacts of the approach.

- When closures were announced in 1965 approximately 53,000 people were employed in the sector. In South Limburg approximately 36% of jobs were expected to be lost, with 45,000 miners losing their jobs and a further 30,000 job losses due to reduced supply to mines.
- Financial support focused on transitioning workers and implementation of fossil fuel subsidies.
- State Mines created a re-industrialization department, engaging with investors to support workers in finding employment. The approach included grouping workers, ensuring the process was smooth and no segment of workers (e.g. older workers) were left out. Approximately 50,000 workers transitioned from mining to alternative work, pensions, or other bridging alternatives.
- Around half of coal workers found a new job or went into retirement. Of these, 20% had a job or pension that prevented any loss of income. For others, the loss of income was partially covered through compensation. Retraining was also made available, especially for young people, and was partially financed.
- Between 1958 and 1974, 56,000 Full Time Equivalents (FTEs) were lost in mining, however only 1,000 FTEs overall were lost in the region. This is reflected in the overall employment rate for the region, which did not differ from national figures from 1965 to1972, when most of the transition took place.

While the transition had shortcomings, investing in worker's shift away from coal and developing a clear managed closure of the sector helped create more opportunities for workers despite the scale of the transition.

Germany. Although Germany has experienced a decline in coal mining since the 1960s, the transition away from coal is still ongoing. As of 2018, coal corresponded to 20% of Germany's energy supply and 40% of its electricity generation. In 2019, Germany committed 40 billion euros to phase out coal by 2038 and support workers and communities that depend on this sector.

- Employment dependency on coal-fired power plants and lignite mines in Germany is low, representing less than 1% of all jobs. This is also the case at the regional level, for example in Lusatia where 3% of jobs are directly or indirectly related to coal mining.
- Financial support was targeted at four states that heavily rely on coal: Saxony-Anhalt, Saxony, North Rhine-Westphalia and Brandenburg.
- A Commission on Growth, Structural Change, and Employment was established to manage the phase out and ensure a just transition for workers. While the transition is still ongoing, its governance structures appear well thought out.
  - Policies relied on using the existing German social security system that already provides effective assistance with training, job placement, and vocational guidance.
  - Policies prioritised the quality of life of local communities by considering ways to support regional economic growth and living conditions, such as financial support to modernise homes.
  - The governance structures put in place included local stakeholders in the design and implementation of policies in order to tailor policy to local circumstances.
- In 2019, the commission published a report proposing the end of all coal-fired power generation by 2038. The report included a number of measures to ensure that

workers were not left behind, coal mining regions had capacity to adapt and consumers were not overburdened. These included:

- Supporting workers through a variety of measures such as training, internal recruitment and early retirement for employees aged over 58, including covering pension deficits through an adjustment fund.
- Involvement of unions, businesses and the government to reach collective agreements, with workers' rights and compensation explicitly addressed in official contracts between plant operators and the state.
- Compensation mechanisms to freeze electricity prices between 2023 and 2038, to ensure that the cost of phasing out coal-powered electricity generation is not passed on to consumers.

The transition in Germany is ongoing, it is therefore not yet possible to assess the effectiveness of this approach. However, this approach presents clear strengths – it created an inclusive engagement between stakeholders with a clear definition of roles while having a package of measures that address the needs of workers and local communities.

Source: Gales, B., Hölsgens, R., (2017) *Coal Transition in the Netherlands*; Furnaro, A., Herpich, P., Brauers, H., Oei, P.Y., Kemfert, C., Look, W., (2021) *German Just Transition: A Review of Public Policies to Assist German Coal Communities in Transition*; E3G (2018) *Why are German coal workers so powerful, when there are so few?*; Oei, P.Y., Hermann, H., Herpich, P., Holtemöller, O., Lünenbürger, B., Schult, C., (2020) *Coal phase-out in Germany – Implications and policies for affected regions*; World Resources Institute (2021) *Germany's "Coal Commission": Guiding an Inclusive Coal Phase-Out*.

We assess the geographic location and concentration, pace of change and workforce characteristics for many sectors that will be affected by Net Zero.

The impacts of the transition will be a function of the location of affected sectors (and the economic dependency of an area on a sector), the composition of employers, the pace of change, the characteristics of the labour force, and the policy response. In the following sections we explore the first four of these factors.

(a) Geographic location and business composition of Core and Enabling sectors

In this section we assess the geographic location, and business population of several Core and Enabling sectors.

The geographic location and concentration of Core and Enabling sectors, and the nature of employers, play a role in determining the potential impacts of the Net Zero transition on the workforce.

- Not all UK regions will have the same experience of the Net Zero transition. How a region's labour market is affected will depend on its current sectoral composition and size of businesses. It will also be affected by its potential to attract new industries, either due to its geography (e.g. proximity to areas suited for offshore wind), or other factors (e.g. decision on where to locate CCS clusters).

- As set out above, and seen in previous transitions, even a relatively small number of job losses could result in significant and long-lasting negative impacts for local communities if they are economically dependent on that sector. For this reason, it is important to consider both absolute jobs in a given sector as well as the contribution to regional employment of a given sector (i.e. regional economic dependence).

- The business size in a sector, and whether a sector is composed predominantly by SMEs or by larger companies, can determine whether businesses in certain regions will have less foresight over the transition or capacity to address Net Zero impacts. The composition of business and the geographical distribution of jobs are correlated. Large firms tend to be fewer in number but also tend to employ a larger number of workers in a single site or plant and to be rooted in certain regions. On the other hand, small and medium enterprises (SMEs) tend to be more widespread across the UK.

In this section, we assess the geographic location and concentration of several Core and Enabling sectors, and also the business size and composition.

- We analyse several sectors:* forestry and horticulture, livestock agriculture, buildings construction and retrofit, oil and gas, manufacturing, vehicle maintenance and education.

- We also assess the size and spread of the business population for the chosen sectors (Table 3.1).

- We do not consider sectors that could see jobs created in new parts of the UK, as it is hard to predict and depends on a range of factors, including

* These sectors were selected as they are expected to maintain a similar geographical distribution to that of today, which helps us illustrate the potential impacts of the transition across the country.

future investment decisions. These sectors include emerging low-carbon markets such as EV and battery manufacturing, hydrogen or CCS.

On the scale of the UK, Core and Enabling sectors employ a small proportion of workers at local authority level, indicating limited dependency on employment at that level.

Overall, we find that on the scale of the UK, Core and Enabling sectors tend to employ a small proportion of people, with limited dependency on employment in these sectors at the local authority level.

- In our sample of sectors, employment at the local authority level ranges from less than 1% to 8% (Figure 3.3). There is an exception with enabling services such as education and finance where employment can represent up to 20% of local jobs.

- Our assessment is limited to the local authority level. While this is relatively disaggregated, it is possible that smaller cities or towns might be dependent on a particular site or plant. Impacts on these, will have much greater implications for workers, as seen in past transitions.

- About half of local authorities with the greatest dependency on Transition sectors are found in Scotland and Wales, with 4% to 5% of job dependency on these sectors at the local authority level. This is driven by the dependency on livestock agriculture and fossil fuel production in some of their local areas. As a result, impacts at the local level will be particularly strong within devolved administrations.

(i) Geographically concentrated sectors

There is still a degree of regional concentration of employment in Core Net Zero sectors, in particular for livestock agriculture, forestry and horticulture, oil and gas and manufacturing.

In this section we assess Core Net Zero sectors that are relatively geographically specific: livestock agriculture, oil and gas, forestry and horticulture and manufacturing. Even these sectors are not very geographically concentrated – providing up to 5% of jobs in each local authority relative to those economically active, however, at the community-level this dependency could be much larger.

Some sectors that are relatively geographically concentrated are expected to phase down or redirect, posing a potential risk to workers and local communities.

There are some Core Net Zero sectors that are relatively geographically concentrated, such as livestock agriculture and oil and gas, that are expected to **Phase down or Redirect**. This can mean a higher risk of disruption to local communities and that supporting workers could be more challenging as resources can be scarcer.

Livestock agriculture employment is not particularly concentrated at a local authority level, although it is more prevalent in certain regions.

- **Livestock agriculture** is mainly concentrated in rural areas, particularly in the north and west of England as well as Wales and Scotland.

  – The shift in land use towards carbon sequestration could have significant impacts on the livestock agriculture sector. As discussed in Box 2.5 it is uncertain whether this would involve a significant shift in the nature of work, or a reduction in jobs. If the latter, job losses could range between 7,000 to 42,000 workers in livestock agriculture, With significant social and cultural knock-on impacts. However, new opportunities for employment in the land sector could also emerge in the same rural areas as livestock agriculture, such as woodland restoration which could create 6,600 to 39,000 new jobs.

  – Scotland and Wales are particularly affected by livestock agriculture as the dependency on employment is largest (accounting for on average 4% of those economically active) in Dumfries and Galloway but also Powys. In England, the highest concentrations of livestock workers at the local authority level are found in the South West, North West and West Midlands, with around 32,000 workers. However, this is

still a relatively small concentration at the local authority level (around 4%).

Livestock agriculture has a relatively high number of very small businesses, and land use can have strong associations with cultural heritage.

  - Within the sector, there are approximately 150,000 businesses of which 30% employ only one person or sole-traders (Table 3.1). The widespread distribution of businesses suggests that there could be limited resources for workers to engage in training to access these alternative professions.

  - The transition poses a risk not only for farmers but also rural communities that might experience a shift to the land which is strongly associated with their cultural heritage. The Welsh Agriculture Bill has recognised this and has aimed to minimise this risk by conserving cultural resources alongside its sustainability commitments.[3]

The fossil fuel industry is concentrated in a few key regions.

- **The fossil fuel industry** in the UK is concentrated in a few key regions which are close to offshore oil and gas infrastructure in the North Sea.

  - The majority of jobs in the fossil fuel industry are in Scotland or Wales, which account for around 63% of the total number of oil and gas jobs. Employment in oil and gas is particularly concentrated in Aberdeenshire and the North Sea relative to those economically active at the local authority level.

  - Around 15,000 workers could see job losses as a result of declining oil and gas production in the UK. This is one of the sectors that is most concentrated, which could therefore largely impact local communities that rely on high-income jobs within this sector. There should be opportunities for workers to be employed in the low-carbon energy sector. Many of these new jobs are expected to also be in Scotland for the development of offshore wind. However, not all of these jobs will be found in the same areas as the oil and gas industry is currently.

  - Businesses in the oil and gas industry tend to be larger, employing more than 250 workers. The resources available to these businesses and the visibility over the changes within the sector could make businesses well placed to ensure workers have access to training and support within the company, with government playing more of a monitoring role.

Some sectors that are relatively geographically concentrated may grow, offering the potential to direct opportunities towards economically deprived regions.

Some sectors that are relatively geographically concentrated, such as forestry and horticulture and manufacturing, may grow. This can offer an opportunity to harness the local development of low-carbon markets and distribute opportunities across the UK, by directing local Net Zero opportunities to communities who are economically deprived, or may be hardest hit by the Net Zero transition:

The distribution of jobs in forestry and horticulture depends on forest cover and tree species, but may be more prevalent in areas with labour market challenges.

- The regional distribution of jobs in **forestry and horticulture** in the UK is highly dependent on forest cover and tree species.

  - Afforestation could see up to 40,000 new jobs, which could offer farmers in livestock agriculture as well as rural workers new opportunities for employment. Some evidence suggests that two-thirds of the most suitable land for tree planting in Great Britain is in constituencies with greater than average labour market challenges.[4]

  - Around half of forestry, silviculture and logging jobs are currently found in England, which is home to the largest area of woodland and has the highest number of tree species. However, the proportion of workers relative to those economically active is highest in Scotland and Wales. Northern Ireland has a relatively small area of woodland and therefore has relatively few jobs in horticulture.

Many jobs in the manufacturing sector could create opportunities in specific locations. There are a relatively large number of large businesses.

- The ongoing development of industrial clusters within the **manufacturing** sector could further create opportunities across the UK. At the same time, without subsidies, the UK industry could be at risk of losing some of its competitiveness and therefore its jobs. Given the local dependency on manufacturing jobs, this could represent a high risk for workers and communities.

  - Many of the jobs in manufacturing will be linked to the development of hydrogen and CCS technology. The development of hydrogen and CCS infrastructure will be location specific. This offers the opportunity to direct investments towards economically deprived areas. As noted above, expected locations are hard to predict and dependent on a range of factors. However, the two largest clusters are expected to be found in The Humber and South Wales. Other clusters could be found in Grangemouth in Scotland, Teesside, Merseyside and Southampton.[5] Clusters could broadly develop in areas that currently employ manufacturing workers such as the North of England, the East Midlands, and Yorkshire and the Humber which represent 16%, 9%, and 21% of energy-intensive manufacturing jobs respectively.

  - Around 40% of employees in the manufacturing sectors are employed by businesses that employ more than 250 employees. There is a relatively large number of businesses in the sector (270,000), however not all of these are found within the clusters. As such, certain businesses might have clear skills plans and requirements to develop industrial clusters, but it is less clear whether that is the case for all manufacturing businesses.

  - While opportunities should stem from the introduction of industrial clusters, the introduction of the United States' Inflation Reduction Act and the EU's proposed Green Deal Industrial Plan have increased the risk to industry competitiveness in the UK.[67] Without support for industry to maintain competitiveness and jobs, there is a risk that jobs could be lost. The local dependency on manufacturing jobs is relatively low at the local authority level, reaching up to 3% of workers employed relative to those economically active. However, this dependency can be much larger for certain regions and local areas thus posing a risk for workers and local communities.

(ii) Geographically dispersed sectors

Core Net Zero sectors which offer the most potential for new jobs, such as buildings, services and vehicle maintenance, should offer employment opportunities across the UK.

Sectors that need to be in closer proximity to demand and that require less access to physical resources can be found in a variety of geographic areas. As such, jobs created in these geographically dispersed sectors could create opportunities for a wide range of workers. At the same time, where jobs are largely dispersed across small and medium enterprises (SMEs) employing a small number of workers, UK-wide policy could be needed to support workers, notably though reskilling and upskilling.

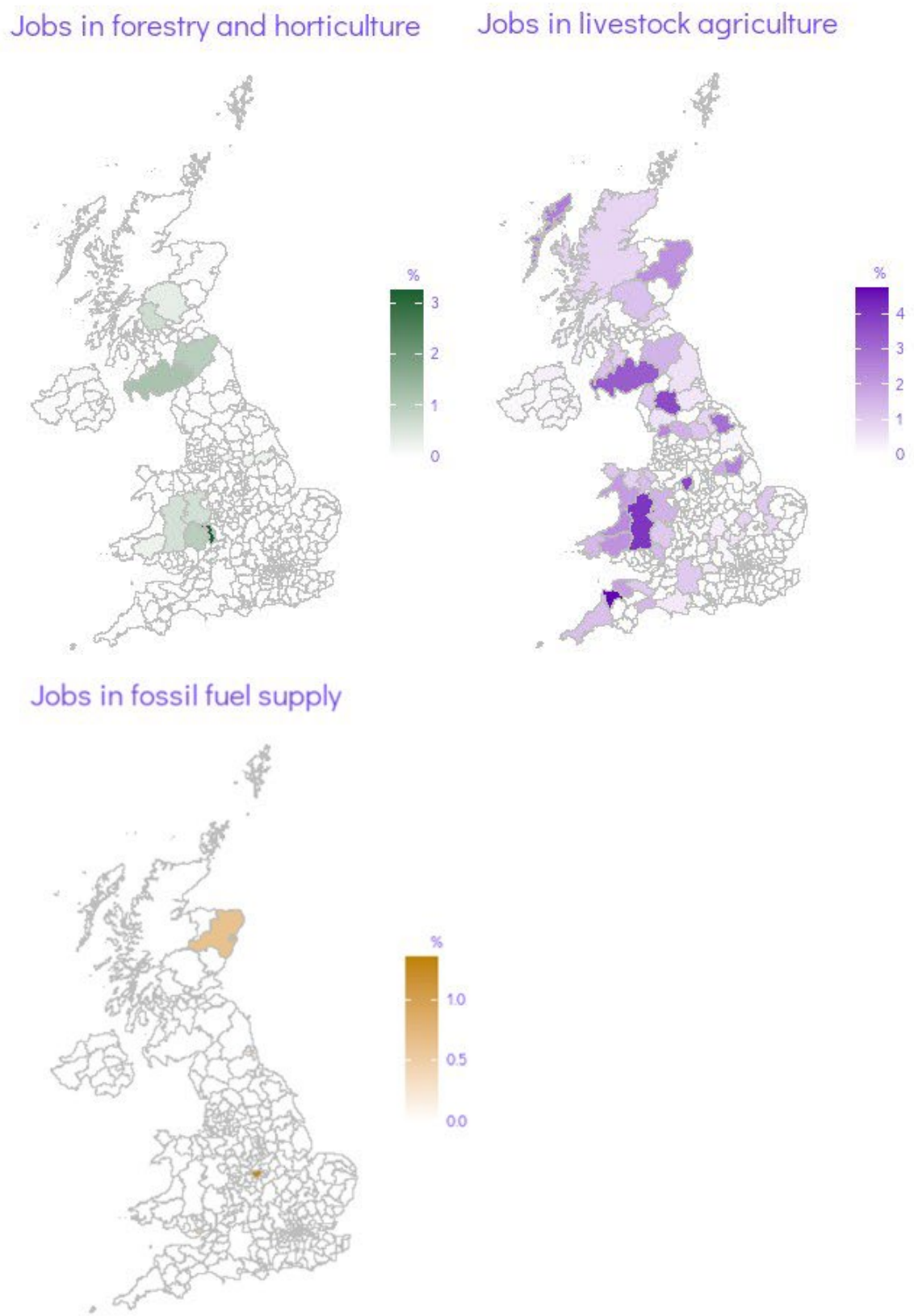
- Decarbonising **buildings** will entail mobilising construction workers and finding more people to install heat pumps and carry out energy efficiency improvements in all homes of the UK. In this instance, the impacts of Net Zero will be widespread and felt across the UK. While the buildings sector has a greater geographic spread than other sectors, it also provides a higher concentration of jobs in some areas. The construction sector has the single largest number of businesses in the UK (around 900,000), many of whom employ fewer than 50 workers. This makes it particularly challenging for these businesses to meet the expected high demand for heat pump and energy efficiency engineers, which could necessitate 120,000 to 230,000 workers by 2030, due to the costs of upskilling.

