



Green Jobs Barometer

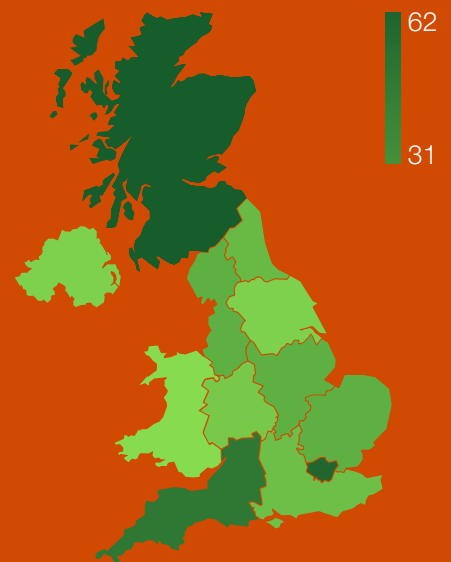
Monitoring the fair transition to a green economy

Q4 2021



The Green Jobs Barometer

The Green Jobs Barometer is the first-of-its-kind tool to track job creation, wider employment benefits, job loss, carbon intensity of employment, and worker perceptions with relevance to the green transition. Interactive and broken down into regions and sectors, the Barometer provides insights that go to the heart of the economy's preparedness for the transition and what that means for jobs and workplaces across the UK.



Note: Min score = 0, Max score = 100

Pillar 01

Green job creation

124,600 of green jobs from **11.2 million** advertisements – equating to **1.2%**.

22.5% of jobs in sectors more closely aligned to the energy transition are green.

Pillar 02

Wider benefits from green jobs

2.4x multiplier for green jobs. For every green job created, there are an additional **1.4** jobs created elsewhere in the economy.

5.0x multiplier for sectors more closely aligned to the energy transition.

Pillar 03

Sunset jobs to disappear

5% of respondents who believed their job would not exist following the transition to net zero.

20.3% of sunset jobs are in the **electricity and gas** sector.

Pillar 04

Carbon intensity of employment

26% proportion of CO₂ emissions accounted for by the electricity and gas sector, equating to **569** tonnes per employee.

Northern Ireland is the region with the highest tonnes per CO₂ per employee, at **13.6** tonnes per employee.

10.1 average tonnes of CO₂ per employee in the UK.

Pillar 05

Green workplaces

5% of respondents who stated that improving the environment was the primary objective of their role.

65% of respondents who stated that improving the environment was a secondary objective of their role.

London is the region with the most environmentally friendly jobs.

- 1 Scotland 62
- 2 London 60
- 3 South West 56
- 4 North East 55
- 5 East of England 42
- 6 North West 42
- 7 East Midlands 42
- 8 South East 38
- 9 West Midlands 36
- 10 Yorkshire and the Humber 35
- 11 Northern Ireland 34
- 12 Wales 31

Index score /100

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Foreword

We are witnessing a monumental global shift. A shift where governments and corporates worldwide are challenged with how best to support a necessary transition to a net zero economy. Global commitments to create a greener economy have come in abundance and there is no denying that we are at the start of a green revolution.

With any revolution or shift in society comes disruption. As we enter this new era, the green revolution, a personal concern of mine, and a concern and sentiment shared across the PwC network, is the impact of the transformation on communities and regional economies across the UK.

In particular, the effect on employment which we expect to be a mixture of job creation and job loss, is likely to be profound. The drastic and rapid reduction in carbon emissions that global climate commitments require will influence the working lives of many across the UK. It is incumbent on each of us to ensure that a reduction in economic opportunity is not the legacy of the green transition in the hardest-hit communities and regions and that the vast benefits we all stand to gain from the decades ahead are as widely and fairly distributed as possible.

In this light, I welcome the launch of the Green Jobs Barometer. This forms a meaningful part of our own contribution to the conversation on green jobs, bringing to bear our experience as a large employer with an extensive footprint across the UK and a focus on social mobility and equality. We hope to provide an evidence base that can help guide policy and business action during the transition.

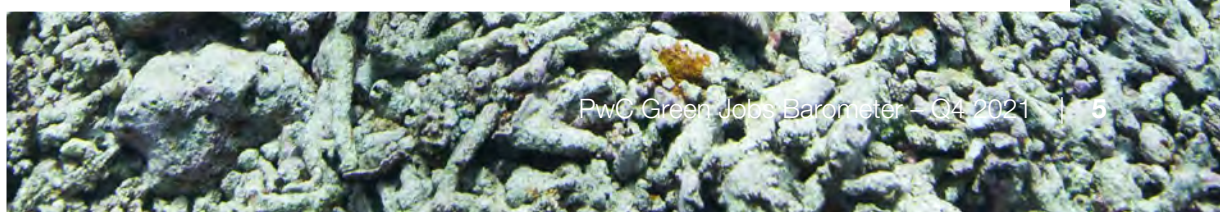
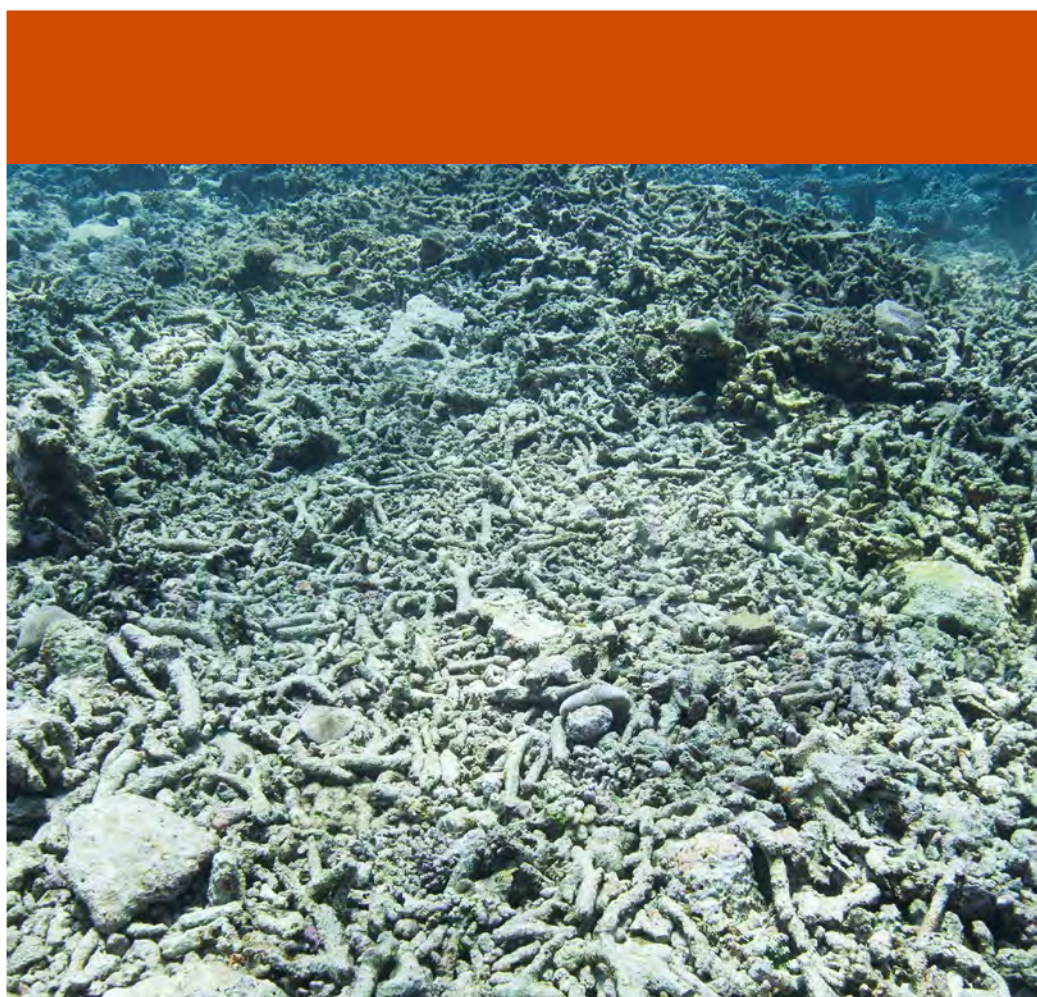
What follows in this report is a starting guide to how to use, interpret and interact with the Barometer. But it is also a clarion call for a more informed and equitable approach to the issue of green jobs. If we are to realise the Government's commitment to create two million green jobs by 2030 – a bold and ambitious commitment – then this requires collaborative and concerted efforts beyond national government.

We are dedicated to playing our part in these efforts and to ensuring that no matter where you are based in the UK, you and future generations stand a chance to benefit from the green revolution.

Kevin Ellis, Chairman and Senior Partner, PwC

Executive Summary

The transition to a net zero carbon economy represents a landmark shift in the way economies worldwide are organised. But as sectors prepare to transform and governments and regulators ratchet up their climate policies, the likely effects of the transition on the jobs market are poorly understood. While many point to the upside of new jobs and industries – with the birth of new sectors such as green tech and clean energy – others highlight the risk it brings to carbon-intensive jobs and the workers and communities that depend on them. Many also are concerned that, left unchecked, the benefits of the transition will be concentrated in specific communities and regions, with at-risk jobs and skill sets disproportionately concentrated in those areas least prepared to lose them.



An accurate assessment of the expected impact of the transition on jobs – across sectors, regions and the UK economy as a whole – is critical to ensuring a national transition that is fair in its distribution of opportunities and effective in its mitigation of risks. At PwC, our firm conviction is that only a transition that is aimed at and perceived to be in the interests of workers across the whole economy, in which benefits are shared widely, will succeed at the pace and scale demanded by the urgency of the climate challenge.

We have therefore constructed the Green Jobs Barometer – the first-of-its-kind tool to track job creation, wider employment benefits, job loss, carbon intensity of employment, and worker perceptions with relevance to the green transition. Interactive and broken down into regions and sectors, the Barometer provides insights that go to the heart of the economy's preparedness for the transition and what that means for jobs and workplaces across the UK.

The Barometer is structured through five Pillars:

01

Green job creation

Measured by the relative density of 'green' job advertisements as a total of job advertisements.

02

Wider benefits from green jobs

Measured as the multiplier effect of new green jobs in creating additional employment.

03

Sunset jobs to disappear

Measured by the distribution of jobs lost as a result of the transition, in the absence of worker reallocation or upskilling.

04

Carbon intensity of jobs

Measured as carbon dioxide emissions per employee, across sectors and regions.

05

Green workplaces

Provided by worker sentiment about how well their employers are enabling their role and workplace to become green.



1. The green jobs market remains small and needs to be scaled up.

In the period July 2020 – July 2021, only 1.2% of total advertised jobs met our broad definition of green jobs, equating to 124,600 unique green job ads. Relative to the scale of emissions reduction and systemwide transformation outlined in national policy and agreed by policymakers and civil society as necessary to keep average global temperature rise within 1.5°C, this number is an encouraging start, but still a low base from which to build upon. It also highlights the work needed to bring green job creation up to HM Government's target of two million green jobs by 2030, as outlined at the launch of the Green Jobs Taskforce in November 2020.

We also recognise a specific need for green job creation in more varied sectors, with existing green job ads concentrated in a small number of particular industries, such as energy and water, sewerage and waste where they account for 21.1% and 19.4% of their total advertised jobs respectively. This is in contrast to education and human health/social work, where green jobs represent only 0.1% of all jobs advertised.