- **Vehicle maintenance** jobs in the UK are fairly geographically distributed, with a large concentration of employment found in major cities such as London, Birmingham, Manchester and Edinburgh. While the availability of workers tends to be higher in more populated regions, the proportion of these workers relative to those economically active is higher in rural areas. This is a sector that could see jobs decline as EVs require less maintenance than traditional cars. If demand for these services declines, these impacts could be experienced across the UK. While the impact might be less visible as employment dependency is less than 1% across local authorities on average, it is important that these workers are able to find alternative work.

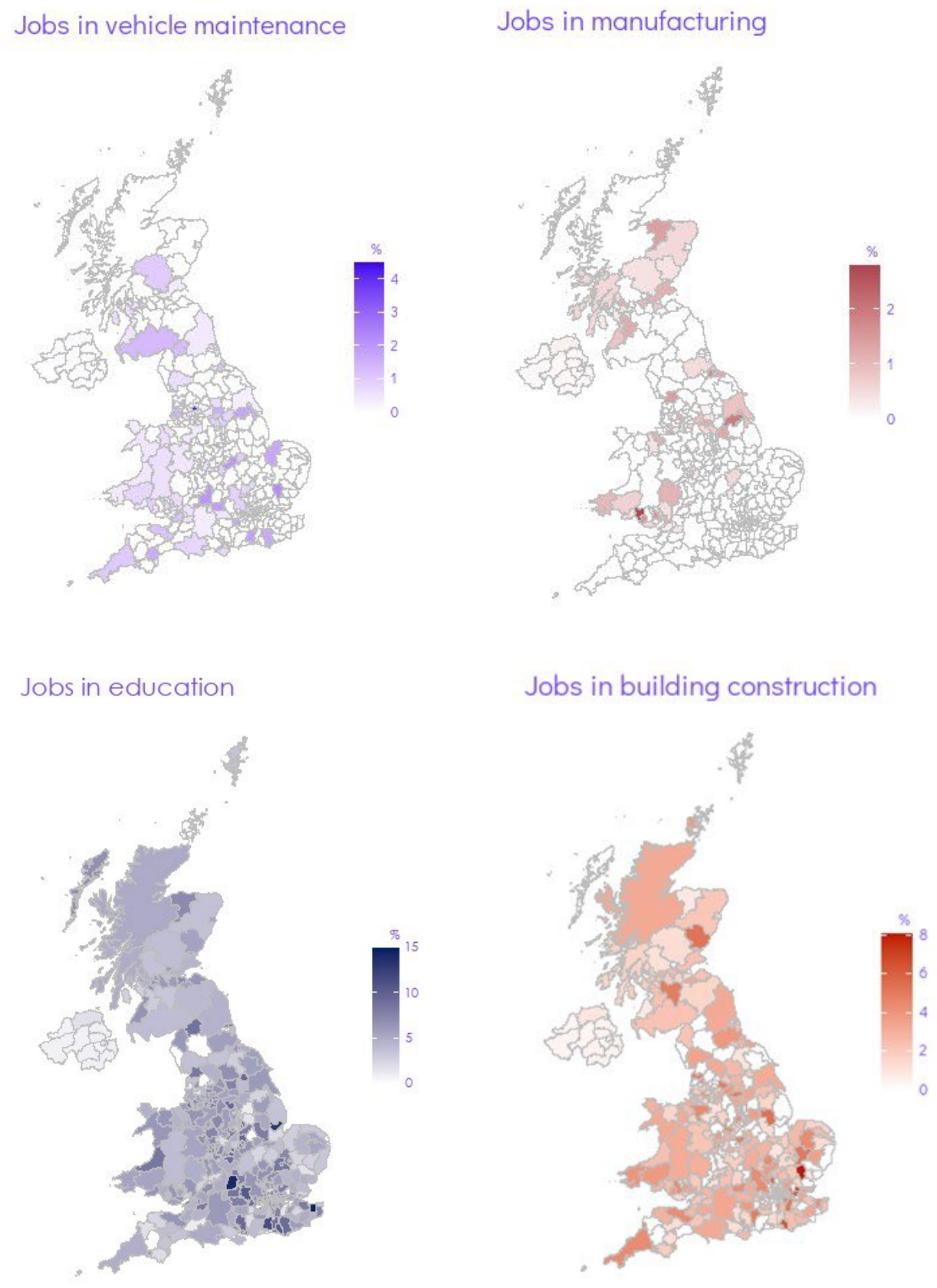
- Employment in **education** is widespread. From the sectors we have explored, local authorities have the largest proportion of employment dependency on the education sector. While the impact on employment is not clear, it is certain that educators will be key to enable the transition across all sectors of the economy by delivering the education and training that will prepare current workers and new entrants. It is an endeavour that will require a UK-wide adjustment to the education and skills systems.

Figure 3.3 Workers in selected Core Net Zero sectors relative to economically active population by local authority

a) Geographically concentrated sectors

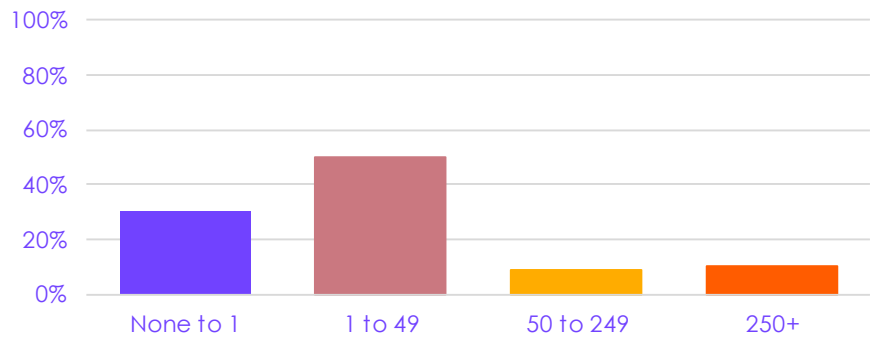
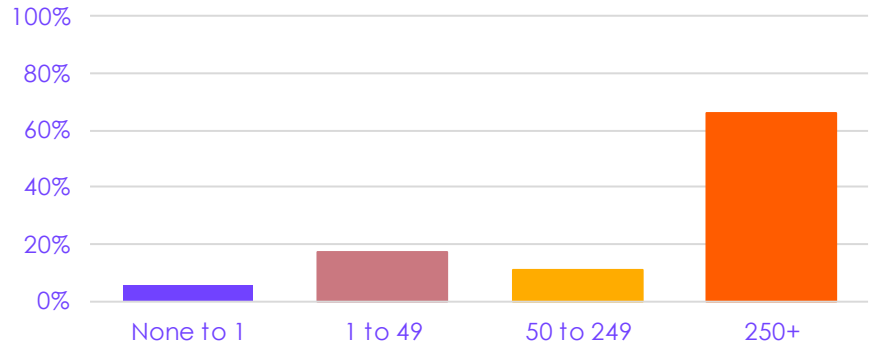
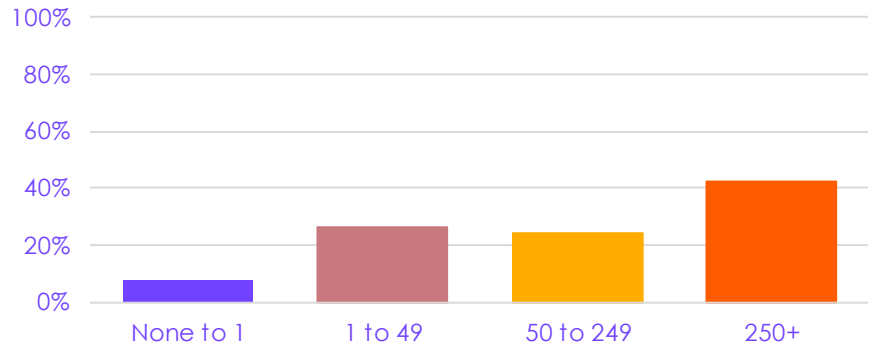
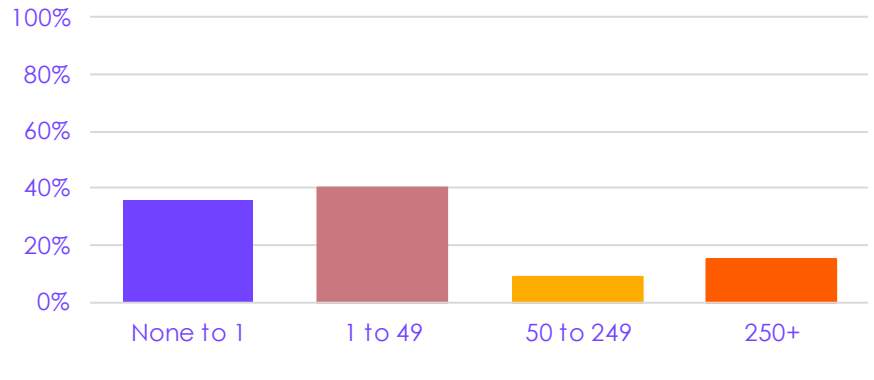


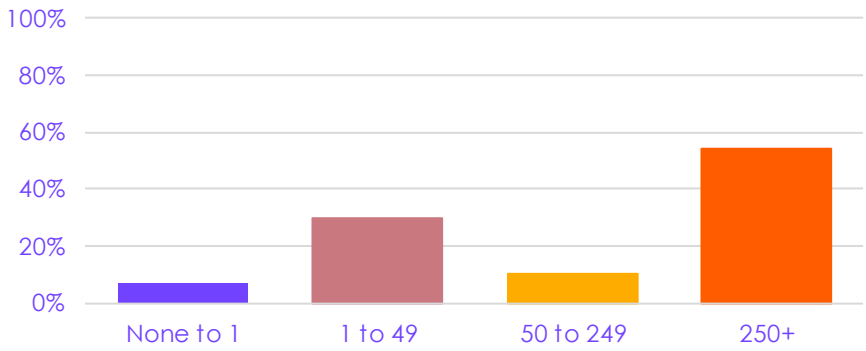
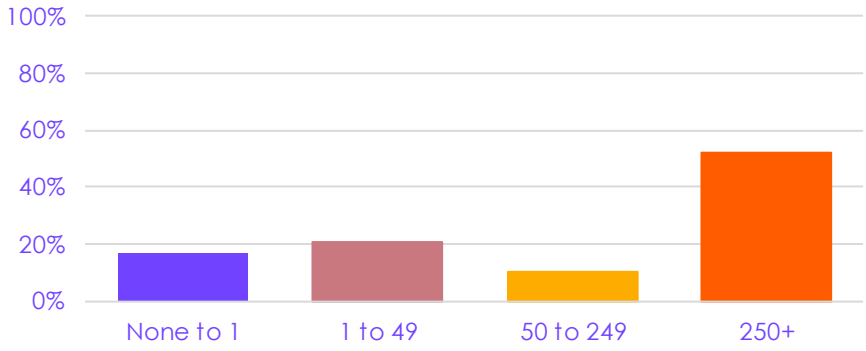
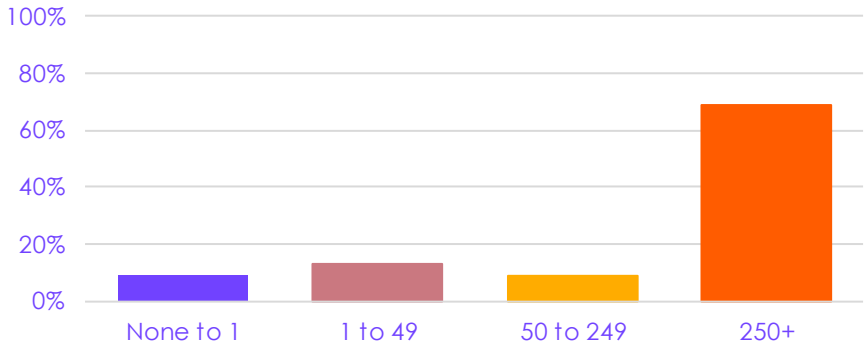
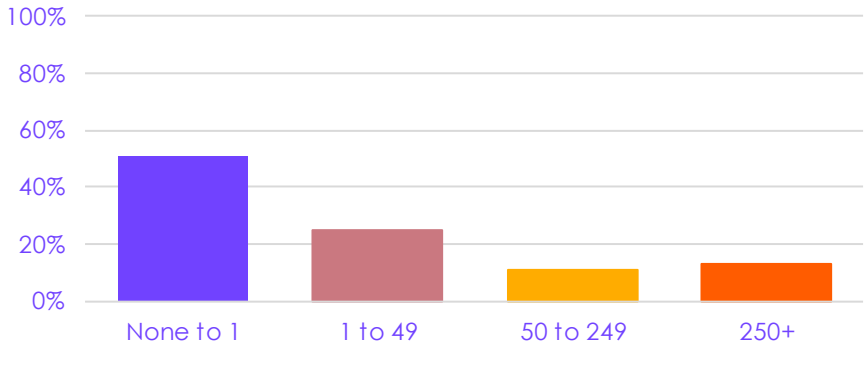
b) Geographically dispersed sectors



Source: CCC analysis
Notes: These maps show the percentage of people currently employed in the indicated sector related to those economically active at the local authority level. Projected changes to employment through either job creation or job losses are not included here – instead we show the current regional dependency on some of the Core Net Zero sectors to identify whether sectoral impacts might be dispersed or concentrated.

Table 3.1
Composition of businesses by sector

Sector	Number of UK businesses	Percentage of employees by size (number of employees)			
		None to 1	1 to 49	50 to 249	250 +
Agriculture, Forestry and Fishing	152,620 (3%)				
Mining and Quarrying; Electricity, Gas and Air Conditioning Supply; Water Supply; Sewerage, Waste Management and Remediation Activities	29,190 (1%)				
Manufacturing	270,000 (5%)				
Construction	913,820 (16%)				

Sector	Number of UK businesses	Percentage of employees by size (number of employees)			
		None to 1	1 to 49	50 to 249	250 +
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	556,930 (10%)				
Transportation and Storage	310,550 (6%)				
Financial and Insurance Activities	98,260 (2%)				
Education	298,250 (5%)				
All sectors	**5,590,900**	**17%**	**31%**	**13%**	**39%**

(ii) The pace of the transition

In this section we consider the pace of the transition for sectors, as rapid transitions carry a greater risk of disruption to workers.

The pace of the transition can contribute to determining the extent to which workers can adjust to changes within their sector. In the past, economic shocks or recession have typically impacted the labour market in a matter of years.

The transition to a Net Zero economy will impact workers over the course of several decades. However, the required rapid emissions reduction over the 2020s and 2030s to meet the UK's 2030 Nationally Determined Contribution (NDC) and the Sixth Carbon Budget imply a distinct step-change, which the education and skills systems will need to match. In some sectors change will occur gradually and in others it will be more rapid. When impacts occur gradually, workers are more likely to shift to alternative sectors with less disruption. With gradual shifts, and provided there is long-term certainty provided by policy, education and training systems are better able to secure funding to support workers which in turn supports workers that can thus take part in training to transition. This is less likely to be the case when impacts are rapid. We consider the transition to be rapid when workers experience the impacts of Net Zero within the next 10 years, as adjusting the skills system to introduce new standards and qualifications can take up to five years to develop.

In this section, we consider the pace at which abatement options need to be deployed in the Sixth Carbon Budget (Boxes 3.4 - 3.8). These measures are used as proxies for determining the pace at which workers will experience the impacts of Net Zero. In reality, some of these impacts will be felt earlier as the deployment of these abatement options is contingent on the availability of skilled workers. In some cases, rapid deployment may not be directly correlated with the rapidity of impacts on employment and skills needs.

Rapid transition

Core Net Zero sectors with the most rapid transition tend to be Grow sectors, presenting growth opportunities but also a risk that a lack of a skilled workforce constrains progress to Net Zero.

We find through our assessment (Boxes 3.4 - 3.8) that the sectors with the fastest-paced transitions tend to be sectors with potential for employment growth, including offshore wind, electric vehicle and battery manufacturing, heat pump and energy efficiency retrofit and afforestation and peatland restoration.

This has considerable implications for the UK's economy. On the one hand the most dramatic shifts will be linked to growth rather than phase down, which as we established earlier could lead to 725,000 net new jobs. However, it also points to the risk of having insufficient workers to deliver sectoral targets and climate commitments. In addition, for areas where growth is conditional, there is a risk the UK will miss opportunities to capture low-carbon markets if there isn't a skilled workforce to attract investment. Certain sectors benefit from targets that provide considerable policy certainty and broadly align with what we identified as needed in our Sixth Carbon Budget. With clear policies that signal a role for these sectors in delivering emissions reductions, the need for skilled workers is underlined.

- The full decarbonisation of the power sector by 2035 will require a ramp up in the deployment of offshore wind, from 1 GW of new operational capacity per year today* to 4.5 GW per year out to 2030 (Box 3.4). With the expansion of renewable generation will come a growing need for skilled workers. Meeting this demand for skilled labour will be vital for achieving the target.

- The roll-out of electric vehicles (EVs) will be one of the fastest transitions given the end of internal combustion engine vehicles sales by 2030 (Box

* Average new operational capacity between 2019 and 2021.

3.5). This will require retraining of some vehicle mechanics as well as new opportunities for training people to install EV charging infrastructure.

- The ban of gas boilers sales announced for 2035 (Box 3.6) will leave about a decade to transform the skills of boiler engineers and manufacturers. Installations of heat pumps and energy efficiency improvements should start to accelerate from this year at 200,000 and 500,000 installations per year, respectively.

Other sectors, such as batteries, afforestation and peatland restoration, have potential for employment growth but do not yet have clear policies.

- Growing demand for electric vehicles will mean an increase in batteries (Box 3.5). The ability of the UK to get a place in the race to capturing shares of low-carbon investment will depend on the development of a strong low-carbon skills base in this area.

- To ensure that the benefits of afforestation and peatland contribute towards the Net Zero target, action must be taken immediately in the 2020s in order for twice the current level of peatland to be restored by 2030 (Box 3.7). This should be accompanied by a rapid ramp up in skilled workers, given the existing shortage.

Gradual transition

The pace of change will be more gradual in areas such as infrastructure, livestock agriculture, oil and gas and development of sustainable aviation fuels.

Transitioning to a Net Zero economy will require sustained and ongoing changes for workers. We find through our assessment that changes to infrastructure, behaviour changes and development of certain technologies may be more gradual.

- The development of infrastructure can take several years or decades to scale up. In manufacturing, the 2020s will mainly be dedicated to demonstrating the potential of low-carbon energy for industrial heat before rolling CCS for process emissions (Box 3.8). Skilled workers will be needed from the 2020s to develop these solutions, however the ramp up is likely to take root in the late 2030s. Similarly, the shift of transport infrastructure should be gradual as ICE vehicles should phase down over several decades until the 2050s, leaving room for workers in vehicle maintenance and the retail of automotive fuel to transition.

- The adoption of behaviour change across society also tends to happen at a slower pace. For example, individual meat consumption should decrease by 20% between 2020 and 2030, from 637 to 510 grams per person per week (Box 3.7). An additional 15% decrease would then be needed by 2050 to reach 414 grams per person per week. As a result, the declining role for livestock in farming and the shift to other forms of agriculture and land use is likely to be slower in pace relative to some other sectors.

- Some technological solutions are yet to become mature. Their development is likely to take place over several decades as is the case with sustainable aviation fuels (SAFs), for example, that could see demand double in the 2040s (Box 3.5).

- The decline of oil and gas consumption, which will be gradual in pace, will be driven by the combination of behaviour change, and the uptake of low-carbon technologies and infrastructure in line with the decarbonisation pathway to Net Zero (Box 3.4). However, the natural depletion of oil and

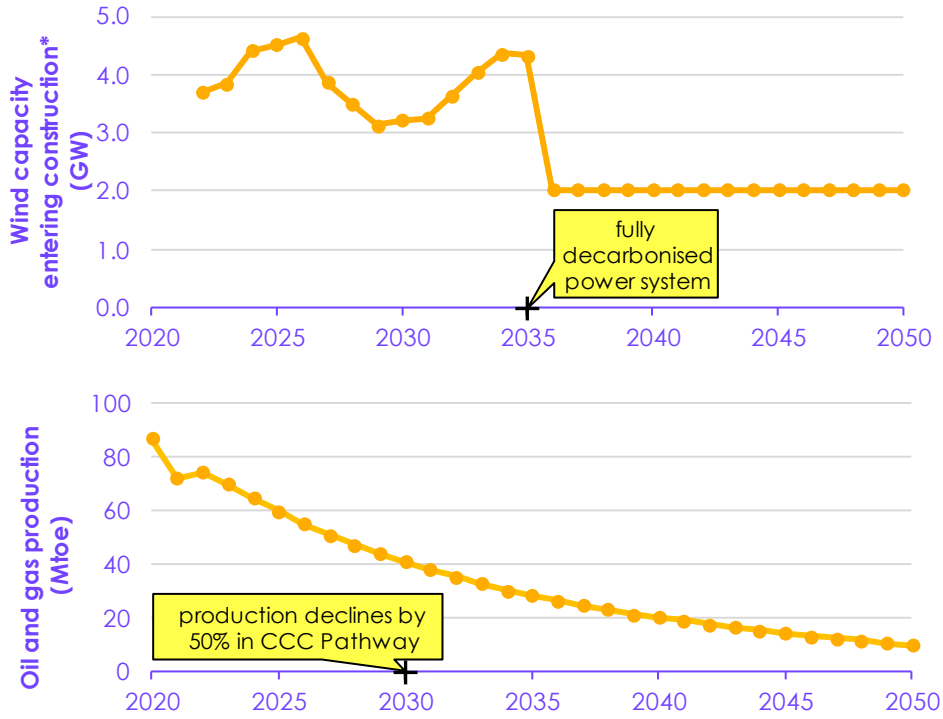
gas reserves in the North Sea is more likely to dictate the pace of the transition for workers in the UK.

This slower pace does not mean that that addressing the impacts of Net Zero on workers in these sectors can be postponed. While the impacts might be felt in the 2040s more strongly than in the 2020s or 2030s, many of these more gradual shifts require structural changes to sectors which need preparation well ahead of them taking place. In addition, while the pace of change appears more gradual than the rapid changes above, the pace may be faster than the shift to a service economy discussed in Section 1, which took place over more than 100 years.

Box 3.4
Pace of change – energy supply

Full decarbonisation of the power sector by 2035 (Figure B3.4) will require a relatively rapid ramp up in the deployment of offshore wind, from 1 GW of new operational capacity per year today* to 4.5 GW per year out to 2030. Continued and significant expansion of the power system through to the mid-2030s should continue to drive demand for planners, engineers and builders, as well as present opportunities for manufacturing of low-carbon technologies (particularly wind turbines and batteries). Our pathway shows a gradual and steady decline of oil and gas production in the North Sea, which is expected to be 50% below today's levels by 2030 (Figure B3.4). This is likely to be driven by a combination of behaviour change and uptake of low-carbon technologies. However, the natural depletion of oil and gas reserves in the North Sea is more likely to dictate the pace of the transition for workers in the UK.

Figure B3.4 Pace of deployment in CCC pathways for energy supply



Source: CCC analysis.

Source: CCC analysis.
Notes: *We assume a linear increase in wind capacity past 2035, however the deployment of new wind capacity is likely to be more frontloaded. These charts present the deployment of abatement measures needed under the CCC's Sixth Carbon Budget Pathway. While the pace of this deployment can inform the pace of change for workers, action to support workers is likely to be required ahead of achieving these deployment milestones. CCS stands for carbon capture and storage.

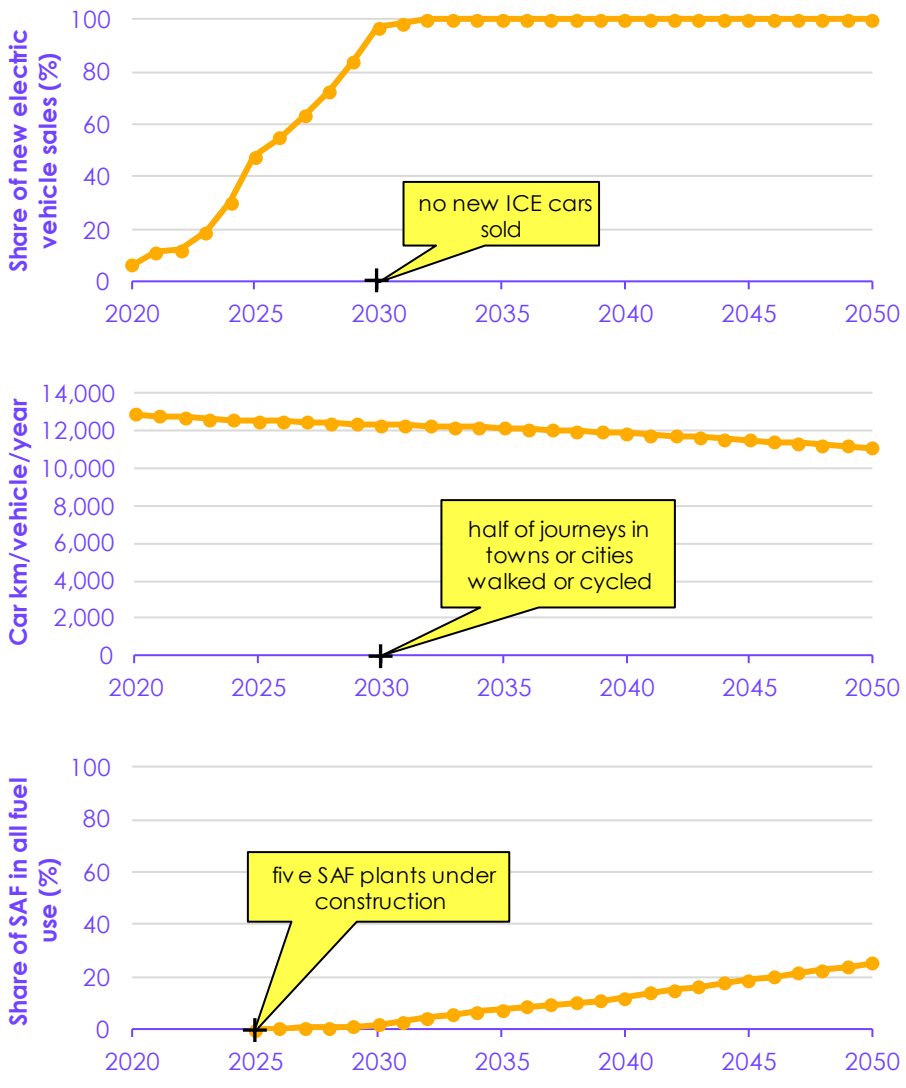
Box 3.5
Pace of change – transport

We can expect a rapid roll-out of electric vehicles in the next decade, given the end of internal combustion engines (ICE) sold by 2030 (Figure B3.5).

- Growing demand for electric vehicles will mean an increase in battery and electric vehicle manufacturing, which could occur in the UK or abroad.
- The installation of a large volume of charging points could grow demand for trained electricians.
- Although there will still be some ICE vehicles on the road until 2050, demand for maintenance and repair of motor vehicles and retail sale of automotive fuel will be much lower.

Our pathway includes a steady increase in walking and cycling, with half of journeys in towns or cities walked or cycled by 2030 (Figure B3.5). This could result in more demand for public transport construction and operation. The development of sustainable aviation fuels (SAF) is likely to take place over several decades (Figure B3.5). This will be accompanied by new markets for sustainable aviation fuels, which could develop in the UK or abroad.

Figure B3.5 Pace of deployment in CCC pathways for transport



Source: CCC analysis.

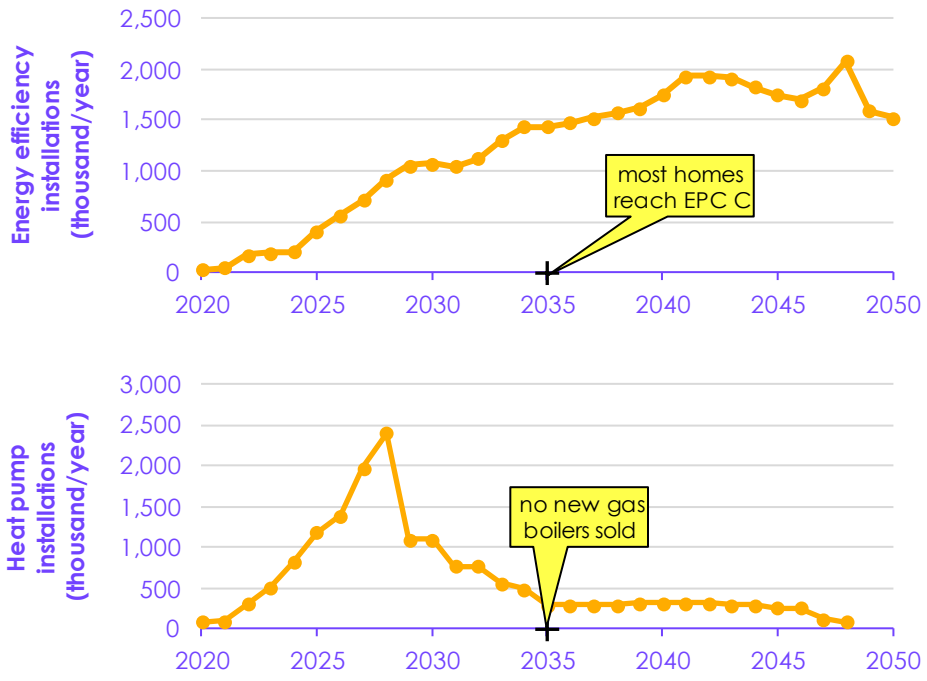
Source: CCC analysis.
Notes: These charts present the deployment of abatement measures needed under the CCC's Sixth Carbon Budget Pathway. While the pace of this deployment can inform the pace of change for workers, action to support workers is likely to be required ahead of achieving these deployment milestones. SAF stands for Sustainable Aviation Fuel. The ZEV Mandate is the Zero Emissions Vehicle Mandate.

Box 3.6
Pace of change – buildings

Government plans to phase out the sale of new gas boilers by 2035 will leave about a decade to transform the skills of boiler engineers and manufacturers. Our Balanced Pathway sees a rapid scale-up in deployment of heat pumps in the run up to this date (Figure B3.6), which would suggest demand for heat pump installers growing until the late-2020s, and growing demand for heat pump manufacturing, which could occur in the UK or abroad.

Our Balanced Pathway sees most homes reaching EPC C energy efficiency by 2035, entailing a rapid increase in energy efficiency installations in the 2020s through the 2030s (Figure B3.6). This could see demand for construction trades to improve the fabric of buildings growing steadily until the beginning of the 2040s.

Figure B3.6 Pace of deployment in CCC pathways for buildings



Source: CCC analysis.

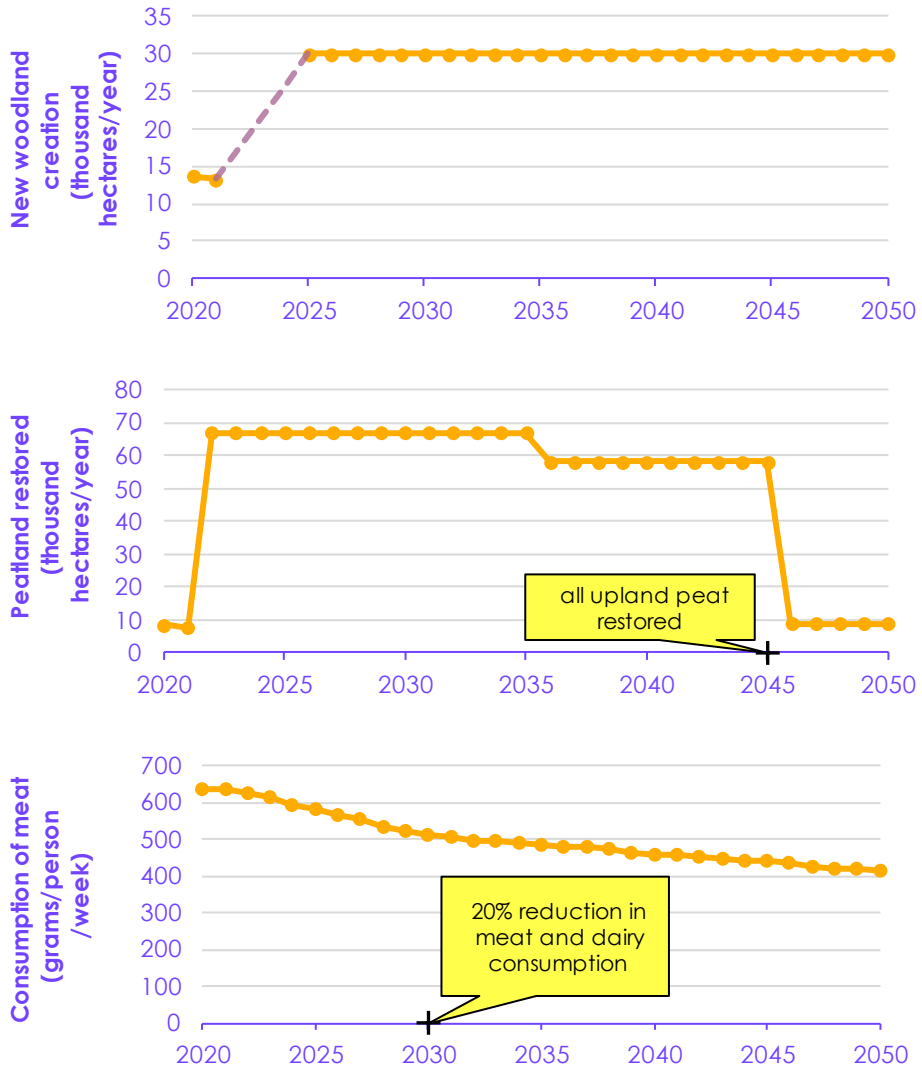
Source: CCC analysis.
Notes: These charts present the deployment of abatement measures needed under the CCC's Sixth Carbon Budget Pathway. While the pace of this deployment can inform the pace of change for workers, action to support workers is likely to be required ahead of achieving these deployment milestones.

Box 3.7
Pace of change – agriculture and land use

In the next 5 years our pathways see a rapid increase in rates of afforestation and peatland restoration (Figure B3.7). This will need to be accompanied by a rapid ramp up in skilled workers.

We expect to see a steady shift in land use and farming practices, enabled in part by a gradual decline in meat and dairy consumption (Figure B3.7). The declining role for livestock in farming and the shift to other forms of agriculture and land use are likely to be slower in pace relative to some other sectors.

Figure B3.7 Pace of deployment in CCC pathways for agriculture and land use



Source: CCC analysis.

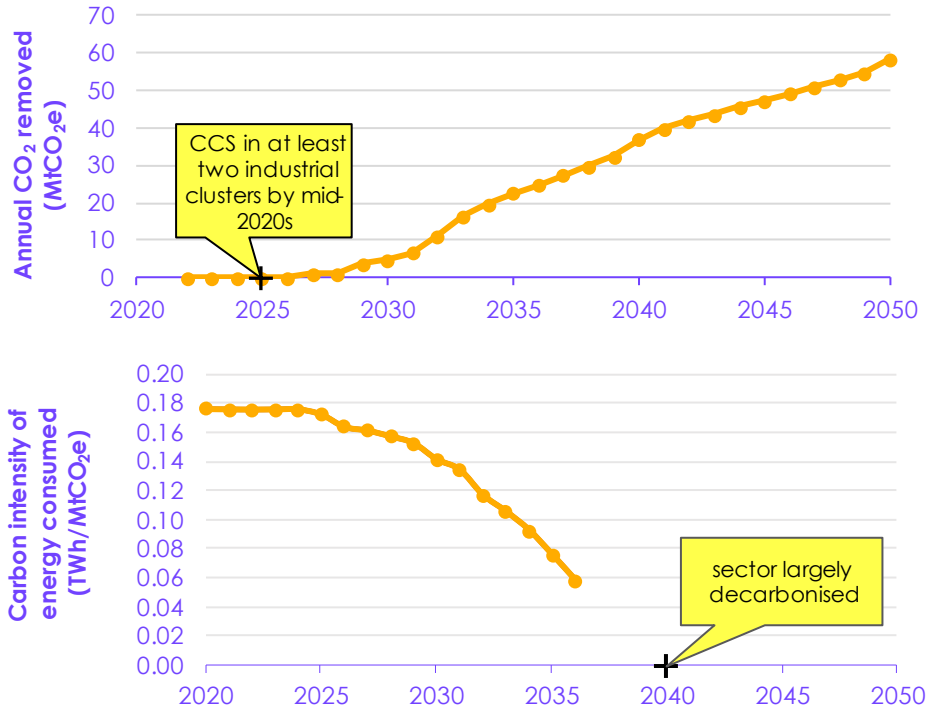
Source: CCC analysis.
Notes: These charts present the deployment of abatement measures needed under the CCC's Sixth Carbon Budget Pathway. While the pace of this deployment can inform the pace of change for workers, action to support workers is likely to be required ahead of achieving these deployment milestones.