The potential opportunity involved with accelerating the growth of the green jobs market is made all the more stark by our initial findings on the wider benefits from green jobs (Pillar Two). Across the economy as a whole, we estimate the multiplier for green jobs to be 2.4x – meaning that for every green job created, there are another 1.4 jobs which can be attributed to that green job. This number rises even further energy, utilities and manufacturing sectors due to their combination of extensive supply chains and highly-paid, skilled jobs. If the rate of green job creation can be increased, then we can expect an faster growth in the economic opportunity that results from it, with substantial added value throughout the wider economy.

2. Despite a small green jobs market, regional disparities are already arising that risk exacerbating existing inequities in regional access to economic opportunity.

When the findings from across the Pillars are combined, the lowest-ranking regions on the overall Barometer Index are Yorkshire and the Humber, Northern Ireland and Wales. Scotland, London and the South West score highest. These results cast a light on the need for a just transition and highlight the challenges the Government's levelling up agenda will need to overcome.

Behind these figures are some important insights. Northern Ireland and Wales, for example, have the highest carbon emissions per employee in the UK, in contrast to London where the carbon intensity of employment is lowest. This is predominantly driven by a greater reliance on more carbon intensive fuels in these areas – such as coal, burning oil, and gas oil – and the limited availability of natural gas. This suggests that there is likely more potential for green energy sectors to grow in these areas, in comparison with other regions.

Workers in London are also more likely to consider improving the environment to be a primary objective of their jobs than employees in any other region in the UK, with green workplace practices also more prevalent in the capital. Conversely, our responses indicate that the Yorkshire and the Humber region has the least training, education, and/or communications from employers with regards to green workplace practices.

Finally, even in regions that rank highly due to a high projected share of green job creation – such as Scotland – the picture is not always bright. Scotland also hosts the largest projected share of regional job loss as a result of the transition, so-called 'sunset jobs,' with the East Midlands in second place. This is driven in the main by relatively high concentrations of workers in mining, manufacturing and utilities sectors, where the risk of job loss is greater than other sectors.



This regional variation offers up opportunity: regions need to set out their own green transition pathways which utilise their unique characteristics (e.g. access to renewable energy, existing skills, industry clusters etc), but regions can also learn from each other and replicate successful green programmes from others (e.g. skills development, business engagement etc).

3. There is a disconnect between public perceptions of the net zero transition impact on jobs and its possible impact.

One striking finding from our survey of 2,085 UK employees is that 5.3% thought that their current job would not exist following the transition to net zero (1.5% felt this strongly). This figure is likely higher if other environmentally damaging occupations are included. Extrapolated to the full UK labour market this is the equivalent of 1.7 million jobs potentially lost, not too far from the Government's target of 2 million new green jobs to be created. This demonstrates just how many workers feel that the transition to net zero is a threat to their current job. Policy makers and employers need to recognise this concern and respond with bold plans for adaptation, retraining and jobs growth, particularly in more vulnerable communities.

However, the number of lost, or 'sunset', jobs, is likely to be considerably lower. Many studies have shown that there is likely to be an overall net positive impact on jobs from the transition to a green economy.¹ Furthermore, many of the current jobs which may be at risk from a transition to net zero, may be easily

transitioned or adapted. An ILO study ² found that 71% of workers who are projected to lose their jobs during energy transition will be able to find jobs in the same occupation in another industry within the same country (e.g. transitioning from managing a coal-fired power station to a utility infrastructure). There are also some occupations which can transition with only modest adaptation and re-training – e.g. manufacturing jobs in a car plant producing petrol powered cars to one producing electric cars.

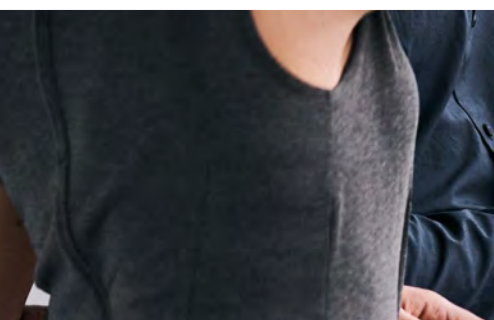
There will still be a significant number of workers who won't be able to transition their job easily. For them, many of their skills may be transferable, but they are likely to require new skills to transition into better, higher paid, greener jobs. This is why training and skills programmes provided by both Government and businesses alike are so critical.

At PwC, our Green Jobs Barometer will continue to track the impact of the green transition on the UK jobs market, providing an evidence base to understand and map job creation, job loss, the carbon intensity of jobs and workplace perceptions, on a regional and sectoral basis. Our purpose is to build trust in society and solve important problems – and as climate change is the most important long-term challenge the world faces, we are committed to help accelerate the transformation needed.

¹ See, for example, Rutovitz and Atherton (2009) Energy Sector Jobs to 2030: A Global Analysis. Sydney. <http://cfsites1.uts.edu.au/find/ist/publications/rutovitzatherton2009greenjobs.pdf>

² ILO (2019), "Skills for a greener future: A global view"

Introducing the Green Jobs Barometer

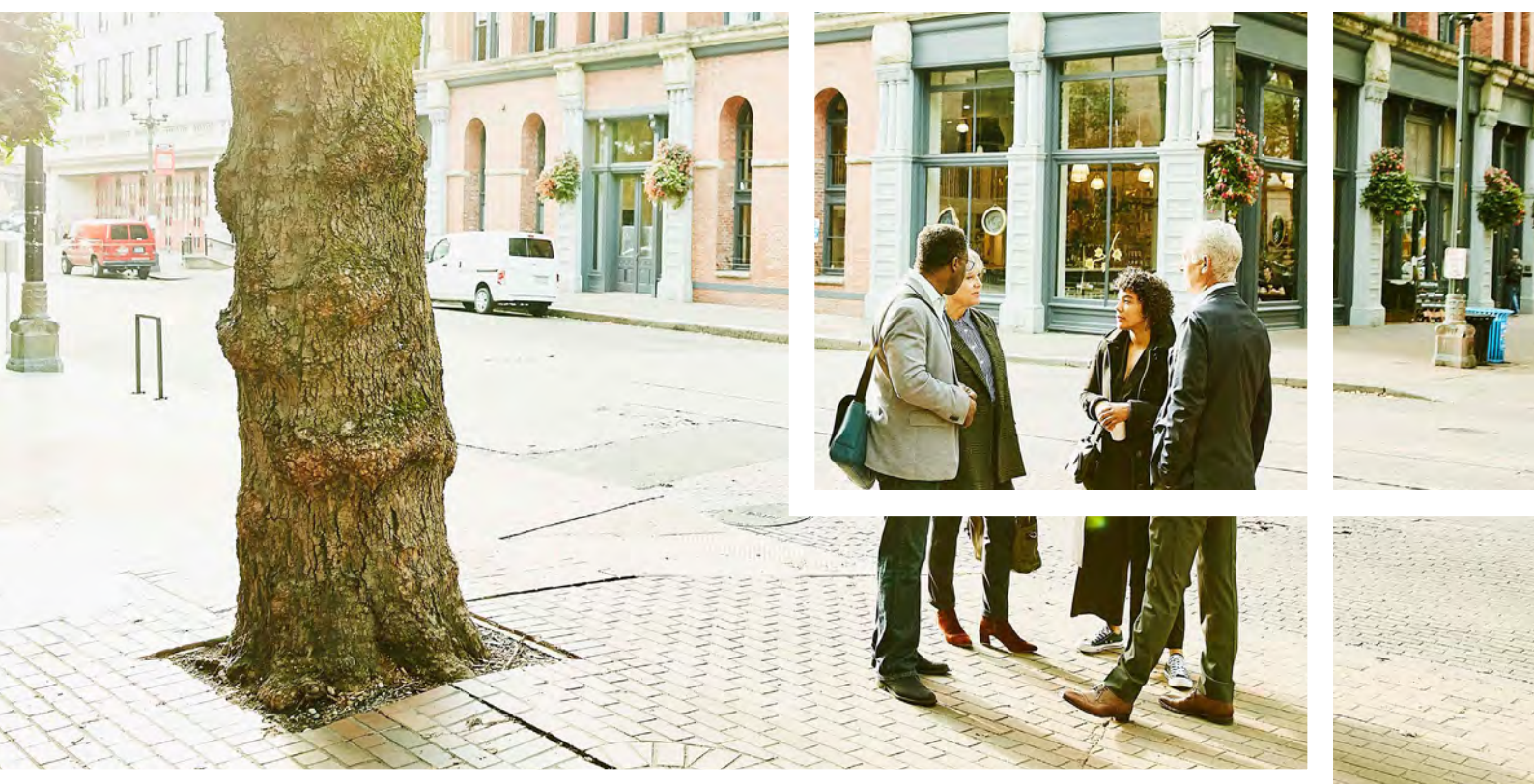


The transition to an environmentally sustainable economy and society (the 'green transition') brings monumental implications for UK jobs – requiring reskilling or upskilling in existing sectors and, for some sectors and regions, creating new so-called “green jobs”. There is currently no formal definition of what constitutes a green job – so we have purposely used a broad definition (this is discussed in more detail below). On this definition, what is immediately apparent is the projected growth of many areas of the economy as a result of the transition.

But not all sectors, regions or workers stand to gain from the green transition in terms of employment. The transition is not just a story of job creation, but also one of job loss and the urgent need to reskill or upskill, as the growth of many sectors and trades is mirrored by the decline of others. UK authorities have made recent progress in outlining how the roadmap and consequences of the coming decades' transformation are likely to look, but there are many things that we still do not know. Evidence about how jobs will

be impacted over the long-term is still scarce and, often, limited in scope. Discussions often focus, for example, on jobs emerging in specific industries such as renewable energies or green technologies, without paying sufficient attention to the impacts across wider sectors of the economy. Efforts to take a whole-economy approach are nascent and as a result, their estimates vary considerably.

To address this, and in order to support an informed approach to green jobs and the green transition, we have created an interactive, accessible and timely data and insights platform – the 'Green Jobs Barometer'. We at PwC believe that this goes to the heart of the climate response and the pursuit of a sustainable, equitable transition. This document accompanies the Barometer. It explains the methodology used to generate the data and highlights some of the most important initial insights obtained.



Defining green jobs

There is no single definition for a ‘green job’ – the Office for National Statistics (ONS) has reviewed the options available and outlined the challenges in doing so.³ This poses a significant methodological challenge when attempting to quantify them.

As the Barometer combines several distinct Pillars of analysis, we adopt a uniform workable definition which can be utilised within each respective Pillar. Adapting an approach developed by the City of Sydney⁴, this study therefore employs a working definition which defines green jobs as work in roles that seek to either produce/provide environmentally friendly products and services⁵ or adapt work processes to become more environmentally friendly or use fewer natural resources⁶. The working definition also acknowledges that other jobs that support the green economy indirectly should be considered green. This could include environmental advisors (e.g., in business consulting, law, and accounting) or experts in environmental/sustainability research and education.⁷ It also reflects the increasing demand for green skills in industries that are not explicitly green – for example, in the apparel sector, where knowledge of sustainable fashion is increasingly required among salespeople, designers and stylists, or in financial services, where sustainable finance skills are in increasing demand.