Box 3.8
Pace of change – manufacturing and removals

In our pathway, industrial decarbonisation is initially achieved through improvements to energy and resource efficiency (Figure B3.8). Whilst this isn't expected to materially change the workforce, there will be increasing need for technical knowledge in these areas.

We expect the 2020s to be largely focussed on showing the potential of low-carbon energy for industrial heat, before rolling CCS for process emissions. This is a more gradual transition (Figure B3.8) than for some other sectors, which could in time create new industries in the UK.

Figure B3.6 Pace of deployment in CCC pathways for manufacturing and removals



Source: CCC analysis.

Source: CCC analysis.
Notes: These charts present the deployment of abatement measures needed under the CCC's Sixth Carbon Budget Pathway. While the pace of this deployment can inform the pace of change for workers, action to support workers is likely to be required ahead of achieving these deployment milestones. CCS stands for carbon capture and storage.

(iii) Characteristics of the workforce

In this section we consider how Net Zero will impact different workers based on age, ethnicity, and gender.

In this section, we consider how Net Zero could impact different groups based on age, ethnicity and gender. Other characteristics were considered but are not included in this analysis due to lack of evidence.

To date, certain sectors have had a disproportionate over- or under-representation of demographic groups in their workforce relative to the UK average. As a result, the effects of Net Zero could fall disproportionately on certain demographic groups. There is also an opportunity to increase diversity in sectors that are expected to grow under the Net Zero transition.

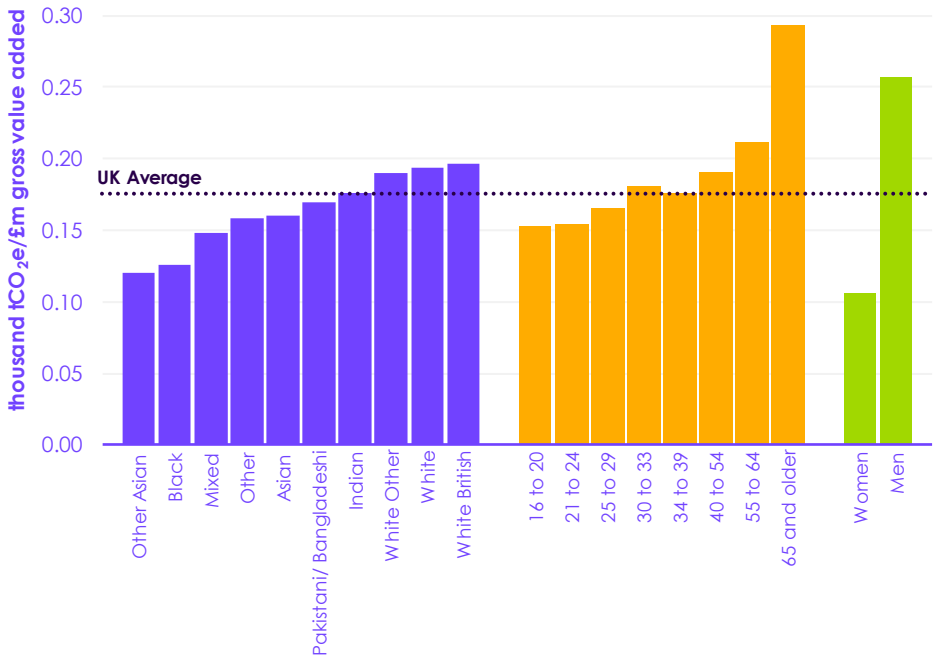
In this section, we review external data at a more aggregated level than in the analysis in Chapter 2, mostly by sector as classified by Standard Industrial Classification (SIC) 2007. As such, the sector labels in this section do not directly match the sector labels used in earlier sections. We supplement our own analysis with external research.

Sector characteristics

Emissions-intensive sectors. We find that people aged over 40, those who identify as men and those who identify as white work in more emissions-intensive sectors on average. In contrast, people aged under 40, those who identify as women and those who identify as ethnic minorities tend to work in less emissions-intensive sectors (Figure 3.3).

People aged over 40, those who identify as men, and those who identify as white, tend to work in more emissions-intensive sectors on average.

Figure 3.3 Average emissions intensity of employment sector, based on worker ethnicity, age and gender



Source: CCC analysis; ONS (2022) *Greenhouse gas emissions intensity in the United Kingdom, 1990 to 2020 and (provisional) 2021.*
Notes: This analysis looks at sector-level greenhouse gas emissions intensities, and cross-references these with ethnicity, age and gender demographics within each sector. The result is an average (mean) emissions intensity for each demographic category, based on relative levels of employment in each sector. This analysis does not consider occupational or sub-sector level emissions intensities, and therefore is likely to underestimate the difference in emissions intensity between people from ethnic minority backgrounds, women and under-40s relative to white workers, men and over-40s – as explained in the Occupational Characteristics section below.

There is considerable variation in age, gender and ethnicity of workers in sectors relevant to Net Zero (Figure 3.4).

Women and people from ethnic minority backgrounds are under-represented in almost all sectors expected to grow as part of Net Zero.

- Women and people from ethnic minority backgrounds are under-represented in almost all sectors where job growth is expected as part of the Net Zero transition.
  - In the construction sector 120,000 to 230,000 jobs could be created across the UK in order to retrofit and insulate the UK housing stock. Women make up 12% of the sector's workforce despite representing 47% of the UK's total workforce, while workers from ethnic minority

backgrounds workers make up 4% of the sector's workforce compared to 13% of the overall UK workforce (Figure 3.4).

  - Forestry and peatland restoration could lead to over 40,000 new jobs. However, to date, only 1% of workers in the agriculture, forestry and fishing sector identify as ethnic minorities, compared to the national average for workers of 13%. While this is partly due to the rural nature of the sector, the data suggests an under-representation even when taking this into account. Women similarly represent only 26% of workers in the sector, below the national average of 47%.

  - In offshore wind, external research highlights that women and ethnic minorities are under-represented. For example, despite representing 50% of GCSE entrants in STEM subjects and out-performing males in achievement, just 16% of graduates with offshore wind-relevant degrees in 2015-16 and fewer than 10% of STEM apprenticeship achievers were female.[8] The offshore wind sector has recognised these gaps to some extent and has set targets for diversifying its workforce, including targets of 33% women and 9% employees from ethnic minority backgrounds by 2030.[9]

More representation of women and people from ethnic minority backgrounds in Grow sectors could help spread the opportunities created by Net Zero, and support Net Zero delivery.

- Under-representation of women and people from ethnic minority backgrounds in sectors expected to grow points to an opportunity to diversify the workforce. There is a risk that a lack of diversity in these sectors limits the effective delivery of Net Zero and means people with these characteristics are not included in the opportunities Net Zero brings.

  - A diverse workforce is especially important in sectors with significant interaction with households and consumers. For example, research from the Energy Systems Catapult suggests that female tradespeople may be preferred in some religious households and by female customers.[10] Increased lived experience within communities and shared cultural values have been shown to increase the likelihood of people buying a service, which is important for uptake of low carbon technologies such as heat pumps and electric vehicles.

  - In sectors that are expected to grow, a wide pool of potential workers will be needed to deliver Net Zero. There is a risk of failing to deliver Net Zero if equal access to jobs and skills is not provided for the entire population.

  - Though the evidence base is still growing, studies have shown that the green jobs created as a result of the Net Zero transition 'pay higher wages and are at lower risk of automation than non-green jobs'.[11] Therefore, there is a risk of exacerbating inequality if this lack of diversity in Grow sectors is left unaddressed.

- The main exception to this trend is in the transport and communication sector, where ethnic minorities make up 18% of employees compared to the national average of 13%. It is important to consider job quality within sectors when this is the case, as variation can exist between different ethnic groups. For example, in this sector workers from a minority ethnic group made up 28% of the jobs vulnerable to shut down during the COVID-19 pandemic despite comprising only 18% of employees. The Resolution Foundation found that this was reflected more widely across all sectors, with workers of Bangladeshi ethnicity more likely to have left employment

altogether, while workers of Black African ethnicity were more likely to be working fewer hours and earnings less.[12]

In some of the main Phase Down and Redirect sectors, those aged over 55 are over-represented.

- In most sectors relevant to Net Zero, the proportion of workers over the age of 55 is similar to the national average (20%). However, in the agriculture, forestry and fishing sector and the oil and gas sector, which correspond to some of the key Redirect and Phase Down sectors in our analysis, workers aged over 55 are over-represented. Tailored support, skills and training for those workers approaching retirement may be needed.

  – Many (38%) of workers in the agriculture, forestry and fishing sector are over the age of 55, compared to a total workforce average of 20%. These workers will need to transition to new forms of agriculture under a low-carbon economy, some of which require digital skills. Reaching and communicating effectively with these farmers may require targeted outreach (e.g. through trusted peers), and some farmers may have had limited access to formal training in these areas.

  – Under-30s make up only 17% of the agriculture, forestry and fishing sector, despite comprising 23% of the UK's total workforce. In parallel, fewer than 20% of surveyed farmers plan on fully retiring and those who do intend to do so past the age of 70.[13] Defra committed to pay up to £100,000 lump sums to farmers to encourage retirement and bring newer farmers into the trade and free up land to encourage changing land use, however this scheme ended in 2022.[14]

  – The ECITB's 2021 Workforce Census Survey found only 12% of the oil and gas sector was aged under 30, despite under 30s making up 23% of the total workforce.[15]

Occupational characteristics

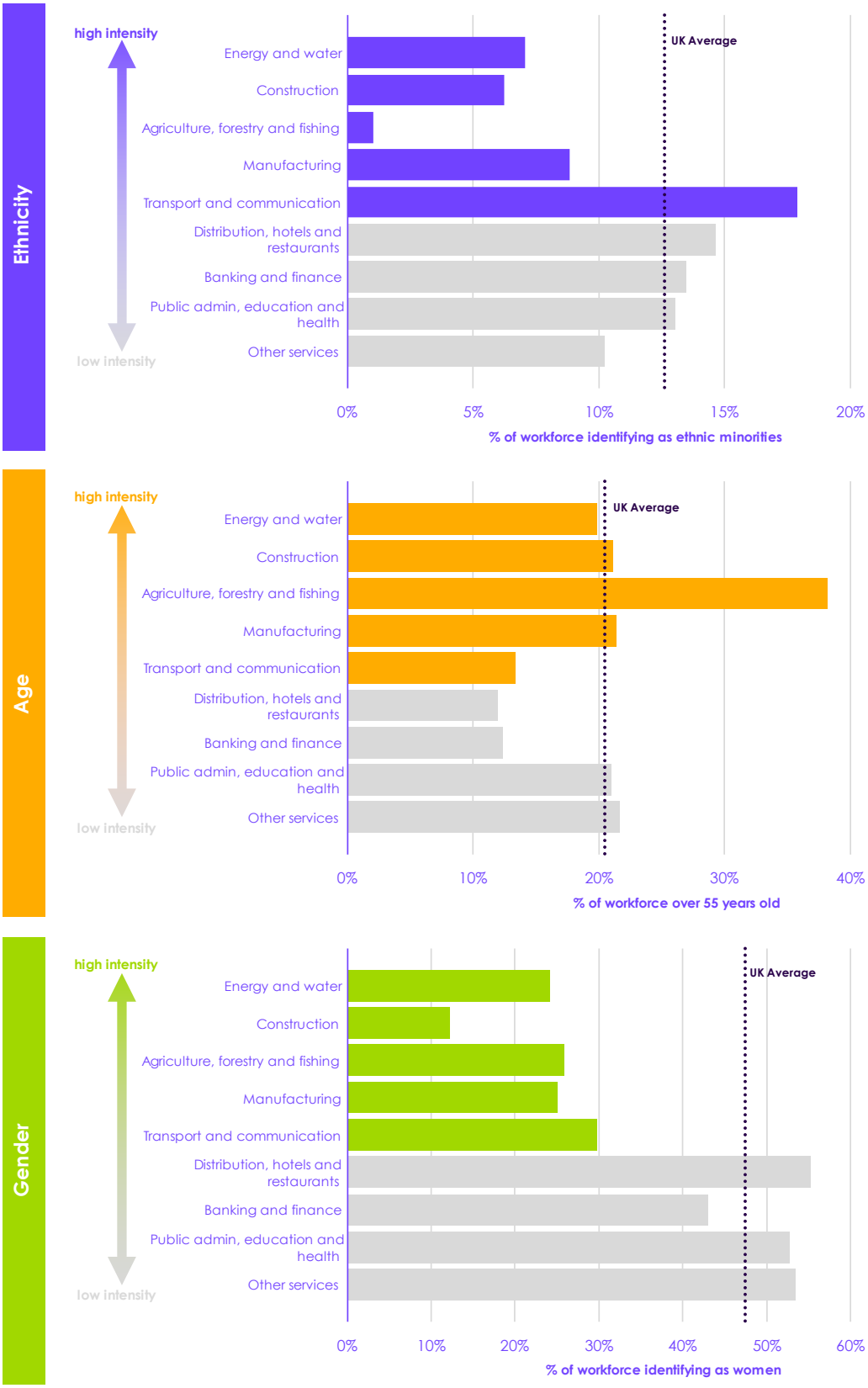
Where 'green' jobs are in managerial and professional occupations, workers from ethnic minority backgrounds may be under-represented.

Evidence suggests that certain demographic groups are also under-represented in 'green' occupations and training programmes within sectors. For example, research from The Economy 2030 Inquiry investigated job characteristics in specific occupations that required green skills, finding that 'Green workers tend to be most prevalent in the highest-paid occupations: including managerial (40% of workers), professional (17%) and associate professional (21%)'.[16]

In the overall UK workforce, ethnic minorities make up only 5% of senior managerial roles despite representing 13% of the total workforce, while women occupy 41% of management roles despite making up 47% of the total workforce.[17,18] If barriers to participation in green jobs training programmes remain, this could widen diversity gaps in high-paid Net Zero related occupations.[19]

Workers who identify as women or who are from ethnic minority backgrounds tend to be under-represented in most sectors expected to grow. Workers over 55 years old are over-represented in agriculture, forestry and farming.

Figure 3.4 Workforce characteristics in sectors most impacted by the Net Zero transition



Source: CCC analysis based on ONS (2022) Employment by sector; ONS (2021) Employment by age, industry and occupation, UK, 2010, 2015 and 2019; ONS (2023) EMP13: Employment by industry.
Notes: Sectors shown are based on SIC 2007 classifications and are ordered from most to least GHG emissions intensive (tCO2e per £ GVA), from top to bottom. Core Net Zero sectors have been marked by colour (purple for ethnicity, orange for age and green for gender), while other sectors have been marked grey. For each demographic, the average percentage of workers of that demographic in the overall UK workforce is shown by a dotted black line. All data shown in this Figure is for 2019.

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Chapter 4

The labour market context

In this Chapter we consider the wider labour market context.

In this Chapter we consider the labour market context in which the Net Zero transition will take place. We assess:

- Major labour market trends and how these might interact with Net Zero
- The status of the current labour market and key challenges, and how these might interact with Net Zero

Our key messages are:

Labour market challenges could make it difficult to ensure appropriately skilled workers are employed to help deliver Net Zero.

- The impact of the transition to Net Zero on the labour market should be understood in the context of a labour market that is constantly evolving in response to various trends and has accommodated shifts in the past.
- Increasing automation could free up workers to support Net Zero in some areas, but equally in others, such as manufacturing, it could compound potential job losses. Net Zero policies should be designed with these potential interactions in mind.
- There is currently a tight labour market, which presents a risk to sectors which need to grow to deliver the Net Zero transition. The UK's ageing population and changing immigration system may also affect the availability of skilled workers, although it is hard to predict the overall effect of changes to the immigration system.
- The Net Zero transition will take place in a UK labour market facing challenges such as skills mismatches, stagnating real wages and economic uncertainty. This may make it harder to ensure appropriately skilled workers are in the right place at the right time to help deliver Net Zero.

The rest of this Chapter is set out in two sections:

1. Labour market trends parallel to Net Zero
2. The state of the labour market system

1. Labour market trends parallel to Net Zero

Future labour market trends will affect the context in which the Net Zero transition takes place and could interact with it both positively and negatively. This section highlights three major trends that are expected to influence the UK labour market in coming years and decades: automation, an ageing population and a changing immigration system.

Increasing automation could help free up workers to help deliver Net Zero, but in certain sectors it could compound potential job losses.

- **Automation** is expected to continue to affect the labour market, with certain professions at particularly 'high risk' of automation (Box 4.1 and Figure 4.1). Automation could free up workers for Net Zero jobs without reducing output elsewhere in the economy, thus resulting in improved productivity. At the same time, the interactions between Net Zero and automation could lead to compounding job losses, such as in manufacturing. Policy should be developed at the intersection of these parallel and overlapping changes to the labour market to ensure workers can adapt to changing needs – not only for a low-carbon economy but one with more automation and greater use of digital technologies.

The UK's ageing population could result in a tighter labour market. A changing immigration system could change the skills those migrating to the UK bring.

- The UK's **ageing population** may result in a smaller proportion of the population being of working-age and an increased demand on workers in health and social care (Box 4.1). This could result in a tighter labour market, which could present a risk for sectors that will need to grow to deliver the Net Zero transition, such as buildings construction and retrofit, afforestation and electric vehicle manufacturing.

- It is hard to assess the long-term impacts of recent changes to the UK's **changing immigration system** (Box 4.1). However, it is possible that there will be a shift in the kinds of skills those migrating to the UK bring with them, which could impact on sectors which need to grow for the Net Zero transition.

Box 4.1
Labour market trends

- **Automation**. Automation has been impacting labour markets and the nature of work since the industrial revolution. It is expected that automation will continue to impact workers in the future, though estimates of its impacts on jobs should be treated with caution, as they have previously been overstated.
  - Around 1.5 million workers in England (7.4% of people) are in occupations at 'high risk' of automation and 65% are in occupations at 'medium risk' of automation.*
  - In the past forecasts of automation have been overstated. Those working in sales, caring, manufacturing or with machinery are more likely to be affected by automation, as are young people, women and part-time workers (Figure 4.1). Many of these occupations are in the transport and manufacturing sectors, which could also be affected by the transition to Net Zero.
- **An ageing population**. As people live longer and birth rates decrease, there are increasing numbers of older people. An older population could risk a shrinking size of the working-age population and greater demand on workers in health and social care, resulting in an even tighter labour market. The challenge of an ageing population is not unique to the UK.
  - The median UK age at death is 82.3 years for males and 85.8 years for females. This is projected to reach 90.1 years for boys and 92.6 years for girls born in 2045. At the same time, birth rates are falling in the UK. There were 624,828 live births in England and Wales in 2021, a notable decrease of 14% from 2012.
  - In 2021, over 11 million people (19% of the total population) were aged 65 years or older, compared with 16 % in 2011. By the mid-2030s, the number of people of pensionable age are expected to increase by 1.3 million people. Although state pension age is linked to life expectancy and is due to increase further (from 65 to 67), not all people work until state pension age and the share of the population who are retired is still likely to increase.
  - Although the number of working-age people is also projected to increase by 2035, this is at a lower rate than those of retirement age, with an additional 1.9 million workers.
  - As the working-age population also becomes older, there could be impacts on labour force productivity due to ill health. Greater caring demands on those of working age is also likely to be a factor. There is likely to be a growing demand for workers in the health and social care sector to cater for the ageing population. However, as noted above, the care sector is also expected to be at 'high risk' of automation.
- **A changing immigration system**. In 2021, the UK introduced a new immigration system that aligns immigration policy for EU and non-EU migrants. It is hard to predict how the UK labour market will shift as a result of the UK's new immigration system, as there is a range of factors at play.
  - Net migration – inward migration minus outward migration – has been relatively steady at around 200,000 people each year for the past decade, following increases in net migration since the early 1990s. Immigrants to the UK tend to be of working age, contributing to an increase in the size of the working-age population.
  - It is difficult to disentangle the effects of the introduction of the UK's new immigration system in 2021 on migration as its start overlapped with movement restrictions due to the pandemic. It could be expected to result in a tighter labour market due to decreased migration from the EU. However, while net migration from the EU decreased from 2020 to 2022, net migration overall increased. The Office for Budget Responsibility (OBR) has predicted net migration will stabilise at 245,000 people each year, while the ONS has reported an increase in long-term net migration to over 500,000 for the year ending June 2022, driven largely by net migration of non-EU nationals and 'a series of world events' such as the end of UK

* The risk of automation is considered to be 'medium' when the probability falls between 30% and 70%. Studies date back to 2017.

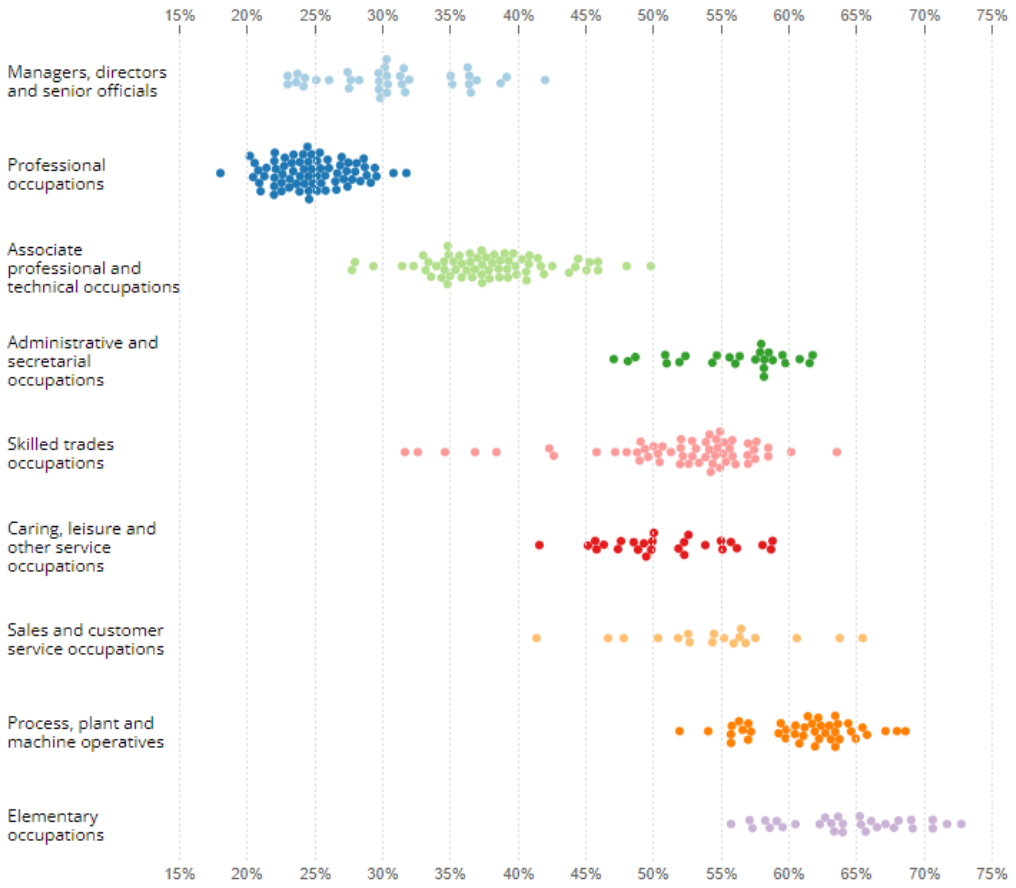
pandemic restrictions, the war in Ukraine, the resettlement of Afghans and the UK's exit from the European Union.

– Changes in composition of workers from EU and non-EU countries, and the change in visa requirements, are likely to affect the availability of skilled workers for various sectors. However, it is hard to predict exactly what this effect will be, as there are a range of options for how employers and workers could respond to the new system.

Source: ONS (2019) *Which occupations are at highest risk of being automated?*; ONS (2021) *National lifetables – life expectancy in the UK: 2018 to 2020;* ONS (2021) *National lifetables – Past and projected period and cohort life tables: 2020-based, UK, 1981 to 2070;* ONS (2021) *Demography and migration: Census 2021 in England and Wales;* ONS (2021) *Voices of our ageing population: Living Longer Lives;* The Migration Observatory (2022) *Net migration to the UK;* Office for Budget Responsibility (2020) *Economic and fiscal outlook – March 2020;* OBR (2023) *Economic and Fiscal Outlook – March 2023 – Chapter;* Migration Laboratory (2022) *How is the End of Free Movement Affecting the Low-wage Labour Force in the UK?; ONS (2023) Long-term international migration, provisional: year ending June 2022.*

Occupations such as process, plant and machine operatives and skilled trades occupations tend to be at higher risk of automation.

Figure 4.1 Average probability of workers at risk of automation by occupation



Source: ONS (2019) *Which occupations are at highest risk of being automated?*
Notes: These estimates represent the average probability of automation for people employed within in a specific occupation and does not differentiate between high, medium, and low risk. This differs from the UK average, and the probability of tasks being automated within an occupation (which is discussed in the text above). We note that probability for each person within the occupation will likely not be the same.

2. The state of the labour market system

The current state of the UK's labour market will inform how ready it is to support workers during the transition to Net Zero and how changes are likely to play out across different regions.

While unemployment rates are low, inactivity rates have increased.

UK labour market statistics paint a mixed picture. While the employment rate, unemployment rate and number of job vacancies point to a tight labour market, inactivity rates have risen since the COVID-19 pandemic. At the beginning of 2022 close to half a million fewer people were in work or looking for work than before the pandemic:[1]

- The UK headline employment rate (the proportion of those aged 16-64 who are employed) has been recovering from pandemic impacts since the end of 2020, reaching 76% in the period between September and November 2022. This is one percentage point below record levels reached just before the start of the COVID-19 pandemic, in late 2019* (Figure 4.2).

Employment rates are highest in the East and South West of England, and amongst those aged 24-49 years old.

- Employment rates vary by region (Figure 4.3) and demographic group, with higher employment in the East and South West of England, and at its highest in groups aged 24-49 years old.

- Data from the ONS shows that 76% of 16–64 year-olds are currently employed, with employment at 72% for women and 79% for men.[2] When broken down by age 62% of 18–24 year-olds are in employment, compared to over 85% of 24–49 year-olds, 71% of 50-64 year-olds and 11% of over 65s.

- At the end of 2022, around 1.2 million people aged over 16 were unemployed and actively looking for work. This represents an unemployment rate of 3.7% - a record low since the 1970s.

- The rate of economically inactive working-age people† was 22% in late 2022, down slightly on the previous quarter, but still one percentage point higher than before the pandemic.‡ There were half a million fewer people in the labour market than before the pandemic at the beginning of 2022.[3] Part of this is explained by a growing number of people reporting long-term sickness for economic activity, particularly due to chronic illness, which overall grew by 363,000 since the start of the COVID-19 pandemic.[4] The biggest increase in economic inactivity was seen amongst 50–60 year-olds, suggesting some people may have opted to take early retirement.[5]

The UK labour market is encountering several challenges. A malfunctioning labour market could notably slow the delivery of Net Zero and a just transition for workers.

The UK labour market is facing several challenges, including economic uncertainty, inflation and a stagnation of real wages between 2005 and 2020.

- **Economic uncertainty**. Current economic uncertainty has not yet had a strong effect on headline labour market indicators, but this may change. In late 2022 inflation was at its highest rate in 32 years and the OBR projected that the UK economy would contract by 0.4% in 2023.[6]

* Comparison for the seasonally adjusted employment rate between the 2019 and 2022 September-November period.

† The rate for economic inactivity is based on the population aged 16-64.

‡ The employment rate, unemployment rate and inactivity rate do not sum to 100% as the employment rate and inactivity rate are based on those aged 16-64 while the unemployment rate is based on the economically active population aged over 16.

However, more recent OBR estimates showed that inflation peaked in October 2022. It is now projected that inflation will fall significantly (from 11.1% to 2.9%) by the end of 2023, and GDP will contract by 0.2% through 2023.[7] The tripling of interest rates experienced in the past year[8] will make it more expensive for households and businesses to borrow, which is likely to affect Net Zero investment. Sustained economic uncertainty could make it more challenging for businesses and workers to plan ahead and invest in the skills needed for the Net Zero transition.

- **Wages**. Although employment rates have increased markedly with significant fluctuation since the 1980s, real wages* were largely stagnant between 2005 and 2020 (Figure 4.4). 2021 saw an uptick in real wages, but the record high inflation in 2022 has resulted in the fastest fall in real wages since records began in 2001.[9] Changes in real wages could impact on workers' incentives to move between jobs, as well as between the UK and abroad.

- **Job insecurity**. Rising numbers of workers in atypical employment (temporary work, agency work, zero-hours contracts or self-employment) may point to issues of job security. The proportion of workers in atypical employment rose from approximately 17% to 21% between 2000 and 2019 for 25-64 year-olds, and from 15% to 25% for 18-24 year-olds.[10] While many people choose to be in atypical employment, the proportion of these workers who would prefer permanent, full-time employment rose from 5% to 12% for 18-24 year-olds, and similarly for 25-64 year-olds, over the same period. Although the number of self-employed workers dropped during the pandemic, as of 2022 self-employment was still 30% higher than in 2000. It is hard to predict how this challenge could interact with the Net Zero transition. While certain Grow sectors tend to be delivered by self-employed workers or very small businesses (e.g. buildings construction and retrofit) others are associated with employed workers (e.g. renewables).

In the UK the skills workers have don't always match the skills employers are seeking, and there is relatively low employer investment in skills.

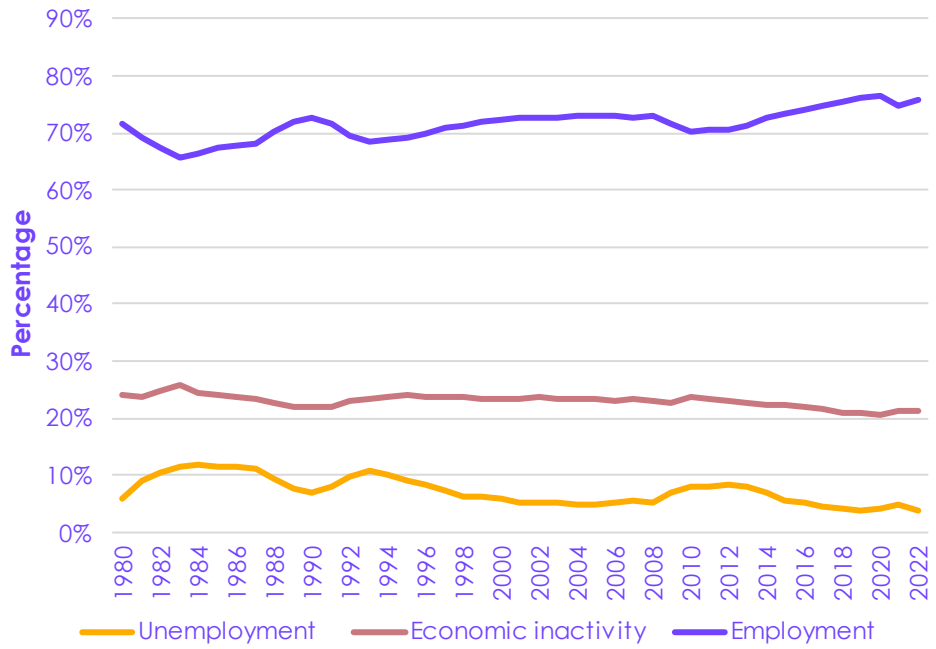
- **Skills mismatches**. Although the UK has a relatively flexible labour market, it suffers from skills mismatches. As of 2019, two fifths of UK workers had a qualification that did not match their employment, with 15% over-qualified and 26% underqualified.[11] There were almost 1.2 million job vacancies in late 2022, nearly 400,000 more than before the pandemic.[12] In early 2022, the number of vacancies overtook the number of unemployed people for the first time since records began in 2001.[13] Depending on the underlying causes of this challenge, this may indicate that in its current state, the UK skills system and labour market will not efficiently see workers equipped with the necessary skills and may not match skilled workers with Net Zero employment effectively.

- **Low employer investment in skills.** This is in part the result of low investment in skills. UK employers' investment in staff training has seen cuts of close to 30% since 2005.[14] This is reflected in the number of hours of training per week per employee, which has declined by over 40% in the last 20 years.[15] Limited investment in skills could pose a particular risk for Transition and possibly Adjust sectors, where workers may need to gain new skills on the job.

* Real wages show the value of wages once they have been adjusted to account for inflation.

Employment is relatively high, although economic inactivity has increased.

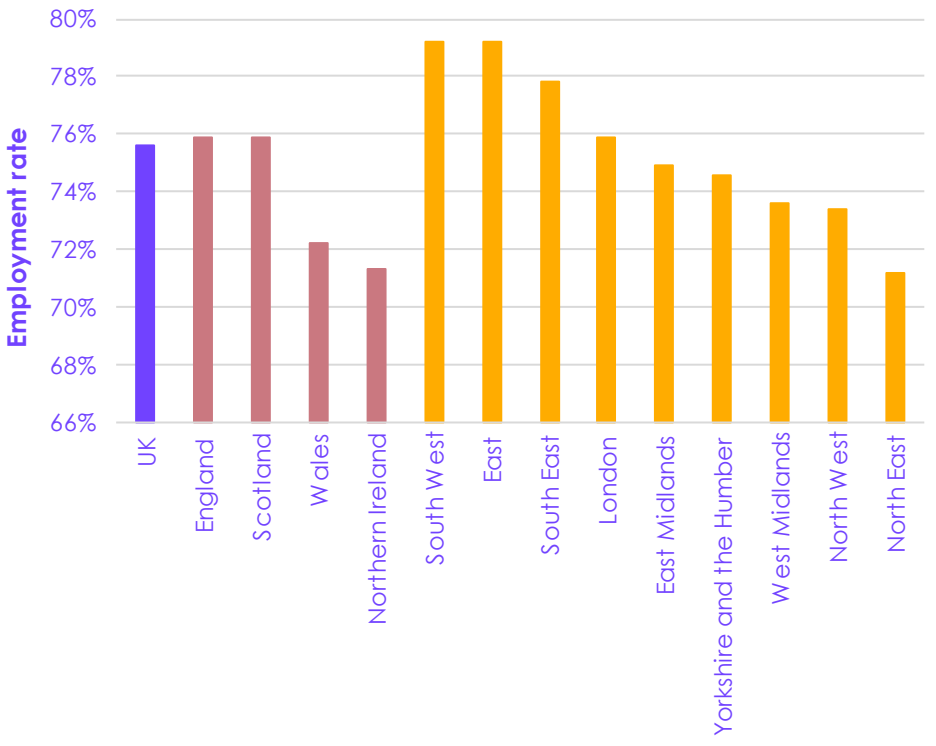
Figure 4.2 UK rate of employment, unemployment and inactivity



Source: ONS (2023) *Labour Force Survey*.
Notes: The headline employment and inactivity rates are based on the population aged 16-64 but the headline unemployment rate is based on the economically active population aged 16 and over.

Employment varies across regions in the UK by up to almost ten percentage points.

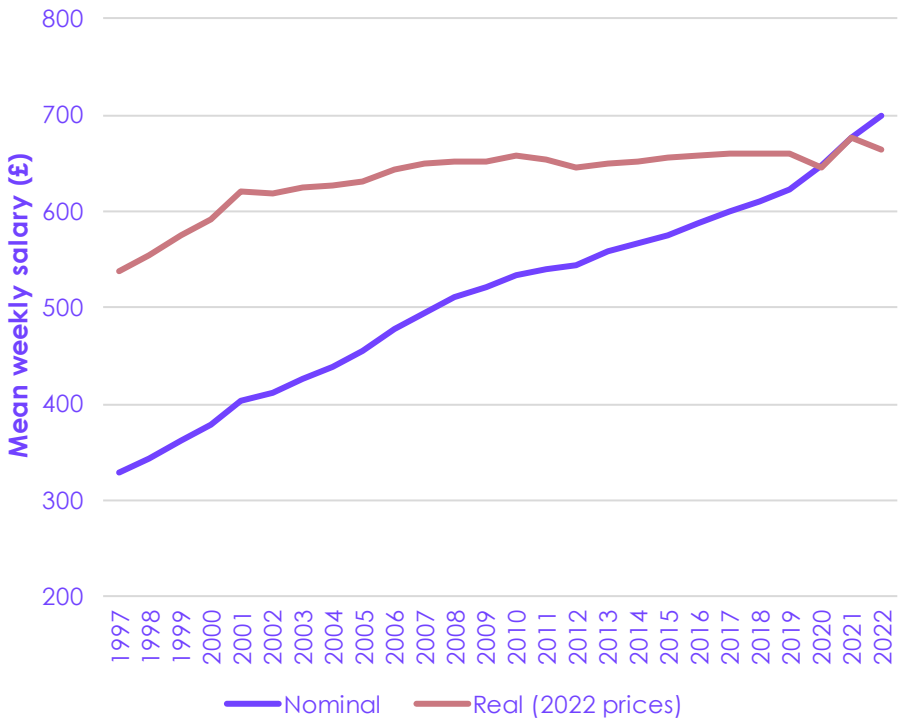
Figure 4.3 Employment in UK nations and regions in September to November 2022



Source: ONS (2022) *Labour Force Survey*.
Notes: The employment rate is calculated by dividing the employment level for those aged 16-64 by the population for that age group.