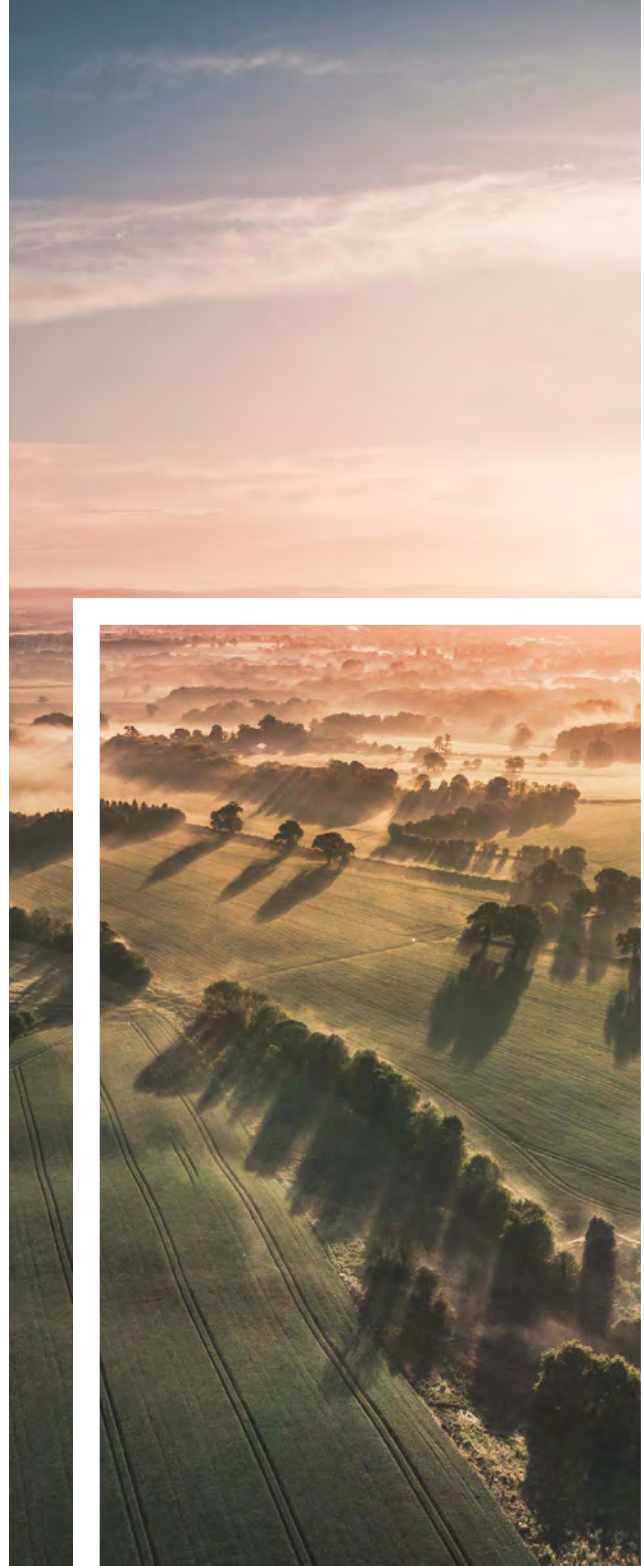
3 ONS (2021). The challenges of defining a “green job”. <https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/thechallengesofdefiningagreenjob>

4 City of Sydney (2019). Building a strong green and circular economy for Sydney. <https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/green-economy-study>

5 This could be, for instance, by producing solar panels or other forms of renewable energy, or collecting and processing recycled waste. Examples also include environmentally friendly versions of traditional products and services (for example electric cars and energy efficient light bulbs). See more details in Appendix A.

6 For example, activities to research, develop, or use technologies and practices to lessen the environmental impact of businesses (independently of the nature of their products). Examples include beer brewed in solar-powered breweries, or operations that are managed from wind-powered offices. Additional examples of ‘adapted’ services might include the provision of green bonds, or sustainable farming. See more details in Appendix A.

7 Please see Appendix B for a more comprehensive overview of the ‘green jobs’ working definition



The transition to a low-carbon economy

Governments worldwide have signaled their ambition to keep the warming of average global temperatures within 1.5C above pre-industrial levels. The drastic and urgent emissions reduction required to achieve this represents a transformation that will touch all parts of the global economy.

For its part, the UK has legislated to achieve net zero annual carbon emissions by 2050.⁸ It is becoming increasingly clear that this requires a suitably skilled workforce and brings with it fundamental shifts in labour demands across the country. The Government's Net Zero Strategy notes that over the next 30 years, approximately 6.3 million jobs are likely to be affected by the green transition.⁹ For its part, The UK's Ten Point Plan for a Green Industrial Revolution sets out an ambition to mobilise £12 billion of government investment, and potentially three times as much from the private sector, to create and support up to 250,000 new green jobs. Whilst some workers will experience an increase in demand for their skills in this context, others will need to reskill or upskill – and the numbers for each will likely be distributed unevenly across regions and sectors.

The impacts of climate change and the green transition on the workforce are already being integrated into policy response. The UK Government's commitments require that policy reflects and responds to the full effects of the transition on UK jobs, which in turn requires better understanding and mapping of where job losses and job creation are likely to occur.

In general, the rise of these types of work and occupations is expected to create “good jobs” that some claim are more productive, meaningful and better paid – while pursuing green/net zero objectives. While the green transition should result in net job gains in the UK, the research suggests that jobs will also be lost over the next 10 years.

To support a clear and substantiated narrative on the performance and development of green jobs over time, The Green Jobs Barometer is based upon five key Pillars. These are set out below:

⁸ It is important to note that some sectors and organisations have quicker voluntary targets.

⁹ HMG (2021) Net Zero Strategy: Build Back Greener

Key features of the Green Jobs Barometer

The Green Jobs Barometer comprises a selection of metrics measuring the relative performance of UK regions and industrial sectors on progress towards the green transition.

Five key Pillars

01

Green job creation

The relative density of 'green' job advertisements as a total of job advertisements.

02

Wider benefits from green jobs

The multiplier effect of direct new green jobs in creating additional employment, whether indirectly or induced via employment effects

03

Sunset jobs to disappear

The number of jobs lost as a result of a transition to environmental sustainability, in the absence of worker reallocation or upskilling.

04

Carbon intensity of jobs

Carbon dioxide emissions per employee. This provides information about the carbon intensity of different sectors and regions.

05

Green workplaces

Worker sentiment about what the green transition means for their own role and workplace.

Each Pillar captures a different aspect of the impact of a transition to a green economy on the UK labour market. In order to capture the overall performance of different UK regions and sectors, the five Pillars are aggregated into a regional index.

Collectively, they are intended to help provide answers to critical questions related to the societal and economic impact of the green transition, including:

- In which sectors are green jobs more likely to be created?
- What fraction of green jobs will be created outside the low carbon economy?

- Which sectors and occupations are more likely to be disrupted?
- Where are the wider benefits of green jobs throughout the supply chain?
- How ready are different UK regions to benefit from the green strategy?
- Is the rest of the labour market becoming as green as it can be?

The multi-Pillar framework also establishes an integrated view of the relationship between the labour market and the green transition, rather than focusing solely on one particular indicator or metric.¹⁰

¹⁰ There have been a number of efforts to quantify green jobs using disparate approaches. Methods vary in terms of geographic application, data requirements, level of detail being captured, ability to elucidate interlinkages within an economy, and temporal scope. The differing approaches employed in respective studies also lack a common metric for defining green jobs, they therefore can only be interpreted in isolation of one another which has the effect of obscuring interlinkages.

Design of the Barometer

This section describes in more detail the rationale for each of the five Pillars captured, how the Barometer is compiled and how the tool can facilitate decision making.



A key feature of the Barometer is that it summarises and aggregates information in a meaningful way. The incorporation of green jobs performance into an empirical framework such as this enables organisations and policy makers to identify trends and challenges, assessing systematically how to adapt to the green transition.

The Green Jobs Barometer allows users to undertake a high-level comparison of regions. They are also able to view the raw data across the five Pillars that make up the index. This feature facilitates quick evaluation of strengths (and weaknesses) of specific sectors and




regions. To formulate action, users will also be able to segregate the data based on regions and sectors. More importantly, the respective Pillar findings offer additional granularity when exploring the range of ways in which regions and sectors will be impacted in the transition to a green economy.




The key design considerations for the Barometer are:

- What information to include such as the number of Pillars and what they represent
- How to normalise the data across different measures
- How to aggregate the Pillars into an overall Barometer metric for each region and sector

Information we include in the Barometer

This section sets out the rationale for including information in the Barometer. We considered a wider number of potential sources of relevant information, but concluded with five Pillars which provide a good breadth to assess green job performance, while being able to draw upon robust information and able to show the degree of progress over time. Full detail of our methodology for each Pillar can be found in Appendix B.

 Rationale: what does the Pillar capture?	 How is performance estimated?	 How can this indicator change over time?
<p>01 Green job creation</p> <p>This Pillar captures performance on creating new green jobs. We focus on green job creation as this is where we expect to first see changes in the labour market (as opposed to the stock of green jobs).</p>	<p>Pillar 1 is estimated as the number of direct green jobs, expressed as a proportion (%) of total jobs advertised. This captures the relative density across sectors and regions to enable comparisons. We also capture the absolute number of jobs adverts in the detailed data, but this is not used in the aggregation of the overall Barometer.</p>	<p>We expect the number to increase over time as the transition to a sustainable economy gathers pace. However, there will be waves of different green job creation across sectors (and regions) over time. Some of this will come earlier in the transition period, and others later. Some jobs will support the transition itself, whereas others will be enduring once fully transitioned to a green economy.</p>
<p>02 Wider benefits from green jobs</p> <p>Pillar 2 seeks to identify where direct green jobs are creating additional employment, across other sectors and regions. This helps to show the full benefits of green jobs, and means policy decisions can be based upon wider economic impacts rather than narrow green employment creation.</p>	<p>Pillar 2 is based on employment multipliers. This measures how many additional jobs in the UK economy as a whole are created from one green job in a certain sector or region. Additional jobs might arise because of indirect employment effects (the supply chain impact of the green job) or induced employment effects (arising because of the spending from the employee in the new green job).</p>	<p>While policy will seek to increase the overall employment benefit of green jobs, we expect multipliers to remain reasonably constant over time. Multipliers are typically higher in well-paid jobs with extensive local supply chains (typically in highly technical roles). As green activities move from highly technical and design roles into broader roles, there is a possibility that multipliers might decrease, but this impact is likely to be minimal over the short term.</p>
<p>03 Sunset jobs to disappear</p> <p>While job creation is covered in Pillars 1 and 2, Pillar 3 provides an insight on job destruction. This lens will be vital for designing the right set of active labour market policies – including reskilling and upskilling, targeted training, and focus on social mobility – in order to ensure a green transition is also a just transition.</p>	<p>Performance is measured by looking at the distribution of “sunset jobs” – ie. those jobs that will become redundant following the transition to the green economy. It is important to note that Pillar 3 does not capture job reallocation – with the right training, individuals in sunset jobs may find employment in growing areas of the same sector, of different sectors, or in the ‘new’ green jobs emerging from Pillar 1.</p>	<p>As these career pathways are realised, we expect the number of sunset jobs to decrease over time. Through the Barometer we will be able to track which regions and sectors are making progress on reducing the amount of jobs that are still likely to be lost through the green transition.</p>

 Rationale: what does the Pillar capture?	 How is performance estimated?	 How can this indicator change over time?
<p>04 Carbon intensity of employment</p> <p>Pillar 4 compares CO₂ emissions in different UK regions and sectors to employment in the same UK regions and sectors. One way in which jobs can become greener is if the carbon intensity of the job reduces, while the job itself is retained (e.g. a bus driver switching to driving an electric bus).</p>	<p>Performance is estimated using CO₂ emissions per employee. This gives us an indication of how environmentally-friendly jobs are, independently of whether such jobs are considered green jobs or not. It also gives us an indirect indication of jobs that could lose out as the green transition accelerates. This measure can be compared across sectors and regions.</p>	<p>We expect there will be accelerated change in carbon-intensive sectors, with diminishing returns for low-carbon sectors and regions.</p>
<p>05 Green workplaces</p> <p>Taken alone, Pillars 1-4 are limited in how much they can tell us about how existing jobs will change – whether through the activities conducted as part of a role, the sustainability of workplaces, or the education and training provided by employers. Pillar 5 seeks to fill these gaps, harnessing employee sentiment to give an extra layer of insight.</p>	<p>Pillar 5 measures how environmentally friendly employees perceive the activities conducted as part of their job to be currently, and whether they expect this assessment to change over the next 1-2 years. These activities span across 8 environmental outcomes – reducing waste, reducing carbon, reducing pollution, protecting biodiversity, improving resource efficiency, reducing water use, increasing reuse and recycling, and reducing energy consumption.</p>	<p>We expect the environmental friendliness of jobs to increase over time. We have scope to include different questions as the transition evolves.</p>

Creating the aggregated Barometer index

Each Pillar captures a different aspect of the transition to a green economy on the UK labour market. Therefore the measurement units of the underlying data vary by Pillar.

For the purpose of comparison across the UK, we aggregate the sector data across each region and Pillar. Each region is then given a score from 0 to 100 using a minimum-maximum normalization

approach.¹¹ Finally, we award each region an overall index score using an equally weighted average of the normalized scores for Pillars 1 to 5. Whereby 0 denotes the worst performing region across every individual Pillar, and 100 the best.

In order to obtain an overall score for the UK (for comparison purposes), we take an average of the scores across Pillars 1 to 5.

¹¹ The normalization approach is inverted for Pillars that are capturing a 'negative' performance metric such as sunset jobs, and carbon exposure.

Overall regional and sectoral green job performance

The Green Jobs Barometer allows users to do a high-level comparison of regions on their overall index score (Figure 1 provides a ranking). They will also be able to view the raw data across the five key Pillars that make up the index. This feature facilitates quick evaluation of strengths (and weaknesses) of specific sectors and regions.

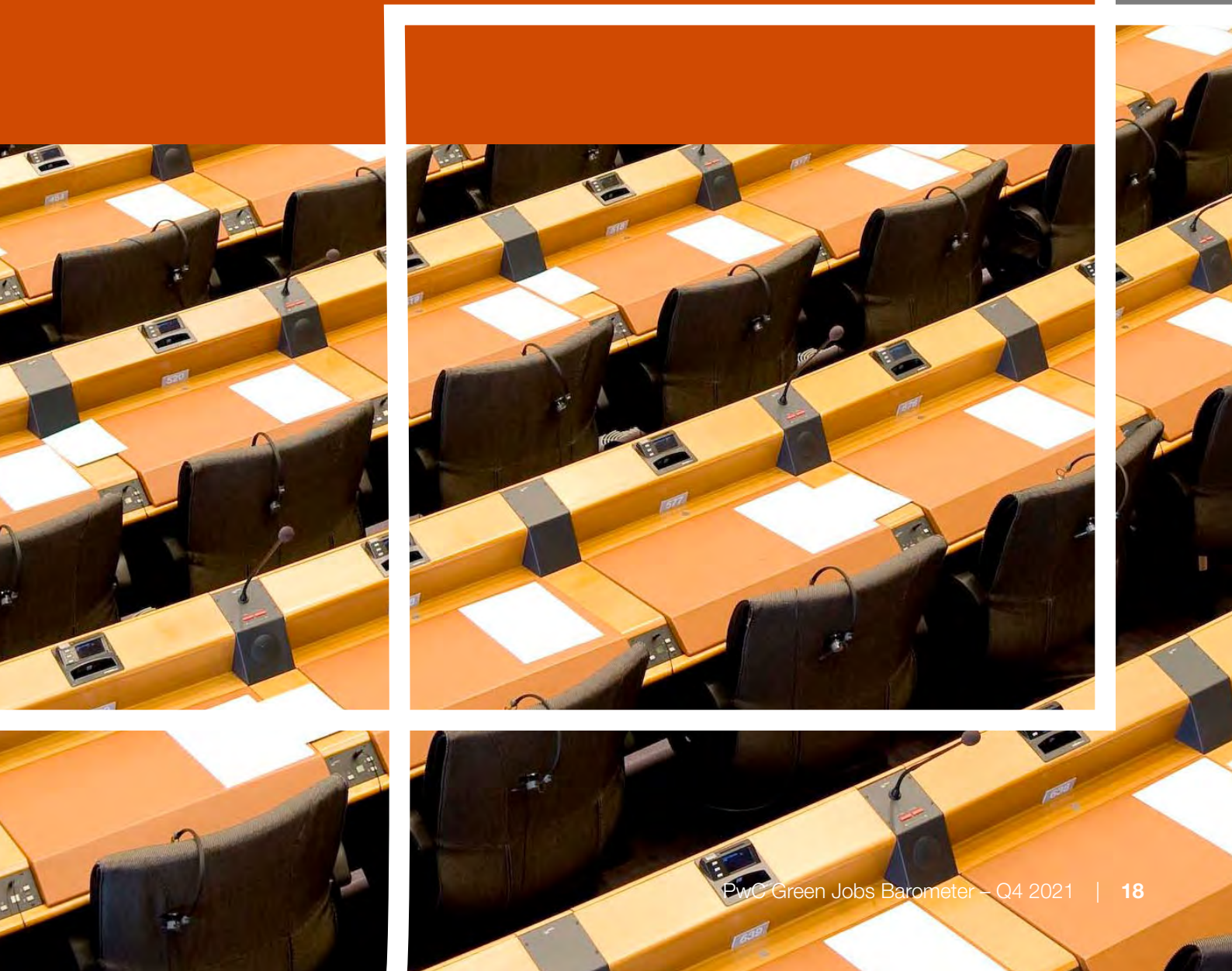


Figure 1: Ranking of UK regions based on the Barometer overall Index

1	Scotland	2	London
3	South West	4	North East
5	East of England	6	North West
7	East Midlands	8	South East
9	West Midlands	10	Yorkshire and the Humber
11	Northern Ireland	12	Wales

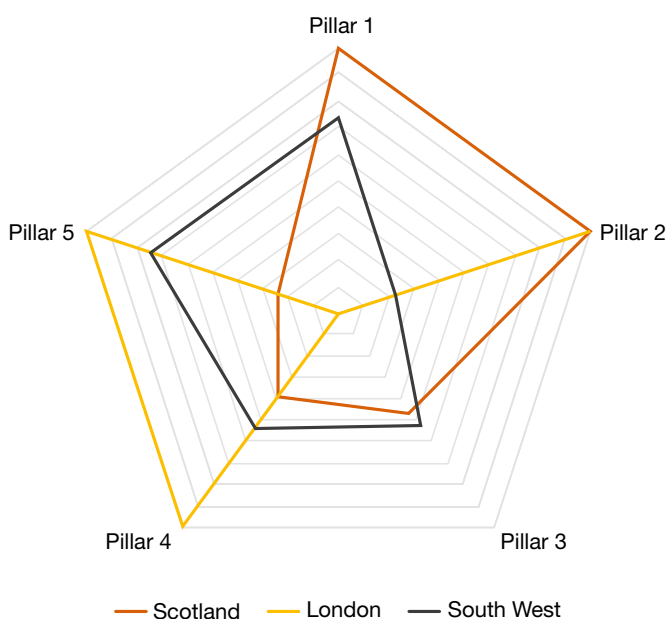
Source: PwC – For methodology see Appendix B.



The regional analysis offered by the aggregation from the Barometer depicts clear disparities when comparing relative regional performance.

- **Scotland** comes out on top with the highest index score, which is the overall performance metrics across the five Pillars. This result is driven by top performance in Pillars 1 and 2 (see Figure 2) – Scotland is the UK region with the greatest proportion of new green job creation (at 1.65%), driven by its strong presence of energy and utilities roles, in particular renewable energy. The creation of green jobs then leads to knock-on effects on wider sectors of the economy.
- **London** is the second strongest performing region in respect of aggregated performance but through a mixture of polarised results – London performed the strongest of all regions in respect to the wider benefits of green jobs, carbon intensity of employment and within the green workplaces survey but came out worst in relative green job creation (measured by the proportion of new jobs which are green) and in respect of sunset jobs to disappear.
- The **South West** is not the strongest performing region in any single facet of the analysis (Figure 2) but is consistently one of the highest performing regions across each and is accordingly ranked as the third strongest performing region at the aggregate level.
- The **West Midlands** and **Yorkshire and the Humber**, by contrast, perform poorest among England's regions – and also Northern Ireland and Wales show weaker performance UK wide. While Northern Ireland, Wales, and the North East have the lowest absolute level of CO₂ emissions in the UK, their smaller than proportional workforces mean they have the highest CO₂ emissions per employee.

Figure 2: Pillar comparison of Index Top 3 regions



Overall performance can hide varied performance across pillars. For instance, while Scotland comes out top in Pillars 1 and 2 given the high multiplier of the renewable energy sector, it also shows a high concentration of sunset jobs (along with East Midlands), as a result of the high concentration of workers in the mining, manufacturing, and utilities (electricity and gas, water) sectors.

The regional findings of the Barometer, generally depicting relatively stronger results in the south and in London and weaker relative results in northern regions, is therefore one which casts a light on the need for a just transition.

Regions whose economies have not performed as strongly in the last couple of decades show promising signs of benefiting from the green transition (see the Regional and Sectoral Spotlights below). The Barometer allows monitoring regional convergence and identifies where the main roadblocks are and also the areas of opportunity.

Regional Spotlight

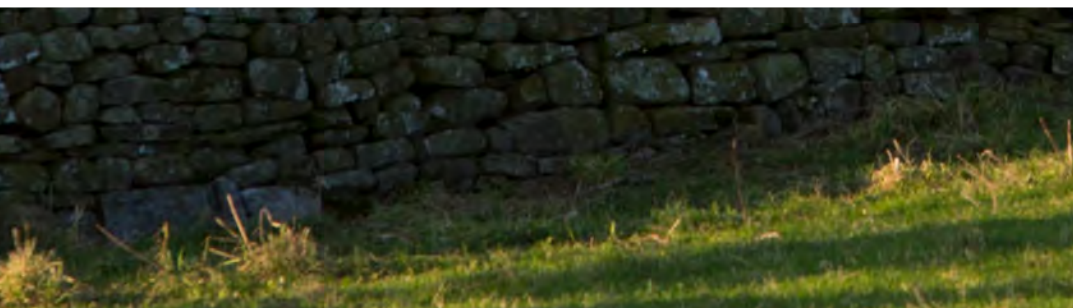
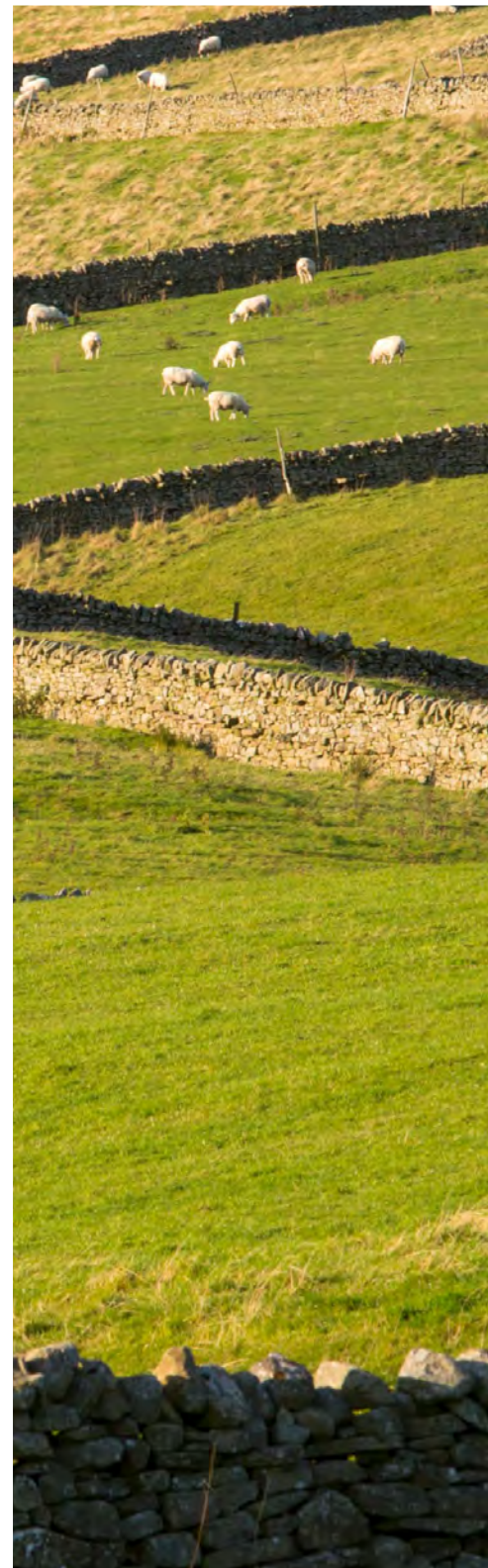
Scotland

The Barometer identifies Scotland as the best performing UK region, ranking 1st in the overall index. The nation leads the analysis for green job creation at 1.65% of all jobs advertised and is best-positioned to maximise the benefits of green investment with the highest returned multiplier effect of any region.