There has been a stagnation in real wages between 2005 and 2020.

Figure 4.4 Wages and real wages



Source: ONS (2023) *Labour Force Survey*.
Notes: Real wages show the value of wages once they have been adjusted to account for inflation.

Endnotes

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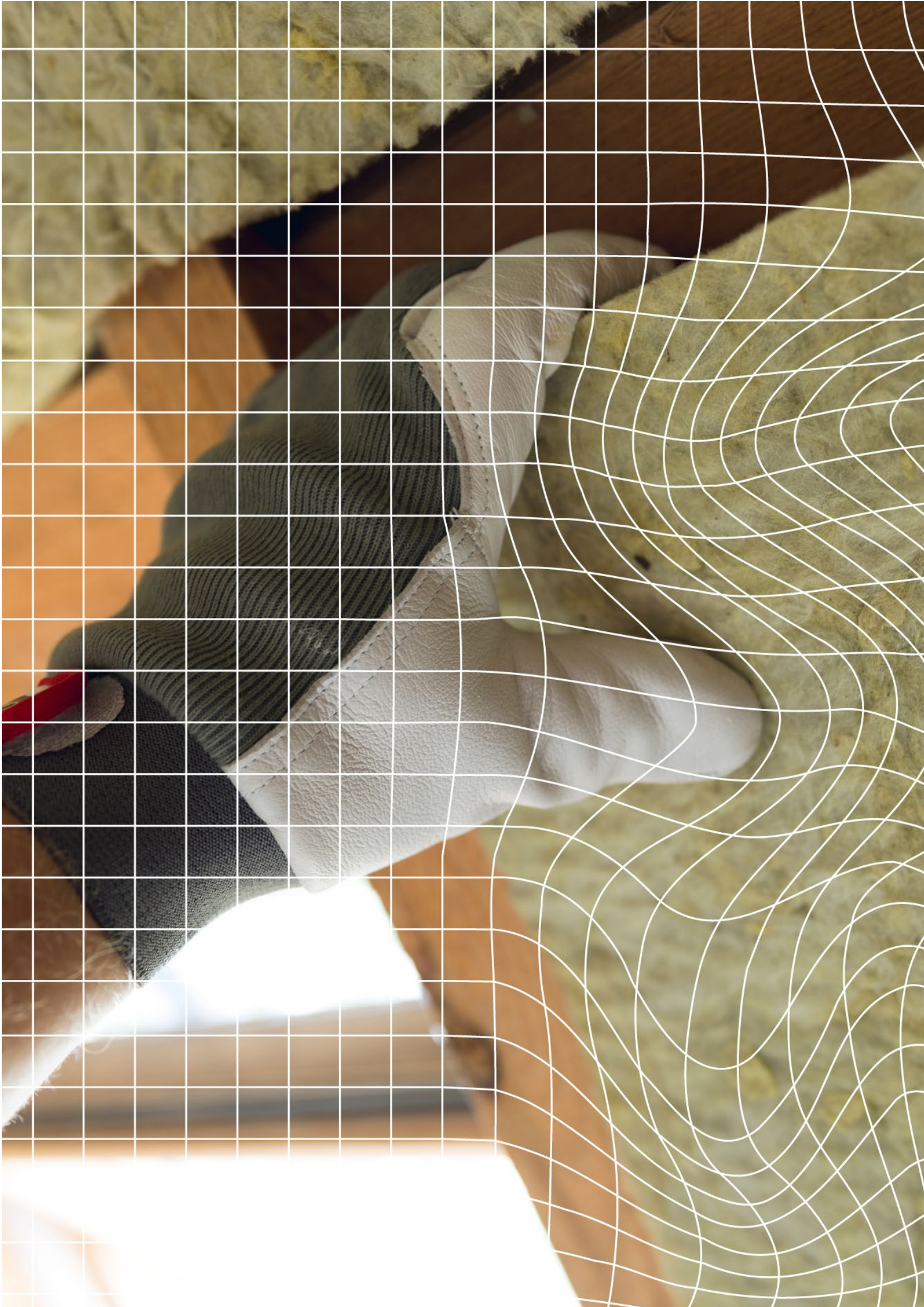


Chapter 5

Conclusions and next steps

In this Chapter we set out next steps for Government, the CCC and businesses.

In this Chapter we summarise key next steps for Government, businesses and the CCC.

- We set out next steps for Government, summarising our existing recommendations to Government on Net Zero Skills and illustrating how the analysis in this report can be used to inform Government policy to ensure a fair and effective Net Zero transition for workers.

- We set out high-level considerations businesses, as employers, should take across different sectors affected by the Net Zero transition.

- Finally, we outline what our next steps as the CCC will be, in particular noting we will publish formal recommendations to Government in our 2023 Progress Report.

1. Next steps for Government

Our existing recommendations. In our 2022 Progress Report to Parliament, we recognised areas of progress in Government Net Zero skills policy and recommended steps the Government should take in relation to Net Zero skills (Box 5.1).[1] These included the need for clear decarbonisation plans, a clear long-term Net Zero policy framework, and the importance of a clear definition of roles and responsibilities. These recommendations still stand.

Evidence and data gaps. In our last Progress report, we highlighted that limited data on specific Net Zero professions and on regional distribution of jobs and skills training can limit evidence-based policy making. Through the analysis in this report, we have identified additional evidence gaps, including a need for more research on job quality in the low-carbon economy, the spread of required skills levels in the low-carbon economy, movements into and out of the labour market in relevant industries and the demographic composition of the labour market by industry. Limited data should not further delay action on Net Zero skills. Instead, the Government and other actors should look to address these gaps in parallel to implementing policy that can start supporting workers to transition.

The evidence in this brief can be used by Government to inform its Net Zero and Nature Workforce Action Plan.

Using this brief. We also recommended the Government develop an Action Plan for Net Zero Skills (Box 5.1). The UK's Net Zero Growth Plan has now committed to a Net Zero and Nature Workforce Action Plan.[2] The analysis in earlier chapters, and the framework we set out below (Figure 5.1) can help inform the Government in the development of this plan. Government can draw on the analysis and framework below, alongside the wider evidence base to develop an Action Plan and identify where further policy responses are needed. Below we set out in more detail how Government can use this brief.

In 2022 we recommended that Government publish a Net Zero skills action plan, address evidence gaps and provide sustained funding and policy clarity.

Box 5.1
Assessment of policies that support workers and skills in the CCC's 2022 Progress Report

In our 2022 Progress Report to Parliament, we recognised that the UK Government has already taken steps that will support workers during the transition to a low-carbon economy.

- **General skills policy**. The UK Government has already brought forward policies that should narrow the considerable current skills mismatch. These policies are mostly led by local employers and authorities, with Government support through public funding.
  - **Identifying skill needs**. Initiatives such as the Local Skills Improvement Plans (LSIPs) and the Energy Supply Chain Taskforce (ESCT), should support the responsiveness of local skills systems to changing employer skills requirements, including for Net Zero.
  - **Retraining and reskilling the existing workforce**. Net Zero has been included in efforts to reform the skills system through programmes such as the Lifetime Skills Guarantee, which supports workers to reskill and retrain, including through Skills Bootcamps in areas like housing retrofit. Other measures like the Lifelong Loan Entitlement could provide individuals with a loan to invest in technical and academic education throughout the transition to a low-carbon economy.
  - **Funding**. This includes £65 million of public grant funding through the Strategic Development Fund. £15 million of public funding has also been committed towards the second phase of the Public Sector Low Carbon Skills scheme, which helps public sector organisations gain expert skills to unlock decarbonisation projects.

- **Green skills and education policy.**
  - **Education**. The Department for Education recently published a Sustainability and Climate Change Strategy that embeds green skills and climate in education and training. While this strategy includes a strong set of actions and policies, such as prioritising green skills in the Skills and Post-16 Education Act, it is unclear whether the pace and scale of Net Zero will be met in the absence of a strategic assessment of the impact of Net Zero on labour markets.
  - **Apprenticeships**. This strategy confirmed the creation of a Green Apprenticeships Advisory Panel that will aim to align apprenticeships to Net Zero objectives and employer needs. Work is underway to map apprenticeship standards to green occupations and consider where new standards are needed in areas such as home retrofits.
  - **Retraining and upskilling**. The New National Skills Fund committed £2.5 billion for retraining and upskilling in view of supporting the green recovery and Net Zero transition.

In our last Progress report, we recommended the Government should take several steps in relation to Net Zero skills and employment policy.

- **Building the evidence base.** The Government should build a stronger evidence base and collect data for monitoring progress. This should include ensuring better data on the current labour market, undertaking new analysis to understand which additional jobs will be needed, and analysing sectors where occupations may be at risk.
- **Clear definition of responsibilities**. The Government should develop a strategic framework to deliver a fair transition for workers. This should clarify the roles of Government, businesses, local authorities, education providers and workers.
- **A Net Zero Skills Action Plan**. The Government should publish its comprehensive assessment of when, where, and in which sectors there will be skill gaps specific to Net Zero. This should include consideration of particular barriers to labour market entry into occupations needed for the transition and Government plans for action on the skills system to facilitate entry into these occupations. This assessment should be used to target policy and funding towards the more pressing skills needs and to consider the role of incentive payments to workers, where workers might be bearing costs or losing earnings due to training.
- **Protecting those at risk**. Once sectors most at risk have been identified and the Government has clarified roles, there will be a need for policies to deliver opportunities and incentives for workers to retrain and move into other sectors.
- **Sustained funding and policy clarity**. Where existing policy trials and schemes are found to be adequate and effective, funding should be sustained to provide certainty to the workforce and the skills landscape. Where the Government hopes to spur market growth through early-stage public funding (e.g. heat pumps, heat networks), credible commitments that go beyond Spending Review cycles will be critical in signalling to businesses and workers that these markets will be profitable and employable in the longer-term.

Source: CCC (2022) *Progress Report to Parliament*, DfE (2022) *Sustainability and climate change strategy.*

(a) Policy considerations arising from our analysis

In relation to the Net Zero workforce, there are three rationales for policy: ensuring Net Zero happens, protecting workers and harnessing wider opportunities.

The transition to Net Zero will materially transform much of the UK economy and labour market. As set out in earlier chapters, all elements of the workforce will be affected in some way, although impacts will vary based on factors including sector, location and expected pace of change. Net Zero is an intentional transition, enshrined in the Climate Change Act's legislated emissions targets and accompanying policies to meet these.

This points to three potential rationales for policy:

1. **Ensuring Net Zero happens.** Government has a responsibility to ensure the Net Zero transition is realised. For the Net Zero transition to occur, there will need to be enough skilled workers in the right place at the right time for key sectors to grow, redirect and enable the transition.

2. **Protecting workers from disruptive impacts.** Government has a role to play to ensure the transition does not have an unfair or negative impact on communities and workers, or those with protected characteristics. This will be particularly relevant for sectors which will need to phase down rapidly.

3. **Harnessing wider opportunities.** Net Zero involves a fundamental shift in the UK economy. Government may choose to seize the opportunity to advance other priorities, such as distributing opportunities across the UK and improving workforce diversity, and to help the UK capture opportunities for growth which could instead go overseas.

Across all areas, long-term policy, a well-functioning education and skills system and effective industrial policy will be needed to ensure a Net Zero workforce is in place.

Cross-cutting priorities. Some of the priorities that arise from these three policy rationales apply across the board, and are not considered in detail in this report, such as the need for clear long-term policy and regulatory frameworks for Net Zero, a well-functioning education and skills system, and effective industrial policy.

- Across all sectors Government will need to provide long-term Net Zero policy certainty, enabling businesses and the workforce to plan ahead and prepare for the transition. We make recommendations relating to key sector policies needed in our annual Progress reports.

- Across all sectors, having an education and skills system that is set up to respond to those changing workforce requirements is necessary. It is beyond the CCC's remit to review the education and skills system, but we note its critical role in delivering Net Zero. Our Expert Advisory Group will publish an independent report recommending changes to the education and skills system to facilitate Net Zero in 2023.

Below we set out a framework for identifying which areas may also require a workforce-targeted intervention.

Priority for a workforce-targeted intervention. In some cases, even with long-term Net Zero policy certainty, a well-functioning skills system and effective industrial policy, risks and opportunities related to the workforce will remain. For example, if a sector needs to grow very rapidly and is largely composed of SMEs, additional intervention to ensure sufficient skilled workers are in place to deliver Net Zero may be needed. Or if a sector will phase down in an area with high economic dependency on those jobs, proactive support for workers to transition may be needed. In the sections below, we outline a framework, drawing on our analysis, for identifying what areas might be priorities for a workforce-targeted intervention, and what some of the interventions might be.

(b) A framework for action

Our analysis in earlier chapters can be used to inform the Government's Net Zero and Nature Workforce Action Plan, and priorities for policy intervention.

Our analysis in this brief has considered how Net Zero may impact a sector, the nature of the impacts, and the wider labour market context.

Figure 5.1 provides a summary of the evidence we have reviewed and developed for this report on the characteristics of Net Zero impacts on the labour market and the policy responses available to governments and businesses to navigate these impacts. It brings together the analytical questions explored in the previous chapters, namely:

1. **How could Net Zero impact a sector (Chapter 2)?** Is the sector likely to Grow (and will that growth will occur in the UK or abroad), Transition (and does that entail phasing down) or Adjust (and is that adjustment a core supporting element of the transition, or will it result in peripheral changes)? What is the potential scale of changes in employment, according to external estimates?

2. **What is the distribution and pace of the impacts (Chapter 3)?** What is the geographic concentration of the sector, the expected pace of change and the characteristics of employers and employees?

3. **What is the labour market context (Chapter 4)?** What are the characteristics of the wider labour market?

It also considers the appropriate range of policy responses to these analytical questions by asking:

4. **What is the rationale for intervention?** As set out in the above section, the Government may wish to intervene to ensure Net Zero is delivered, to minimise harmful impacts to workers and communities, or to use the shifts in the labour market to harness other opportunities such as distributing opportunities across the UK, economic growth or improving diversity in certain sectors.

5. **Which policy responses are available?** As set out in the above section, these include cross-cutting policies which should be in place across the board: Net Zero policy, education and skills policy and industrial policy, and for some, additionally, a range of workforce-targeted interventions (including those from past transitions – see Chapter 3).

Figure 5.1 Analytical framework for policy considerations

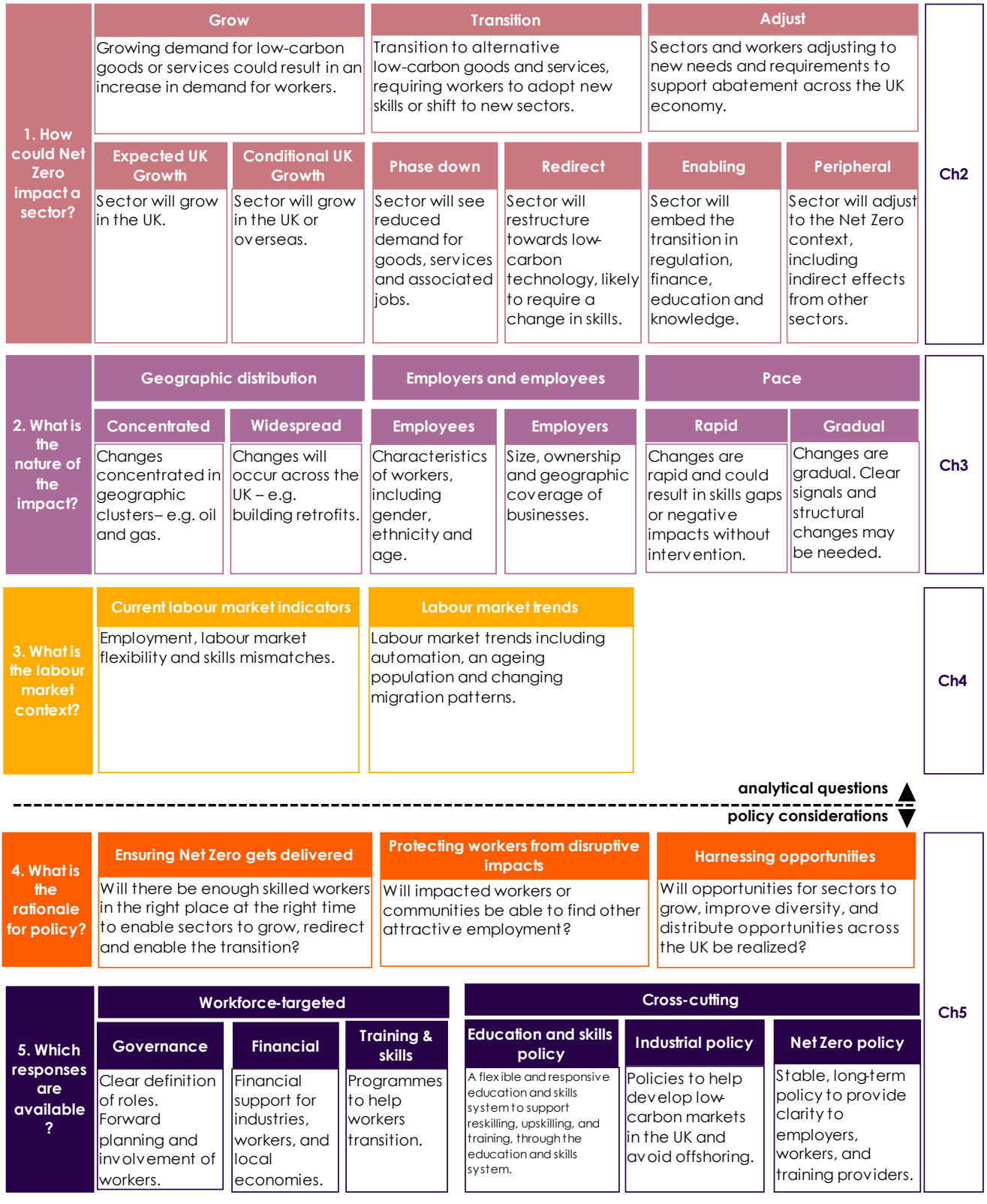


Figure 5.1 can be used as a 'decision tree' to step through analytical questions and identify priorities for intervention, as illustrated by Figure 5.2.