The demand for green jobs in Scotland, to a large extent, mirrors much of the UK by being driven in part from the utilities and energy sectors. Scotland however leads the UK in green job creation within professional, scientific, and technical activities. The higher absolute contribution of this sector to the UK and Scottish labour force means that only a marginal relative increase in this sector has a material impact on the overall number of green jobs occurring within the respective region.

Tonnes of CO₂ emitted per job are higher than average in Scotland (10.4 tonnes per employee compared to 9.1 tonnes per employee for the UK as a whole) but unlike other high performing regions such as London, it contains a relatively higher composition of labour employed in energy and utilities and mining roles, a greater relative density of manufacturing industries and more carbon intensive transport sector. These factors also contribute to Scotland's higher than average proportion of sunset jobs (as per Pillar 4).

Scotland's leading regional position does not mean it is without challenges which will need to be addressed in a transitioning economy. Respondents to the survey (Pillar 5) highlighted that Scottish employers are amongst the lowest performing for delivering workplace training, education and communications associated with the greening nature of the economy as well as yielding some of the lowest scores associated with perceptions of potential for their jobs to become more environmentally friendly in the future.



Yorkshire and the Humber

Yorkshire and the Humber ranks 10th out of the 12 regions in our overall Barometer. It attains lower than average relative performance across every Pillar of the Barometer with the exception of Pillar 3 'Sunset Jobs' where it performs only marginally better than the region average.

Yorkshire and the Humber's greater dependency on high carbon industries results in a workforce whose per employee concentration of CO₂ (10.2 tonnes) is almost double the best performing region, London (5.3 tonnes). The analysis from Pillar 4 serves as a stark reminder of how Yorkshire and the Humber's decarbonisation needs to advance further in comparison to other regions.

The most striking demonstration of the region's performance relative to the rest of the UK comes out in the analysis of the Pillar 5 survey results for 'Green Workplaces'. As the UK's lowest performing regions, respondents from Yorkshire and the Humber were far from sanguine about the effects a green transition is having or could have. Along with recipients from Wales, the region ranked lowest in the perceived environmental friendliness of their jobs, a finding which is consistent with the high regional composition of hard-to-abate industries.

Notwithstanding these challenges this region faces in a decarbonising economy, the energy sector has shown signs of recent improvement in their capacity building for a greener future. The Pillar 1 analysis shows that within the region, this sector has a higher demand for green jobs than the UK regional average. Given the regional dependency on this sector, its efforts to decarbonise should not only be welcomed but encouraged through targeted policy.



Sectoral spotlights – Drawing parallels with the mining and energy sectors in the UK

The current energy crisis has highlighted just how heavily the UK still relies on fossil fuels to meet demand. The electricity and gas sector has traditionally been the sector responsible for the largest emissions in the UK (26% of total in 2019, as per Pillar 4), driven by fuel combustion for electricity generation in power stations. Energy companies are under increasing scrutiny from their regulators to invest and innovate in new technologies, processes and approaches that protect the environment.

Accordingly, our analysis shows that the electricity and gas sector is at a high risk of sunset jobs (as per Pillar 3). Without the right investment in skills and technology, efforts to decarbonise these carbon intensive sectors risks mirroring the impact wrought by the demise of mining and traditional manufacturing.

Many mining communities were decimated after pits were shut down during the second half of the last century, with unemployment levels jumping well above the national average as a result. Employee sentiment (as per Pillar 5) continues to reflect this demise – one third of respondents to our online panel survey believe that their jobs will not exist following the transition to net zero. Mining – the second most carbon intensive sector in the UK (as per Pillar 4) is associated with a myriad of environmental impacts – from water pollution, use, and depletion, to tailings dams and air pollution from smelting. However the

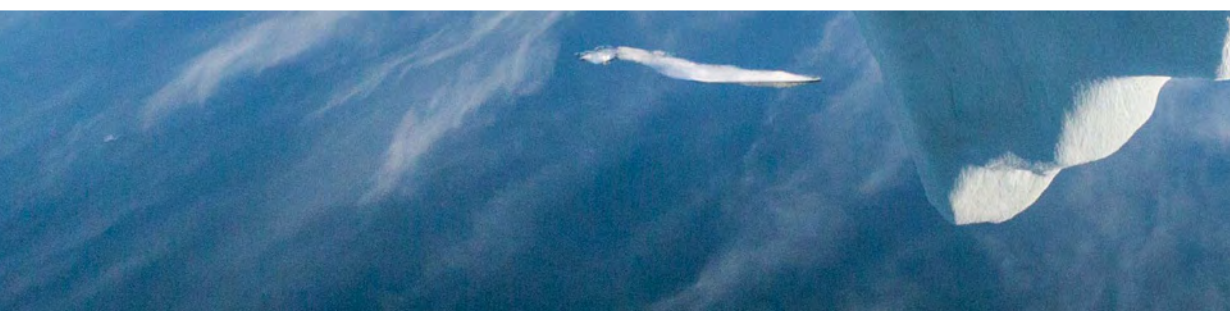
absolute size of this sector is now relatively small – responsible for only 0.2% of total UK employment.

The most carbon intensive sectors – such as electricity and gas – also have some of the best potential for green jobs.

Despite having the most carbon intensive employment, and a high proportion of sunset jobs, our analysis shows that the electricity and gas sector also has the one of the largest opportunities for green jobs (at 23.2% of total advertised jobs). Indeed, the sector is already experiencing the “greening” of jobs – with employees in the sector considering improving the environment to be a primary objective of their jobs more than employees in any other sector. Importantly, and with the right reskilling and upskilling, those in sunset jobs (and in particular those in highly skilled occupations, such skilled metal, electrical and electronic trade, and skilled construction and building trades) can utilise existing technical and soft skills in new occupations in green jobs.

Jobs in the electricity and gas sector also generate the highest multipliers – 1 green job (in FTE terms) yields 6 additional jobs (in FTE terms) in the UK economy as a whole. This is as a result of a combination of well-paid, skilled jobs in the sector, and an extensive supply chain.

It is therefore vital to ensure that key enablers such infrastructure, skills and governance are in place to capitalise on these opportunities.



The regional and sectoral strengths and weaknesses identified by the Barometer, accompanied by granular data in each of the Pillars, can bring the data needed to inform different policy areas (from skills development to place-based policies) – which will be explored in more detail, along with recommendations for policy and businesses, in future research linked to the Barometer. Please see the ‘What next?’ section for more detail.

In the following sections we describe in detail each of the Pillars, including the methodology used and the sectoral and regional findings.



Pillar 1: Green jobs creation

Overview of the Pillar

The global trend of transitioning towards greener economies is already having a profound impact on the labour market, both in terms of labour demand, and in respect to the specific skills and domain knowledge being called for. To understand the extent to which a workforce has to change and become equipped for this transition, it is important to monitor how the greening of the economy is impacting the labour market through the creation of jobs.

Pillar 1 focusses on green job creation. In this Pillar we are seeking to understand how many green jobs are being created and where they are being created in the economy. This will allow us to identify both areas of strength in green

job growth and areas where Government and business intervention may be necessary to speed up progress.

The emergence of 'green jobs' (see Appendix A for the definition of a 'green job' used in our analysis) as a subject for economic research is a relatively recent phenomena. Many jobs that are widely considered to be 'green' by contemporary standards have been around for decades, but efforts to quantify the number of green jobs in an economy have been limited, and can be often characterised as lacking a common or even similar definition of what a green job is. As a result, different studies offer wide ranging estimates of the size of the green economy.



Methodology and data used

Pillar 1 'Green jobs creation' is represented by the relative 'green density' of the UK labour market by measuring what proportion of that labour market is composed of green jobs.¹² To create this Pillar, we evaluated more than 11.2 million unique UK job advertisements over 12 months, from July 2020 to June 2021.

Online job advertising offers the most comprehensive data source capturing demand for jobs and this serves as a reliable proxy for job creation within an economy. Job advert data is highly granular, meaning that it can be used to evaluate regional, sectoral and occupational trends with a high degree of validity as well as providing insights into the skills associated with those jobs through the analysis of the job descriptions they are listed with. As green jobs are subjectively defined and therefore not easily classified, the granularity of these data, particularly in respect to the skills listed within job descriptions make it possible to identify green jobs based on the green skills and characteristics a job description contains. Once identified, these green jobs can then be quantified.

We commissioned Geek Talent to analyse more than 11.2 million unique job vacancies advertised over 12 months, from July 2020 to June 2021.¹³

The output of Pillar 1 is expressed as the number of green job advertisements of total job advertisements for UK sectors and regions, and UK sector-region pairings.

The analysis can be repeated at frequent intervals and can therefore be used to observe trends in the growth of green jobs and track performance against the UK government's targets on green job creation.

¹² Since regions and sectors are varied in size and other dimensions, the analysis pays attention to both absolute numbers (to show where the jobs are) and proportion of jobs (to show density). As the UK labour market is not homogeneously distributed across sectors, so the proportional composition of green jobs is considered to hold greater analytical value than absolute contribution when analysing sectors.

¹³ Geek Talent are a specialist provider of real-time insight into the UK job market and skills landscape.

Overall findings

Our analysis identified 124,600 unique green jobs from a population of 11.2 million unique ads over the period from July 2020 to July 2021.¹⁴

Our findings show that over this period only a small proportion of UK jobs can be defined as green, with only 1.2% of advertised jobs in the UK being identified as green. To contextualise this number, the UK government has set a target of creating 2 million green jobs by 2030 – which would equate to 6.2% of UK employment.¹⁵ In Table 1 we present green jobs as a proportion of total jobs across both sectors and regions.

Table 1: Green job advertisements as a proportion of total in UK sectors and regions, July 2020 to June 2021

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Agriculture, forestry and fishing	-	1.9%	0.9%	0.2%	1.6%	0.5%	3.3%	6.6%	0.5%	-	17.5%	1.5%	2.5%
Mining and quarrying	-	-	-	16.7%	-	-	71.4%	66.7%	-	-	63.2%	-	18.8%
Manufacturing	1.8%	2.0%	2.7%	2.8%	2.0%	1.9%	3.2%	2.2%	2.0%	2.8%	2.4%	1.8%	2.1%
Electricity, gas, steam and air-conditioning supply	31.0%	24.4%	29.3%	15.9%	21.6%	20.2%	26.8%	18.1%	24.1%	20.8%	27.4%	5.7%	21.1%
Water supply; sewerage and waste management	16.3%	25.7%	14.1%	22.8%	28.1%	20.9%	11.5%	13.1%	34.0%	16.8%	11.3%	-	19.4%
Construction	1.5%	1.9%	2.3%	1.8%	1.9%	1.3%	1.4%	1.4%	2.0%	1.8%	2.6%	3.5%	1.6%
Wholesale and retail trade; repair of motor vehicles	0.6%	0.4%	0.4%	0.4%	0.4%	0.3%	0.5%	0.4%	0.4%	0.2%	0.3%	0.3%	0.4%
Transportation and storage	1.7%	1.2%	1.5%	1.2%	1.2%	1.3%	1.5%	1.6%	1.9%	2.2%	1.1%	1.2%	1.3%
Accommodation and food service activities	0.4%	0.7%	0.4%	0.9%	0.6%	0.5%	0.4%	0.6%	0.5%	0.7%	0.2%	1.1%	0.5%
Information and communication	0.4%	0.2%	0.1%	0.3%	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%	0.2%	0.5%	0.2%
Financial and insurance activities	0.6%	0.1%	0.2%	0.2%	0.3%	0.2%	1.0%	0.3%	0.3%	0.3%	1.0%	0.3%	0.4%
Real estate activities	-	-	-	-	-	-	-	-	-	-	-	-	-
Professional, scientific and technical activities	4.5%	6.6%	3.5%	3.5%	3.3%	2.9%	2.5%	3.7%	4.8%	3.3%	7.2%	3.8%	3.6%
Administrative and support service activities	1.2%	1.1%	1.0%	0.9%	0.7%	0.7%	1.0%	1.0%	1.4%	1.4%	2.1%	1.4%	1.0%
Public administration and defence; compulsory social security	0.4%	2.5%	2.1%	1.8%	2.9%	2.7%	2.8%	2.8%	3.6%	2.3%	3.4%	0.5%	2.5%
Education	0.1%	0.1%	-	0.1%	0.1%	-	-	-	0.1%	0.1%	0.1%	0.2%	0.1%
Human health and social work activities	0.1%	-	-	-	-	0.1%	0.1%	0.1%	-	0.1%	0.2%	0.1%	0.1%
Arts, entertainment and recreation	1.0%	0.7%	1.0%	0.9%	0.8%	1.6%	0.7%	1.3%	1.4%	0.3%	0.7%	1.6%	0.8%
Other service activities	-	5.0%	1.0%	-	5.9%	1.7%	3.0%	5.4%	2.4%	1.9%	0.9%	17.5%	2.7%
Activities of households as employers	-	-	-	-	-	-	-	-	-	-	-	-	-
All Sectors	1.3%	1.5%	1.2%	1.2%	1.1%	1.0%	0.9%	1.1%	1.5%	1.1%	1.7%	1.2%	1.2%

Source: PwC analysis of Geek Talent data

¹⁴ We note that we have not analysed the impact of COVID-19 on job advertisements. This means that we may not capture the impact of increased flexible working – for example a role may be advertised as being based in London, but flexible working may have enabled the job to be conducted in another region.

¹⁵ Gov.uk (2021) Press release: UK government launches taskforce to support drive for 2 million green jobs by 2030 <https://www.gov.uk/government/news/uk-government-launches-taskforce-to-support-drive-for-2-million-green-jobs-by-2030>
Calculation for UK employment is based on the seasonally adjusted employment level for July to September 2021. ONS (2021). Employment in the UK: November 2021. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/employmentintheuk/november2021>

To illustrate the distribution of green jobs across broad different ‘types’ of job, we have segmented the sectoral impact as follows – to those sectors which are more closely tied to energy transition; those sectors which are more closely tied to producing and adapting green products and services; or those sectors which are more closely tied to advisory, advocacy, and research and other support services.

Table 2: Apportionment of sectoral impact to different definitions of green

Category	Sectors aligned to this category
Sectors more closely tied to energy transition	Mining and quarrying; Electricity, gas, steam and air-conditioning supply; Water supply, sewerage and waste management
Sectors more closely tied to producing and adapting green products and services	Agriculture, forestry and fishing; Manufacturing; Construction; Accommodation and food service activities; Transportation and storage
Sectors more closely tied to advisory, advocacy, and research and other support services	Information and communication; Financial and insurance activities; Real estate activities; Professional, scientific and technical activities; Administrative and support service activities; Education; Human health and social work activities; Public administration and defence, compulsory social security; Arts, entertainment and recreation; Other service activities; Activities of households and employers; Wholesale and retail trade, repair of motor vehicles

Source: PwC analysis of ONS and Geek Talent data

As shown in Table 3, our analysis finds that green job creation (as a proportion of total job creation) is concentrated in those sectors more closely aligned to the energy transition – with the impact in these sectors more than 15 times the impact in other definitions of green, and the UK wide impact. In the remainder of this section, we explore the sectoral and regional findings in more detail.

Table 3: Green job advertisements as a proportion of total in UK sectors and regions, by green segments, July 2020 to June 2021

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Sectors more closely aligned to the energy transition	28.6%	24.5%	26.5%	17.5%	22.4%	20.4%	25.1%	16.7%	27.6%	20.4%	27.4%	5.6%	22.5%
Sectors more closely tied to producing and adapting green products or services	1.4%	1.4%	1.7%	1.5%	1.4%	1.2%	1.2%	1.3%	1.6%	1.8%	1.6%	1.9%	1.4%
Sectors more closely tied to advisory, advocacy, or research	1.1%	1.4%	0.9%	0.9%	0.9%	0.8%	0.8%	1.0%	1.2%	0.8%	1.4%	1.0%	1.0%
All Sectors	1.3%	1.5%	1.2%	1.2%	1.1%	1.0%	0.9%	1.1%	1.5%	1.1%	1.7%	1.2%	1.2%

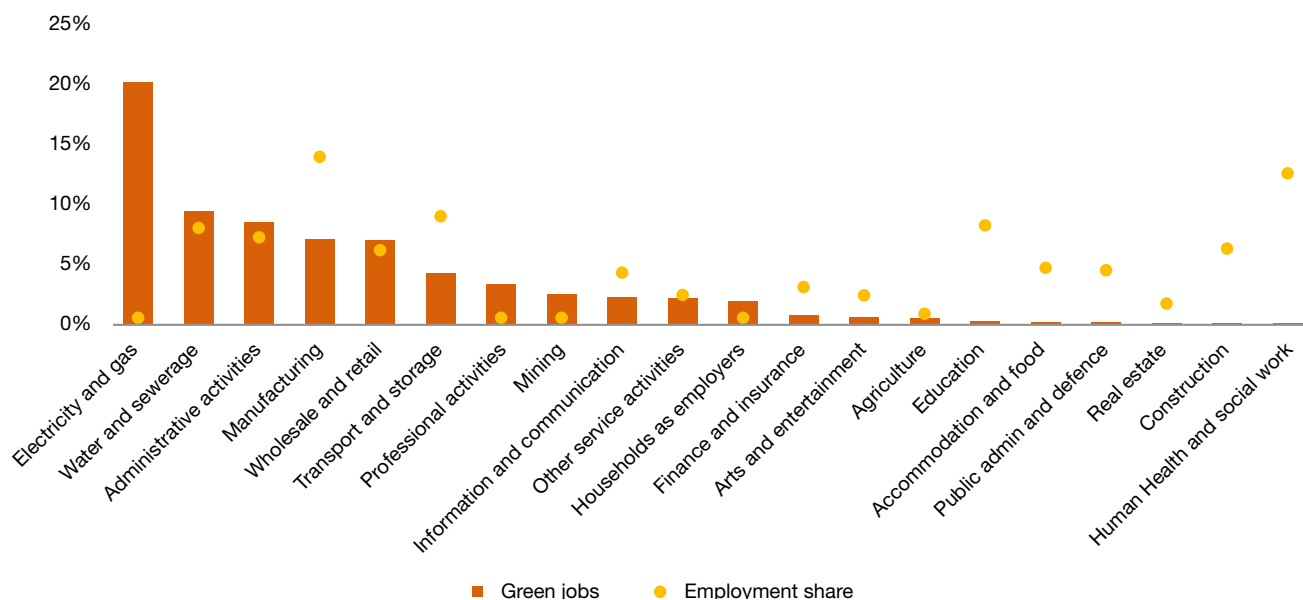
Source: PwC analysis of Greek Talent data

Sectoral findings

The **professional, scientific and technical** sector accounts for the largest absolute share of green job creation (responsible for 44% of all green job advertisements). In relative terms, our findings show that green jobs are proportionately most well represented within the **electricity and gas**, and **water and sewerage** sectors, where they account for 21.1% and 19.4% of their total advertised jobs respectively. By contrast, job adverts for **education**, and **human health and social work** contain the lowest proportion of green jobs of all sectors. Within these sectors, green jobs represent only 0.1% of all jobs advertised.

By sector, the demand for green jobs is significantly higher in sectors aligned to energy transition where they represent 22.5% of all advertisements in contrast to a value of 1.2% for the UK as a whole. A green transition will require a labour force equipped with green skills and domain knowledge, the **education** sector would therefore appear to represent a current gap in the capacity building necessary for a green transition.

Chart 1: Sectoral green jobs and employment share, July 2020 to June 2021



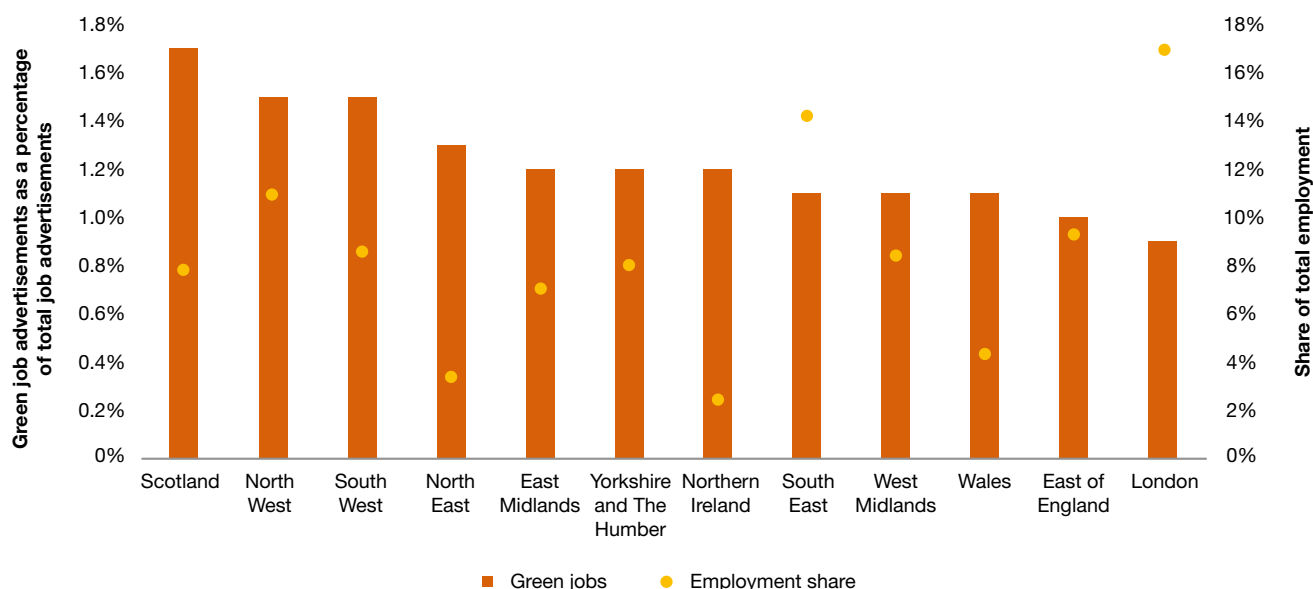
Source: PwC analysis of ONS and Geek Talent data

Regional findings

Our regional analysis shows that the largest absolute contribution to green job advertising comes from the **South East** and **London**, which respectively account for 18% and 14% of all green jobs advertised (or 21,900 and 17,200 jobs respectively). This is partly because London and the South East have among the largest workforces in the UK, but also because they have a high concentration (over a third of total employment) of jobs in the professional, scientific and technical sector – the sector with the largest absolute contribution of green jobs in the UK.