Figure 5.1 can be treated as a form of 'decision tree', where policy makers can step through each analytical question, in order to identify priorities for intervention. The 'decision tree' could start from a sector or from one of the three policy rationales.

- The 'decision tree' could start from looking at a sector (i.e. – starting from question 1 and working down to identify policy rationales and kinds of intervention needed). Figure 5.1 illustrates how this could be done.

- The 'decision tree' could start from a policy rationale (i.e. – starting from question 4 and working up to identify priority sectors, before identifying policy interventions). Figure 5.2 illustrates how this could be done.

Government can use this analysis and framework to identify the specific policy priority and interventions needed.

We have identified principles to help inform which interventions are prioritised.

We have identified some broad principles which may help inform where interventions are prioritised, and produced Figure 5.2 to illustrate how certain sectors might be analysed through the decision tree to identify appropriate responses from government and businesses:

- **Cross-cutting policies.** Across the board, to ensure Net Zero delivery, effective industrial policy, clear and credible Net Zero policy and a functioning and flexible education and skills system will be needed, to help businesses and workers prepare for the transition in skills and employment. Below we set out examples of where these might be sufficient, meaning a workforce-targeted intervention may not be a priority.

  - **Ensuring Net Zero is delivered.** For some sectors, such as those that will see more gradual shifts (e.g. public transport operation), or where sectors will play more of an Enabling or Peripheral role (e.g. finance), cross-cutting policy may be sufficient to ensure the workforce will play their part in helping deliver the Net Zero transition. For example, Net Zero policy, targets or regulation could signal to the finance sector the level of investment needed in skills.

  - **Protecting communities from disruptive impacts.** For some sectors, such as those where the impacts are not geographically concentrated, are more gradual, and where the sector is Grow or Enabling, cross-cutting policies may be sufficient to avoid significant disruption to workers and communities. For example, a general increase in education and skills spending policy that enhances the flexibility and responsiveness of the market could support sectors that are more geographically spread like vehicle maintenance.

  - **Harnessing wider opportunities.** For some sectors, such as Grow sectors where growth is not conditional, is geographically dispersed, and the workforce is already diverse, proactively harnessing opportunities to support distributing opportunities across the UK or diversity may not be a priority. For example, government investment into R&D to develop EV and battery manufacturing supply chains in the UK may be sufficient.

- **Workforce-targeted response**. In some areas, a more workforce-targeted response may be required in addition to cross-cutting policies.

Sectors that will need to grow rapidly, and where employers are SMEs, such as buildings construction and retrofit, may be priorities for a workforce-targeted intervention.

  - **Ensuring Net Zero is delivered**. Growing sectors where the pace of change is rapid such as home retrofit may require proactive intervention to ensure education and training opportunities are available and attractive now to avoid labour or skills shortages in the next few years. Finding the workers that can support the delivery of low-carbon infrastructure, supply chains and markets could be a challenge if the labour market remains tight, and will result in costs around recruitment and training. For example, as energy efficiency and heat pump installations is a rapid Grow sector, primarily delivered by SMEs, Government may need to support SMEs with reskilling workers, and to ensure education and skills policy is aligned with the proposed 2035 boiler phase-out date. An effective governance structure for assigning responsibilities between government, businesses and training institutions, and for identifying skills needs may be needed.

Sectors which may see concentrated job losses, which may impact groups with protected characteristics, or which may affect practices with socio-cultural significance to communities may be priorities for a workforce-specific intervention to protect communities from disruptive impacts.

  - **Protecting communities from disruptive impacts.** For Phase Down and Redirect sectors where the pace of change is rapid, where the sector is geographically concentrated, concentrated in a group with protected characteristics, or where workers are at the intersection of several Net Zero impacts, intervention may be needed to prevent disruption to particular communities. Our analysis does not find sectors which meet all these criteria. However, some sectors meet some of these criteria. For example, livestock agriculture, depending on how the shift in land use is achieved, could potentially see a reduction in livestock agriculture jobs, or a change to agricultural practices. Although the change would be gradual, the agricultural practices carry social and cultural significance to communities. Potential interventions could involve inclusive place-based planning that involves communities in decision-making, financial support, retraining programmes, and prioritising relevant regions or communities for other growth opportunities. For Transition sectors that are geographically concentrated, if workers may reskill and relocate, such as regions with a high concentration of jobs in oil and gas production, local regeneration interventions may be needed.

Grow sectors which could have a more diverse workforce, are location-specific, or are exposed to international competition may be priorities for a workforce-specific intervention to harness wider opportunities.

  - **Harnessing wider opportunities.** Grow and Enabling sectors which could have a more diverse workforce, such as construction and financial services, could be a priority for targeted training and education programmes that encourage more diverse workers to gain Net Zero skills and join the sector. For sectors that are location-specific (e.g. CCS, low-carbon hydrogen, renewable energy and automotives), and which will grow, Government may wish to direct investments towards economically deprived areas. For example, CCS and hydrogen can support growth in industrial clusters in Merseyside, Humberside, Scotland, and south Wales, and electric vehicle manufacturing could support growth in the Midlands. Finally, for sectors which could grow, but are exposed to international competition, such as battery manufacturing, reskilling the UK workforce may be needed to attract investment into the UK. In some instances, the objectives of distributing opportunities across the UK, competing internationally and supporting Net Zero may intersect, if for example Government chose to invest in a skilled workforce for battery manufacturing in an economically deprived region.

The size and location of employers should inform the roles and responsibilities of Government and business in workforce-specific interventions.

- **Responsibility for delivering the response**. In assessing priority areas for workforce-targeted intervention, Government should consider the nature of employers, in particular their scope and resource, to identify the appropriate balance of delivery between Government and businesses.

  - **Local assessment and decision-making.** Our assessment of the regional impacts of Net Zero indicate that identifying those impacts at the local authority level must be done to determine what actions are needed to support a fair transition and who will be responsible for delivering those actions, as Net Zero will not have a homogenous impact across the UK.

  - **Public-private partnership.** All responses to the impacts of Net Zero for the workforce will require coordination across Government, businesses, local authorities, education providers and workers. A public-private partnership with a clear definition of responsibilities is needed.

  - **Government leadership**. In sectors that are largely composed of SMEs, the cost of training and qualifications in green skills may be prohibitive, and there may be less of a market-led overview of skills and employment needs. For example, heating engineers and companies are not yet familiar with heat pumps and processes required to install and maintain heat pumps and may not be placed to invest in green qualifications. Government may want to prioritise such sectors to play a more active role, through funding, or helping coordinate mapping training needs and the provision of training opportunities.

  - **Business leadership.** In sectors that require a workforce-targeted response, but where businesses have the resources to support workers, such as in the oil and gas industry, Government may not need to play such an active role or to fund training opportunities. Another example is battery manufacturing, where large firms could use their resources to invest in workers, provided this is enabled by a clear industrial policy. That said, as noted above, Government may still need to focus on regional regeneration if workers relocate, and to monitor progress to ensure businesses are taking appropriate action.

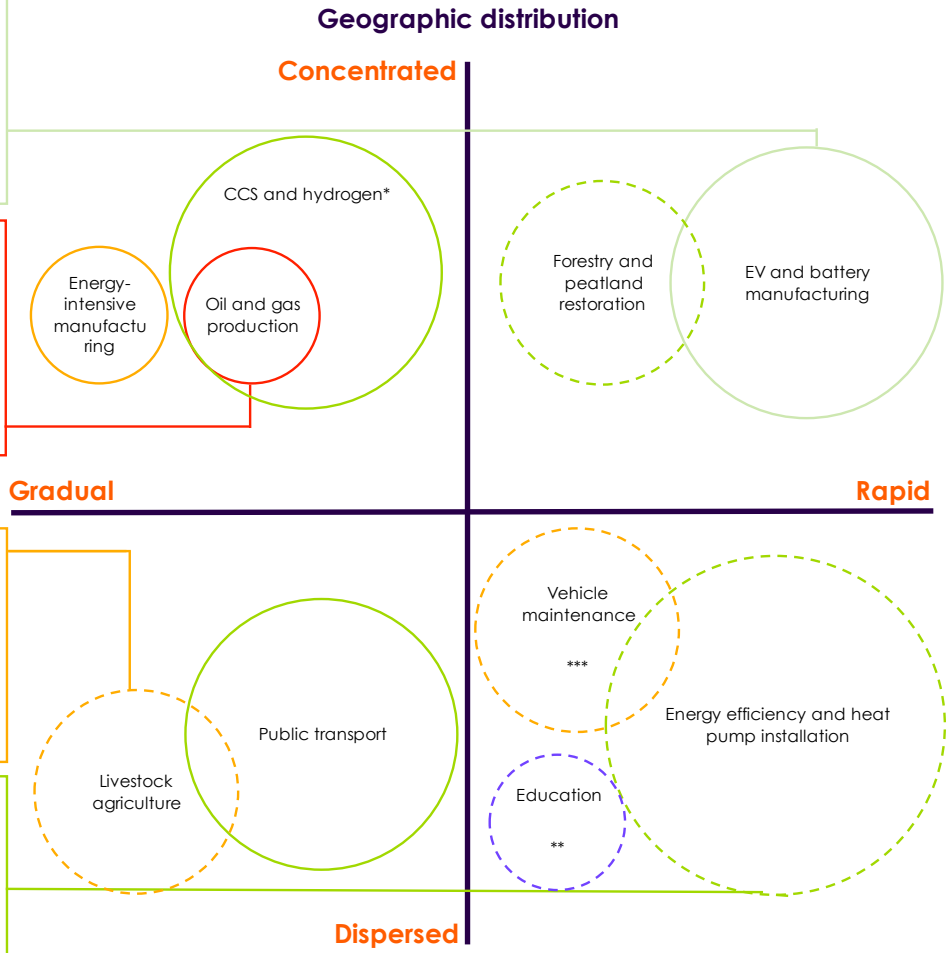
Figure 5.2 Illustrative policy responses based on transition characteristics

- **Reskilling** will be necessary to **attract investment** in the UK.
- **Large firms should use resources** to invest in workers accompanied by a clear **industrial policy** from Government.

- Oil and gas workers **have sought-after skills** in CCS and hydrogen.
- If the transition were to lead workers to relocate, **regeneration policies** at the local level might be needed.

- Farmers may need support to transition skills towards low-carbon farming or reforestation.
- Given strong social and cultural ties, **place-based strategies** and support may be needed.

- SMEs will need the guidance and support of **Government for reskilling**.
- The implementation of **education and skills policy** should align with the end of gas boiler sales by 2035.



Legend

Size of most employers:

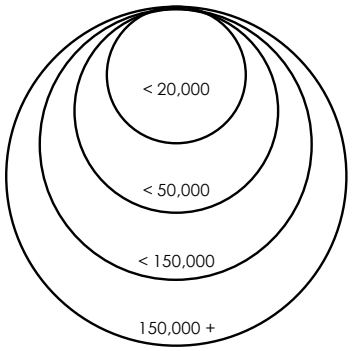
——— Large businesses

- - - - - Small and medium businesses

Net Zero impact:

- Expected UK Growth
- Conditional UK Growth
- Redirect
- Phase Down
- Enabling

Potential scale of change in jobs (according to external estimates)



Notes: *We assume for CCS and hydrogen employers are likely to be large, due to the level of technical and financial investment required. **Our Sixth Carbon Budget does not have a pathway for changes to education, so we have assessed the pace of change based on the need to rapidly upskill the workforce. ***We did not find estimates for the potential scale of employment change in vehicle maintenance, so have based our assessment on the current size of the sector, and the potential changes in vehicle type and ownership.

2. Next steps for businesses

Businesses will have a key role to play in ensuring a fair transition for workers, including by considering how they will be impacted, identifying skills gaps, and working with Government to support workers.

Businesses have a significant role in helping cultivate the UK skills landscape, whether they are in a Grow, Transition or Enable sector. The Net Zero transition can be a positive one for workers, provided businesses actively coordinate with government and workers, make choices that align with the required transition and prepare for the changes that are needed.

As noted above, the extent to which a business may need support for transitioning its workforce will be affected by how large and well-resourced the business is.

- Large firms are more likely to have the resources to provide support, internal employment opportunities and necessary retraining for employees.

- Small and medium businesses are less likely to have the resources to fund and deliver training in-house. Government intervention may be required to ensure training opportunities are available where needed.

All businesses should consider how they will be affected by the transition to Net Zero by identifying and understanding potential opportunities and risks, including any implications for their suppliers and workforces.

- The Government plans to require all listed UK companies to disclose Net Zero transition plans. The draft 'Transition Plan Taskforce Implementation Guidance' highlights Net Zero transition plans and states that transition plans should summarise how the business will mitigate risks and leverage opportunities posed to the workforce by its transition plan.[3]

- For businesses in Grow sectors, such as low-carbon energy supply or energy efficiency, businesses may need to identify skills gaps and work with Government to ensure a supply of trained workers to meet demand.

- For businesses in emerging sectors, such as CCS or green hydrogen, this may require new skillsets to be developed or for workers from other sectors to be retrained, so businesses should work with Government to design new training programmes and qualifications.

- Where growth is conditional on the UK capturing opportunities, strong business-Government communication channels could help highlight where the UK skills base is lacking compared to labour markets abroad.

- For businesses with activities being phased down (e.g. fossil fuel production), this will require clear communication with workers about the implications of the transition, supporting workers to transition and develop other skillsets where possible.

- As all workers have a role to play in the Net Zero transition, even businesses in Peripheral or Enabling sectors will need to consider what upskilling of employees will be needed, including across functions such as procurement and HR.

In priority sectors where businesses can play more of an active role, Government should remain engaged, identifying where additional support may be needed, and monitoring progress to ensure appropriate action is being taken.

3. Next steps for the CCC

The Expert Advisory Group who steered this brief will publish a Chair's report in 2023 assessing the skills needs for Net Zero and setting out policy recommendations.

The Committee's view is that workers and skills will be key to delivering the Net Zero target. Our objective is therefore to integrate these considerations into our analysis and statutory reports. However, Government, education and training providers together with businesses must come together to identify specific skills gaps and develop clear plans or strategies for Net Zero Skills.

- **Independent report on skills.** This brief has been steered by an Expert Advisory Group. Their work will continue with the publication of an independent Chair's report in 2023 that will assess skills needs for Net Zero and develop independent policy recommendations to Government.

- **Formal recommendations.** We will draw on our analysis in this brief, and the Chair's report, to inform formal recommendations to Government in our 2023 Progress Report.

- **Monitoring progress.** In the coming years we will develop an approach to monitoring progress in this sector. We may rely on quantitative indicators such as number of employers, split by sector and region, number of workers with Net Zero skills, as well as a qualitative assessment of skills policy, training routes, transition plans and place-based case studies.

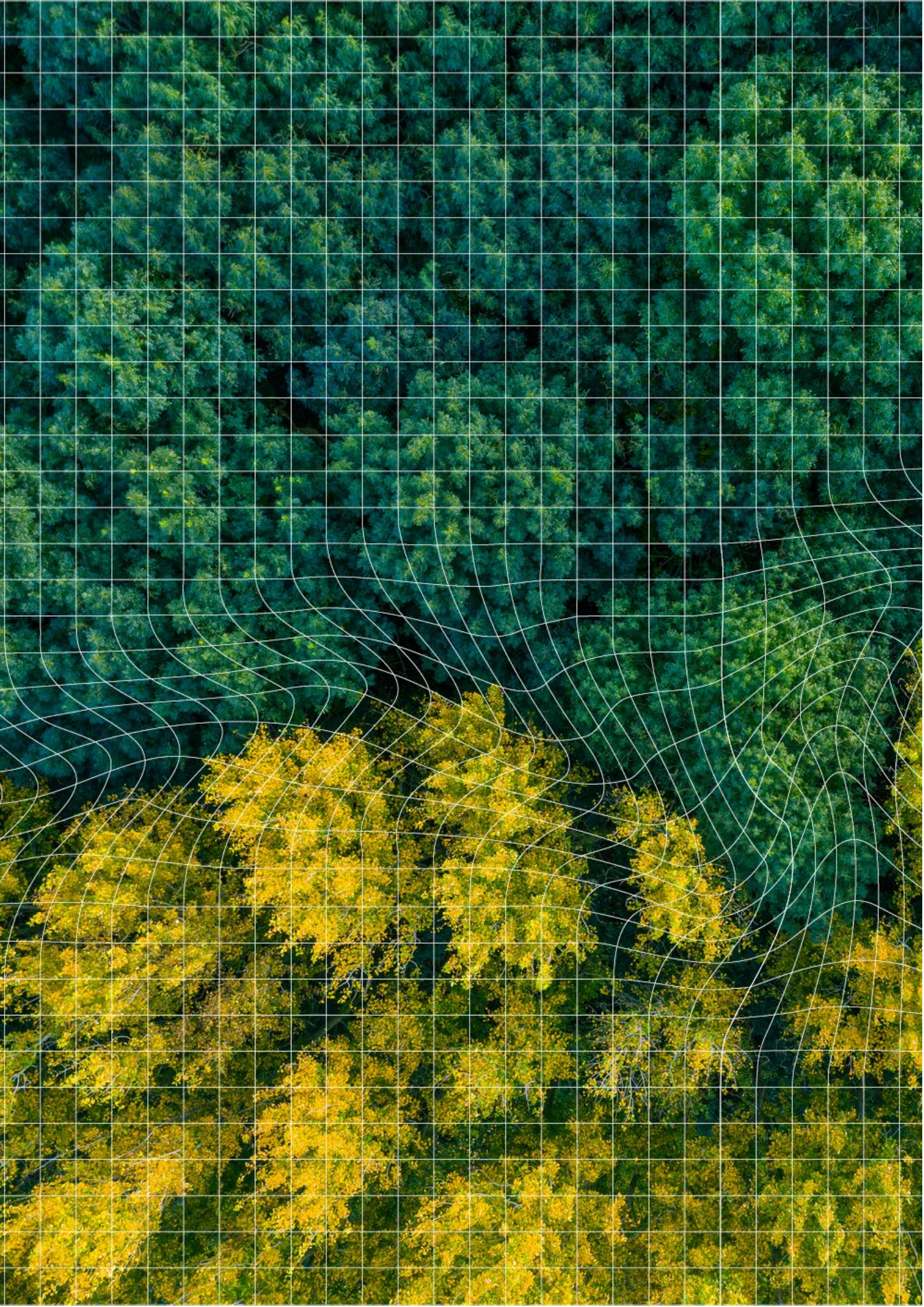
- **Carbon Budget.** In developing our analysis for our advice to Government on the Seventh Carbon Budget, we will seek to embed the three policy considerations of deliverability of Net Zero, addressing disruptive impacts and harnessing wider opportunities.