The relative proportions of green job advertisements (of total job advertisements) are distributed much more evenly across regions than it is for UK sectors – with a standard deviation of only 0.2%. The UK region with the greatest proportion of new green job creation is Scotland, at 1.7%. One reason for Scotland's higher proportion is due to the strong presence of energy and utilities roles, in particular in renewable energy.

Chart 2: Regional green jobs and employment share, July 2020 to June 2021



Source: PwC analysis of ONS and Geek Talent data

Pillar 2: Wider benefits from green jobs

Overview of the Pillar

The creation of green jobs can be accompanied by wider employment gains. It may also create further jobs in the same sector, for example through clustering, or in other sectors through increased demand for goods and services within the supply chain. The size of this additional impact can be measured using 'multipliers'.

Pillar 2 seeks to identify where direct green jobs are creating additional employment, across the UK. This helps to show the full benefits of green jobs, and means policy decisions can be based upon wider economic impacts rather than narrow green employment objectives.



Methodology and data used

We first set out the difference between direct, indirect, and induced employment effects. Essentially, if there is an increase in output for a particular sector, there will likely be an increase in employment in that sector. This is the **direct effect**. As producers increase their output (e.g. manufacturing more wind energy turbines), there will also be an increase in use (and therefore employment) within their suppliers and so on down through the associated supply chain. This is the **indirect effect**. Finally, as a result of these direct and indirect effects, the level of household income will increase throughout the economy as a result of increased wages. A proportion of this increased income will be re-spent in the economy, which will again support more employment. This is the **induced effect**.

Type I and Type II multipliers can be used to show the relationship between the direct, indirect, and induced effects. Multipliers are expressed as full-time equivalent (or FTE) and measure the ratio of direct

plus indirect (plus induced if Type II multipliers are used) employment changes to the direct employment change. In other words, if you have the change in FTE employment for one sector, the employment multiplier can be used to calculate the change in FTE employment for the economy as a whole (including the direct change).

We estimate Type II multipliers for each sector and region pair using a bespoke input-output model. Our methodology to create this model is based upon standard approaches for measuring economic impact and is set out in Appendix B. In order to identify those sectors and regions where 1) labour demand for green jobs is high, and 2) the employment effect (as measured by the Type II multiplier) is high, we have calculated the weighted average of the sector-region multipliers for the share of green jobs in each sector and region as a whole. These weighted multipliers are respectively reported in the final column and final row of Table 5.

Overall findings

We estimate the multiplier for green jobs is 2.4x. This means that for every green job created, there are another 1.4 jobs which can be attributed to that green job. These jobs will likely be dispersed around the economy and across sectors, but indirect and induced jobs are typically more concentrated in adjacent sectors, or adjacent regions. This overall result demonstrates the importance of capturing wider employment effects.

When looking at different ‘types’ of green jobs – as per Table 2 in Pillar 1 – we see that, as detailed in Table 4, multipliers in sectors more closely aligned to the energy transition have over double of those in different sectoral segments, and the UK as a whole. In sectors more closely aligned to the energy transition, the multiplier for green jobs is 5.0x. This means that for every job created, there are another 4.0 jobs which can be attributed to that green job.

Table 4: Green job employment multipliers (Type II), per green job definition, for UK sectors and regions

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Sectors more closely aligned to the energy transition	5.3	4.6	5.9	4.5	5.0	4.9	4.3	6.7	5.7	5.4	5.0	5.3	5.0
Sectors more closely tied to producing and adapting green products or services	2.4	2.3	2.3	2.3	2.2	2.4	2.4	2.3	2.4	2.5	2.3	2.6	2.3
Sectors more closely tied to advisory, advocacy, or research	2.0	2.0	2.0	2.0	2.0	2.1	2.2	2.2	2.1	2.0	2.1	2.0	2.0
All Sectors	2.4	2.0	2.3	2.1	2.3	2.5	3.0	2.4	2.2	2.3	3.0	2.0	2.4

Source: PwC analysis of ONS data.

Note: We have used a UK I-O table as the basis for our bespoke I-O model.

Sectoral findings

In Table 5 below we report the Type II employment multipliers for UK sectors and regions. This shows considerable variation – some jobs do not contribute to wider employment as much as other jobs.

Table 5: Green job employment multipliers (Type II) for UK sectors and regions

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Agriculture, forestry and fishing	3.1	2.3	3.1	2.9	2.3	2.5	1.7	1.7	3.1	3.8	2.8	4.3	2.5
Mining and quarrying	6.3	6.7	7.4	6.2	6.2	5.0	3.5	11.2	8.8	7.4	4.2	4.5	5.6
Manufacturing	2.3	2.6	2.3	2.2	2.4	2.6	2.6	2.7	2.4	2.5	2.6	2.2	2.4
Electricity, gas, steam and air-conditioning supply	7.7	5.1	8.1	5.3	6.7	7.3	7.2	6.9	6.0	6.7	8.6	9.3	7.0
Water supply; sewerage and waste management	1.9	2.0	2.1	2.1	2.0	2.4	2.2	2.2	2.4	2.2	2.2	2.2	2.3
Construction	2.8	2.6	2.6	3.0	2.8	3.2	3.5	2.9	2.8	2.7	2.4	2.8	2.9
Wholesale and retail trade; repair of motor vehicles	1.8	1.8	1.8	1.9	1.8	1.9	1.9	1.9	1.8	1.9	1.8	2.1	1.9
Transportation and storage	2.0	2.0	1.9	1.9	1.9	2.1	2.6	2.2	2.0	2.0	2.1	2.2	2.0
Accommodation and food service activities	1.7	1.9	1.8	1.7	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.7	1.7
Information and communication	2.2	2.1	2.1	1.8	2.1	2.1	2.4	2.2	1.9	1.5	2.1	1.7	2.2
Financial and insurance activities	2.9	2.7	2.6	2.6	2.9	2.7	3.7	2.9	2.5	2.9	3.0	2.6	3.3
Real estate activities	3.2	2.7	3.4	3.2	2.6	4.2	3.1	3.9	3.7	3.7	3.5	3.4	-
Professional, scientific and technical activities	1.8	1.7	1.6	1.7	1.7	1.7	2.1	2.0	1.8	1.6	1.9	1.7	1.8
Administrative and support service activities	1.5	1.7	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.6	1.6	1.5	1.7
Public administration and defence; compulsory social security	1.9	1.9	2.0	2.0	2.0	2.1	2.0	2.3	2.3	1.9	2.0	2.0	2.1
Education	1.6	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.6	1.7
Human health and social work activities	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.7
Arts, entertainment and recreation	2.1	2.0	1.8	2.3	2.1	1.9	2.2	2.0	1.7	1.8	1.8	1.7	2.0
Other service activities	1.7	1.8	1.9	1.8	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.6
Activities of households as employers	-	-	-	-	-	-	-	-	-	-	-	-	-
All Sectors	2.4	2.0	2.3	2.1	2.3	2.5	3.0	2.4	2.2	2.3	3.0	2.0	2.4

Source: PwC analysis of ONS data.

Note: We have used a UK I-O table as the basis for our bespoke I-O model.

Several factors determine the size of the multipliers for different sectors. The first is the sector itself – its supply chain and impact on other sectors. Some green jobs may aid growth in other sectors – for example advances in low carbon fuels in the **electricity and gas** sector may involve employing consultants and engineers from the professional, scientific and technical activities sector. Indeed, 1 additional green job (in FTE terms) in the electricity and gas sector yields 6.0 additional jobs (in FTE terms) in the economy as a whole. This sector is also a high-technology, capital incentive sector – resulting in further impacts in those sectors which support capital investment, such as construction. Other sectors may have smaller local supply chains. For example, 1 additional green job (in FTE terms) in the **education** sector results in only 0.7 additional jobs (in FTE terms) in the economy as a whole.

The second impact comes from the workforce's local spending. Some sectors, such as **arts and entertainment**, may make a local area fashionable and attract other skilled workers. For these sectors, we would therefore expect a slightly higher multiplier, despite having relatively smaller local supply chains.¹⁶ Well-paid, high-skilled workers (for example those in the **finance and insurance** sector) have more money to spend locally than less well paid workers. This impact is amplified in high-technology sectors – which have a combination of well-paid, skilled jobs, and extensive supply chains – resulting in potentially large multipliers. Accordingly, each additional job (in FTE terms) in high tech sectors (such as **mining**) yields 4.8 additional jobs (in FTE terms) in the rest of the economy.

Regional findings

On a regional basis, employment multipliers are typically higher in those regions where economic activity is higher. Evidence shows that, in general, multipliers increase both as the total regional GVA increases and also as the GVA per capita increases.¹⁷ This is consistent with our own analysis, where Type II multipliers are higher in **London** than the rest of the UK. In this region, 1 green job (in FTE terms) yields an additional 2.0 jobs in the economy as a whole. Our analysis from Pillar 1 has shown that the second largest absolute contribution to green job advertising also comes from London which is responsible for 14% of all green jobs advertised. Our analysis from Pillar 2 implies that – when accounting for the indirect and induced effects of this direct employment – the knock-on impacts on employment are also significant.

This has implications on regional inequalities. London may create greatest economic benefit from green job creation, but a just transition seeks to ensure that the substantial benefits of a transition to a green economy are shared widely, while also supporting those who stand to lose economically – be they regions, sectors, or workers.¹⁸ A green transition that is also a just transition for the workforce will be crucial to inclusive economic development across the whole UK.

Interestingly, **Scotland** also comes out top when considering the multiplier effect. This finding is again supported by our analysis for Pillar 1, where this region has the largest relative number of green jobs advertised. One reason for Scotland's strong performance is due to its high composition of energy and utilities roles – in particular renewable energy – combined with the high multiplier for this sector.

¹⁶ Lee and Clarke (2016). High-tech industries, multipliers, and living standards in Britain. https://www.sheffield.ac.uk/polopoly_fs/1.7358691/file/C3_3_Clarke.pdf

¹⁷ McCann (2016). The UK Regional-National Economic Problem. <https://doi.org/10.4324/9781315627151>

¹⁸ Matching supply and demand for skills is always a challenge as some sectors decline and others grow. The ability to help those affected understand which skills they already possess and how these relate to new roles is vital. As part of extended analysis for Pillar 1, we will showcase the most transferable skills from jobs in decline which map to green careers. See the 'What Next' section of this report for more detail.

Pillar 3:

Sunset jobs to disappear

Overview of the Pillar

The process of transitioning to a green economy is likely to disrupt labour markets (through both job creation and job destruction) and will require reskilling and upskilling of workers to reduce the risk of rising unemployment and inequality. Job creation and job destruction have very different dynamics – job losses may result quickly from certain policy designs (for example banning single use plastics, or closing fossil fuel facilities), while job creation may be more gradual (involving, for example, development of new clean technologies). For this reason, balancing job creation and job losses is a key policy challenge, and both are important indicators within our Barometer. Pillar 3 explores the distribution of job loss by sector and region, rather than the number of potential job losses.