Endnotes

[1] Climate Change Committee (2022) *Progress Report to Parliament*, https://www.theccc.org.uk/publication/2022-progress-report-to-parliament/

[2] HMG (2023) *Powering up Britain: The Net Zero Growth Plan*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147457/powering-up-britain-net-zero-growth-plan.pdf.

[3] Transition Plan Taskforce (2022) *Consultation: the transition plan taskforce disclosure framework,* https://transitiontaskforce.net/wp-content/uploads/2022/11/TPT-Disclosure-Framework.pdf.



Annex 1

Methodology and limitations

The analysis that informed this brief consisted of: (1) Allocating all sectors of the economy into categories of Net Zero impacts (2) Reviewing the literature and drawing out estimates of changes to employment.

1. Net Zero impacts

This section of the annex sets out the methodology used to analyse the impacts of the transition to Net Zero for the workforce. Here we explain how we defined the categories of Net Zero impacts as well as how we allocated sectors and associated workers in each category.

Defining Net Zero impacts. The Green Jobs Taskforce concluded that 'every job has the potential to become 'green' as the world moves to combat climate change'. Our first analytical exercise aimed to reflect this by navigating the range of impacts that could result from the transition to Net Zero across all sectors of the UK economy. In turn, this could inform what responses might be needed to support workers and for delivering Net Zero.

- To identify and define categories of impacts, we relied on the literature as well as analysis from the CCC on the Sixth Carbon Budget to draw out the drivers of changing demand for goods, services and employment. We further considered the extent to which these outcomes would be conditional on policy, emissions reduction targets and market competition.

- We engaged in an iterative process with members of our Workers and Skills Expert Advisory Group, the Committee and external stakeholders to refine our definitions and group sectors into common drivers. This resulted in six distinct impacts of Net Zero that fall under three overarching categories: Grow, Transition, Adjust.

Allocation into Net Zero impact categories. Having identified and defined categories of Net Zero impacts, we then allocated the sectors of the UK economy into each category.

- The UK's 2007 Standard Industrial Classification of economic activities informs the scope of each sector in our analysis. For each sector, we use 2019 emissions data from the National Atmospheric Emissions Inventory (NAEI) to understand contributions to UK total emissions. We also rely on the definition of CCC sectors to identify high-emitting sectors, which comprise surface transport, buildings, manufacturing, electricity supply, fuel supply, agriculture and land use.

- We also rely on data from the Business Register and Employment Survey (BRES) for the number of workers in each sector to understand the distribution of workers currently employed across our Net Zero impact categories.

- Based on the definitions of Net Zero impacts, we used a series of questions to categorise our sectors in a more systematic manner (Figure A1.1).

  - **What is the sector's contribution to UK emissions?** We differentiate between high and low emitting sectors as defined in the Sixth Carbon Budget analysis. Low emitting sectors will have few emissions linked to their processes, like in education, while high-emitting sectors will produce a large share of UK emissions. As such, the latter have a larger role to play in delivering direct emissions reductions. It is assumed that the remainder contributes much less to UK emissions and therefore to meeting our UK climate targets.

- **Does the sector have a role to play in facilitating emissions reductions?** For sectors that are not high emitting, we recognize that they could still have a role in facilitating emissions reductions that will occur in other sectors of the economy. Those that will support Net Zero, such as finance or education, thus fall under our Enable category while other sectors are assumed to experience only Peripheral changes. The latter could still lead to substantive changes in the context within which workers will operate, however changes to day-to-day skills are not expected.

- **Does the sector have options to decarbonise?** We further consider the options available to high emitting sectors to decarbonise, as those that cannot reduce their emissions are less likely to be compatible with UK climate targets and would therefore need to phase down.

- **How will demand for goods and services change under Net Zero?** High-emitting sectors that have options to decarbonise should see changes to demand for goods and services based on decarbonisation options. Demand could indeed grow, as is the case for low-carbon electricity. It could also fall, for example in the coal sector, in which case the sector would be categorised under Phase Down. It could equally remain neutral or be uncertain. That is the case in manufacturing where demand for low-carbon manufacturing goods could grow for the UK or decline if there is offshoring of industrial activities. In this case, we assume that sectors will need to redirect or change business plans and skills to at least maintain jobs in the UK.

- **Can goods and services be imported?** Goods and services which will see growing demand could be produced in the UK but could be produced offshore, depending on competitiveness and whether the sector is traded. This determines whether a sector is assigned the category Expected UK Growth (i.e. – not exposed to international competition) or the category Conditional UK Growth (increased demand for goods and services could be met from abroad).

- For the purposes of this brief and to ease the communication of our analysis, we have further grouped our categories based on their role for delivering Net Zero. We have defined Core sectors as playing a core role in the transition of the UK to Net Zero. They have a direct role in delivering emissions reductions and providing abatement options to other sectors. Core sectors are: Expected UK Growth, Conditional UK Growth, Redirect and Phase Down.

- While our categorisation of Net Zero impacts gives insights into the actions that could be taken to support workers and delivering Net Zero, the analysis comes with limitations (outlined in Box 2.2).

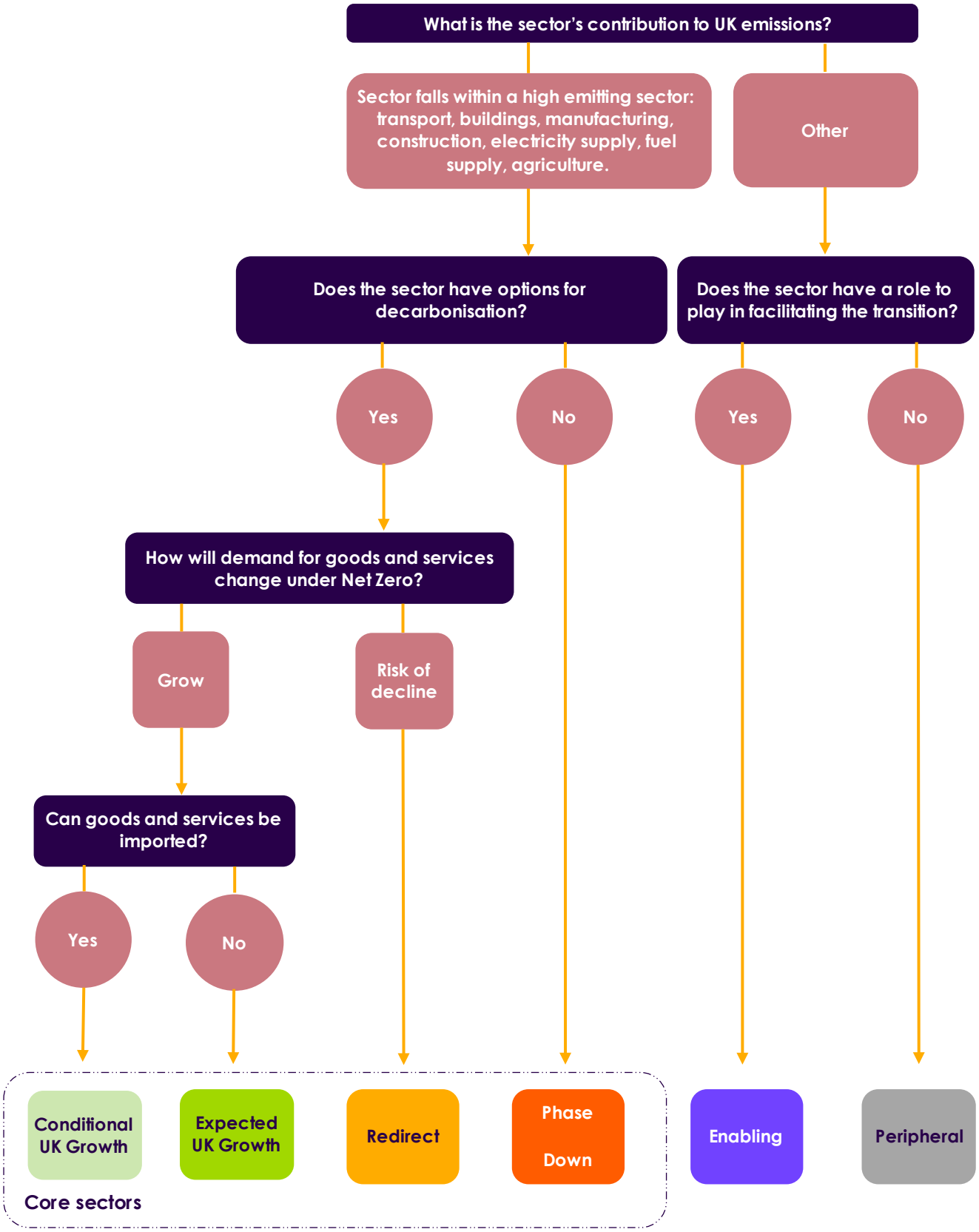
  - Our assessment does not consider the impacts of Net Zero on occupations within each sector. For example, the offshore wind industry could see growing demand for engineers while maintaining demand for corporate workers. At the same time, demand for corporate workers could be growing proportional to the size of the sector. It remains highly uncertain how Net Zero will impact different workers within each sector. The results of our analysis are likely to overestimate the number of people affected by the transition.

- Our analysis is based on a qualitative assessment that allocated economic sectors into categories of Net Zero impacts. Identifying these impacts, defining them and carrying out the allocation required an iterative process with experts, which allowed us to distil the factors driving changes for workers. For example, the type of Net Zero impact could depend on whether a sector was traded and the extent to which it contributed to emissions reductions. However, the impact of Net Zero is uncertain in some sectors. We therefore relied on the judgement of our Workers and Skills Expert Advisory Group (Box 1.1).

- The analysis does not provide a forecast of the impact of the Net Zero transition on future employment, rather a snapshot of current employment in sectors likely to be impacted.

- A particularly challenging sector to categorise was livestock agriculture. This is because it is unclear whether the sector can be expected to significantly phase down (if land currently used for livestock is instead managed by those using it for carbon sequestration), or to redirect (if livestock farmers adjust their practices to engage in a mix of livestock and carbon sequestration). In light of current Government Environmental Land Management (ELM) policy, which aims to incentivise farmers to contribute to decarbonisation through measures such as afforestation, and in recognition of the expectation that livestock agriculture will remain a sizeable part of the UK, we categorised it as "redirect", but included clear indications in the text of the possibility of job losses.

Figure A1.1 Approach to categorising Net Zero impacts



Sectors that could see demand for their goods or services change could similarly see changes to their level of employment, which is why we also collated estimates of job creation and job losses from 28 reports.

- We first developed a long list of reports that related to Net Zero skills, macroeconomic impacts of Net Zero, or the labour requirements of deploying low-carbon technologies. Members of the Workers and Skills Expert Advisory Group as well as stakeholders further contributed to pulling together a long list of reports.

- We then extracted estimates for job creation and jobs losses and classified these by the timescale of these changes, the scope of job creation (whether direct or indirect), the geographical coverage, and the conditions attached to the change.

- We were then able to select estimates that could be compared with each other given that these share the same definition of direct employment and the same timeline to 2030.

While reviewing the literature has allowed us to collate a large number of employment estimates on like-for-like basis, there are limitations to this approach.

- Our assessment is not based on a comprehensive literature review. We focussed on publications which covered the sectors identified as most likely to be affected by Net Zero, based on changes occurring in our Balanced Pathway (as described above). We were unable to find figures for some of these sectors, such as vehicle maintenance. We have also not actively searched for estimates on some of the smaller emitting sectors such as F-gases, waste and shipping, nor have included how deeper transformations to the economy, such as the creation of a circular economy could affect workers.

- Not all estimates were produced with Net Zero in mind. Certain studies were based on the UK's previous emissions reduction target, of reducing emissions by 80% target by 2050, relative to 1990 levels. These estimates are therefore likely to represent a lower range, as in many sectors deeper decarbonisation would be expected to result in greater impacts.

- In addition, details of the methodologies to estimate jobs created or lost due to the transition to Net Zero are sometimes vague and methodological approaches are not always consistent.

Annex 2

Sector definitions

Sector	Definitions
Agriculture (non-livestock)	• Growing of non-perennial crops • Growing of perennial crops • Plant propagation
Architectural and engineering activities and related technical consultancy	• Management consultancy activities • Architectural and engineering activities and related technical consultancy • Technical testing and analysis • Research and experimental development on natural sciences and engineering • Research and experimental development on social sciences and humanities
Aviation	• Manufacture of air and spacecraft and related machinery • Freight air transport and space transport • Passenger air transport
Battery manufacturing	• Manufacture of batteries and accumulators
Buildings construction and retrofit	• Development of building projects • Construction of residential and non-residential buildings • Building completion and finishing • Other specialised construction activities
Buildings construction installations	• Electrical; plumbing and other construction installation activities
Coal production	• Mining of hard coal • Mining of lignite
Construction of roads and railways	• Construction of other civil engineering projects • Demolition and site preparation
Education services	• Pre-primary education • Primary education • Secondary education • Higher education • Other education • Educational support activities
Energy-intensive industry	• Manufacture of man-made fibres • Manufacture of glass and glass products • Manufacture of refractory products • Manufacture of clay building materials • Manufacture of other porcelain and ceramic products • Manufacture of cement; lime and plaster • Manufacture of articles of concrete; cement and plaster • Cutting; shaping and finishing of stone

	• Manufacture of abrasive products and non-metallic mineral products n.e.c. • Manufacture of basic iron and steel and of ferro-alloys • Manufacture of tubes; pipes; hollow profiles and related fittings and steel • Manufacture of other products of first processing of steel • Manufacture of basic precious and other non-ferrous metals • Casting of metals • Manufacture of structural metal products
Financial and insurance activities	• Monetary intermediation • Activities of holding companies • Trusts, funds and similar financial entities • Other financial service activities; except insurance and pension funding • Insurance • Reinsurance • Pension funding • Activities auxiliary to financial services; except for insurance and pension funding • Activities auxiliary to insurance and pension funding • Fund management activities
Food processing (non-meat and non-dairy)	• Processing and preserving of fruit and vegetables • Manufacture of vegetable and animal oils and fats • Manufacture of grain mill products; starches and starch products • Manufacture of bakery and farinaceous products • Manufacture of other food products
Forestry, silviculture, and logging	• Silviculture and other forestry activities • Logging • Gathering of wild growing non-wood products
Gas distribution	• Manufacture of gas; distribution of gaseous fuels through mains
ICE vehicle manufacturing	• Manufacture of motor vehicles • Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers • Manufacture of parts and accessories for motor vehicles
Legal and accounting services	• Legal activities • Accounting; bookkeeping and auditing activities; tax consultancy • Activities of head offices
Livestock and mixed agriculture	• Animal production • Mixed farming • Fishing • Aquaculture • Other crop and animal production; hunting and related service activities

Manufacture of central heating radiators and boilers	• Manufacture of tanks, reservoirs and containers of metal • Manufacture of domestic appliances • Steam and air conditioning supply
Meat and dairy processing	• Processing and preserving of meat and production of meat products • Processing and preserving of fish; crustaceans and molluscs • Manufacture of dairy products • Manufacture of prepared animal feeds
Oil and gas production and refining	• Extraction of crude petroleum • Extraction of natural gas • Support activities for petroleum and natural gas extraction • Manufacture of refined petroleum products
Other manufacturing	• Mining of iron ores • Quarrying of stone; sand and clay • Mining and quarrying • Support activities for other mining and quarrying • Manufacture of tobacco products • Preparation and spinning of textile fibres • Weaving of textiles • Finishing of textiles • Manufacture of other textiles • Manufacture of wearing apparel; except fur apparel • Manufacture of articles of fur • Manufacture of knitted and crocheted apparel • Tanning and dressing of leather; manufacture of luggage; handbags; saddlery and harness; dressing and dyeing of fur • Manufacture of footwear • Sawmilling and planing of wood • Manufacture of products of wood; cork; straw and plaiting materials • A longer list of "other manufacturing" exists but was not included to this table for brevity
Other services	• Wholesale of agricultural raw materials and live animals • Wholesale of food; beverages and tobacco • Wholesale of household goods • Wholesale of information and communication equipment • Wholesale of other machinery; equipment and supplies • Other specialised wholesale • Non-specialised wholesale trade • A longer list of "other services" exists but was not included in this table for brevity.
Other transport	• Sale of motor vehicles • Sale of motor vehicle parts and accessories

	• Wholesale on a fee or contract basis • Retail sale of automotive fuel in specialised stores • Other passenger land transport • Freight transport by road and removal services • Renting and leasing of motor vehicles • A longer list of "other services" exists but was not included in this table for brevity.
Power generation, transmission and distribution	• Manufacture of electric motors; generators; transformers and electricity distribution and control apparatus • Electric power generation; transmission and distribution • Construction of utility projects • Transport via pipeline
Rail operation	• Manufacture of railway locomotives and rolling stock • Passenger rail transport; interurban • Freight rail transport
Services related to agriculture and forestry	• Support activities to agriculture and post-harvest crop activities • Hunting; trapping and related service activities • Support services to forestry • Manufacture of agricultural and forestry machinery
Shipping	• Building of ships and boats • Sea and coastal passenger water transport • Sea and coastal freight water transport • Inland passenger water transport • Inland freight water transport
Vehicle maintenance	• Maintenance and repair of motor vehicles • Sale; maintenance and repair of motorcycles and related parts and accessories
Waste	• Water collection; treatment and supply • Sewerage • Waste collection • Waste treatment and disposal • Materials recovery • Remediation activities and other waste management services

- It is often not possible to aggregate external estimates of distinct job creation within a sector (e.g. jobs created from woodland projects and jobs created in relation to hedgerows). As a result, in aggregating external estimates we take a conservative approach, not summing estimates within sectors of job gains unless it is clear the additional jobs would be distinct.

A Net Zero workforce
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Climate Change Committee
1 Victoria St
Westminster
SW1H 0ET

www.theccc.org.uk
@theCCCuk