Estimating the number of job losses is a key area of interest in respect to labour market policy design but estimates vary significantly, are hard to compare as they are modelled on disparate macro-economic scenarios, and employ different methodological approaches. Our survey finds that 5% of surveyed employees think their current job will cease to exist as a result of the transition to net zero. Extrapolated for the UK-wide labour

market this would represent 1.72 million job losses. However, within this we would expect a substantial proportion of jobs to be reallocated (including within the same sector) subject to reskilling and upskilling. Interpreting this figure as a pure loss of jobs would therefore seem an overestimation.

Evaluating how job losses are distributed has yielded greater consensus, with carbon intensive sectors consistently identified as being at higher risk of disruption and low skilled workers within those sectors being those requiring the greatest support to transition into other employment.

Noting the greater consensus for distributive rather than absolute numbers of sunset jobs and acknowledging the challenges of quantification, measuring how job losses are distributed within the UK in relative terms offers arguably greater value in the context of a Green Jobs Barometer designed at measuring the relative performance of UK regions and industrial sectors on progress towards the green transition.



“Sunset jobs” are those jobs that will become redundant following the transition to a green economy. It is important to note, however, that with the right set of active labour market policy measures, including reskilling and upskilling, career guidance, targeted training, and focus on social mobility, workers from sunset jobs will be able to find re-employment in either the same sector or different sectors. Some sunset jobs in a particular sector will be in occupations replicated in growing sectors, offering job openings in which workers from shrinking sectors can find employment; net new “green” jobs will also be created during the transition that will require relevant skills from existing jobs; and finally, workers who cannot reallocate can

still reskill and upskill in order to benefit from these new jobs. Power plant operators who find their jobs in decline, for example, can find jobs as water and waste-water treatment plant system operators, or electromechanical engineering technicians in other areas. Some reskilling and upskilling may be needed, especially in relation to the specific machinery and technologies used in new jobs. There are also likely to be a core set of soft skills, in addition to technical skills and knowledge, that will be re-used in reallocated occupations.

Methodology and data used

Our analysis builds on a methodology developed by the International Labour Organisation (ILO)¹⁹. The ILO develop a multi-regional input-output model to analyse 163 sectors across 44 countries. Using this model, the ILO quantify the employment impact (job creation and job destruction) of the transition to an 'energy sustainability' scenario (associated with global warming of 2°C) compared to a 'do nothing' scenario (associated with global warming of 6°C). The ILO take sector-level results and apply the occupational structures for each sector to derive occupational-level results. Full detail of the ILO methodology can be found in Annex 5 of their report and our application of their methodology in Appendix B.²⁰

We map the ILO sector-level results for a sample of broadly similar countries to the UK onto the Standard Industry Classification for the sectors we use in the Barometer (consistent with the other Pillars) and spread across regions according to their distribution of jobs.

The climate scenario we consider is based solely on the impact of transformations in energy production and consumption that will be needed to achieve an 'energy sustainability' scenario in line with the 2°C global warming goal. These transformations are centred around changes in the energy sector such as the increased use of renewable energy sources and improved energy efficiency in buildings.

The analysis does not account for the estimated job loss as a result of the transition to a scenario with – say – the shift to a circular economy mode (based on minimising resource use and extraction by relying on reuse, repair and recycling).

Overall findings

While the highest proportion of sunset jobs is concentrated in the **professional, scientific and technical** activities sector, when considering workforce size, the largest relative impact is felt in the **electricity and gas** sector. On a regional basis, the largest relative impact is projected in **Scotland** and the **East Midlands**, as a result of the high concentration of workers in the mining, manufacturing, and utilities (**electricity and gas, water, sewerage and waste**) sectors.

We note that in relation to the overall projected number of new green jobs being advertised and created, there is a clear net positive position. This suggests that sunset jobs can be absorbed back into the labour market, but the concentration of these jobs in regions and sectors means that specific policy support (e.g. retraining) will be helpful to manage the transition.

In Table 6 below we present the distribution of projected jobs lost across both sectors and regions.

¹⁹ See Appendix B for a detailed methodology.

²⁰ Ibid.

Table 6: Distribution of sunset jobs to disappear in UK sectors and regions

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Agriculture, forestry and fishing	–	–	–	0.1%	0.1%	0.1%	–	0.1%	0.1%	0.1%	0.1%	0.1%	0.7%
Mining and quarrying	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	1.3%	0.1%	2.7%
Manufacturing	0.3%	0.9%	0.8%	0.8%	0.8%	0.6%	0.4%	0.8%	0.7%	0.4%	0.5%	0.3%	7.3%
Electricity, gas, steam and air-conditioning supply	1.4%	2.2%	1.1%	2.4%	2.0%	0.8%	1.4%	3.2%	2.0%	0.8%	2.7%	0.3%	20.3%
Water supply; sewerage and waste management	0.3%	1.0%	0.7%	0.7%	0.9%	1.0%	0.8%	1.5%	1.0%	0.5%	0.8%	0.3%	9.6%
Construction	–	–	–	–	–	–	–	–	–	–	–	–	0.1%
Wholesale and retail trade; repair of motor vehicles	0.3%	0.8%	0.6%	0.5%	0.7%	0.7%	0.9%	1.1%	0.6%	0.3%	0.5%	0.2%	7.2%
Transportation and storage	0.2%	0.5%	0.4%	0.4%	0.4%	0.4%	0.8%	0.5%	0.3%	0.1%	0.3%	0.1%	4.4%
Accommodation and food service activities	–	–	–	–	–	–	0.1%	–	–	–	–	–	0.4%
Information and communication	0.1%	0.2%	0.1%	0.1%	0.1%	0.2%	0.8%	0.5%	0.2%	0.1%	0.1%	–	2.5%
Financial and insurance activities	–	0.1%	0.1%	–	0.1%	0.1%	0.3%	0.1%	0.1%	–	0.1%	–	0.9%
Real estate activities	–	–	–	–	–	–	0.1%	–	–	–	–	–	0.3%
Professional, scientific and technical activities	0.7%	3.3%	1.8%	1.8%	2.0%	2.7%	7.2%	4.1%	2.1%	0.8%	1.9%	0.4%	28.8%
Administrative and support service activities	0.3%	0.9%	0.7%	0.6%	0.8%	0.9%	1.7%	1.1%	0.6%	0.3%	0.7%	0.2%	8.7%
Public administration and defence; compulsory social security	–	–	–	–	–	–	0.1%	0.1%	–	–	–	–	0.4%
Education	–	–	–	–	–	–	0.1%	0.1%	–	–	–	–	0.5%
Human health and social work activities	–	–	–	–	–	–	–	–	–	–	–	–	0.1%
Arts, entertainment and recreation	–	0.1%	0.1%	–	0.1%	0.1%	0.2%	0.1%	0.1%	–	0.1%	–	0.8%
Other service activities	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.4%	0.4%	0.2%	0.1%	0.2%	0.1%	2.4%
Activities of households as employers	–	0.2%	–	0.1%	0.1%	0.2%	0.3%	0.6%	0.2%	0.1%	–	–	2.1%
All Sectors	3.8%	10.9%	6.9%	8.1%	8.4%	8.2%	15.6%	14.5%	8.4%	3.8%	9.4%	2.1%	

Source: PwC analysis of Geek Talent data.

Notes: We have provided a colour-coding according to where the largest negative impact is felt. Since sunset jobs are a 'negative' metric, sectors and regions with larger numbers of sunset jobs are highlighted in red. Sunset job estimates of <0.05% are marked by a dash, and shaded in grey.

Sector findings

Chart 3 presents a comparison of the distribution of sunset jobs that we project could disappear compared to the share of employment the respective sector accounts for (in 2020). 20% of sunset jobs are concentrated in the **electricity and gas** sectors. This sector is traditionally energy intensive and has a large amount of carbon embedded in its production processes, as confirmed by our analysis in Pillar 4. Indeed, energy companies are under increasing scrutiny from their regulators to invest and innovate in new technologies, processes and approaches that protect both the local and global environment, while keeping energy bills affordable for all.

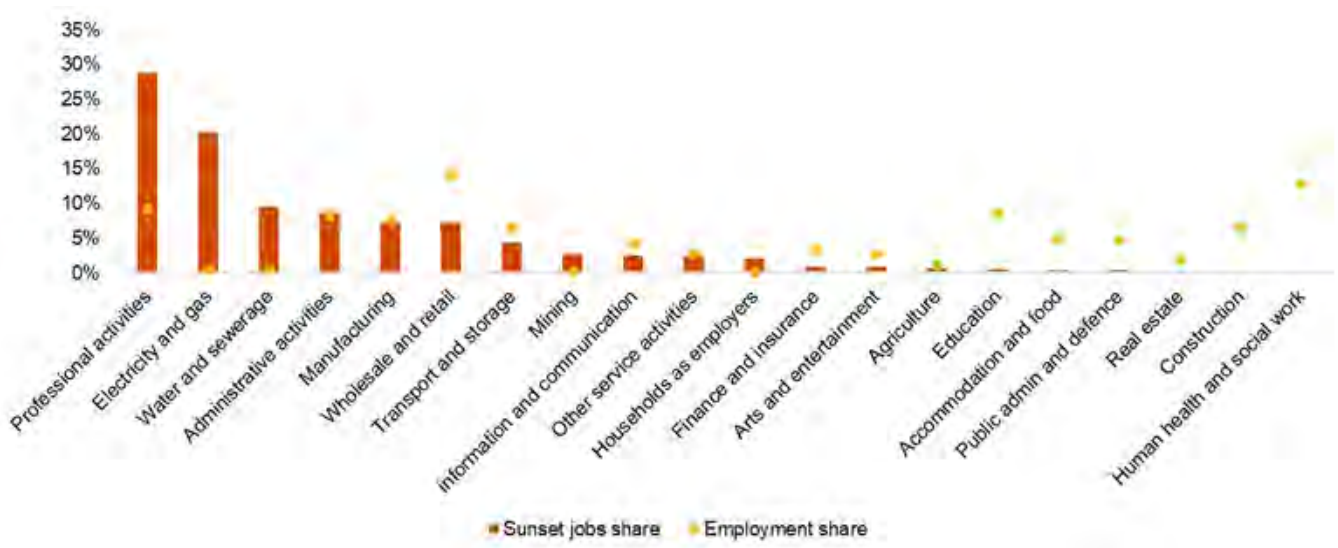
The largest distribution of sunset jobs is concentrated in the **professional, scientific and technical activities** sector – almost a third of the total. The ILO argues one potential reason for this is as a result of spillover effects from changes in the utilities' sectors – as businesses purchase goods and services that serve as inputs to energy generation. When taking career pathways into account, however, since the ILO identifies the professional activities sector as having some of the highest skilled occupations (such as science and engineering professionals), with clear job reallocation into the same or expanding sectors, so the net impact is somewhat mitigated.

Petroleum engineers, for example, may find jobs in other branches of engineering in growing or other green sectors.

While sectors such as **construction, real estate**, and **agriculture** perhaps surprisingly account for a relatively low proportion of total sunset jobs (all below 0.7% of total), there may be a high employment impact when considering the types of activities that workers in these sectors carry out. For example, there may be an increased environmental awareness within a role, or changes in how waste is managed, which don't result in a sunset job. We explore the concept of greener workplaces in more detail in Pillar 5.

Some sectors, such as **transportation and storage** will be very important for achieving reduction in carbon emissions, yet are unlikely to experience substantial employment effects. Instead, in this example, most employment effects are likely to be felt in the manufacturing of electric vehicles, rather than in the transportation itself. These effects are captured in Pillar 2, which shows that 1 green job (in FTE terms) in the transportation and storage sector yields 2.0 jobs (in FTE terms) in the economy as a whole, when accounting for direct, indirect, and induced impacts.

Chart 3: Sectoral sunset jobs (proportion of total sunset jobs) by 2030 and employment share, 2020



Source: PwC analysis of ONS and ILO data

Regional findings

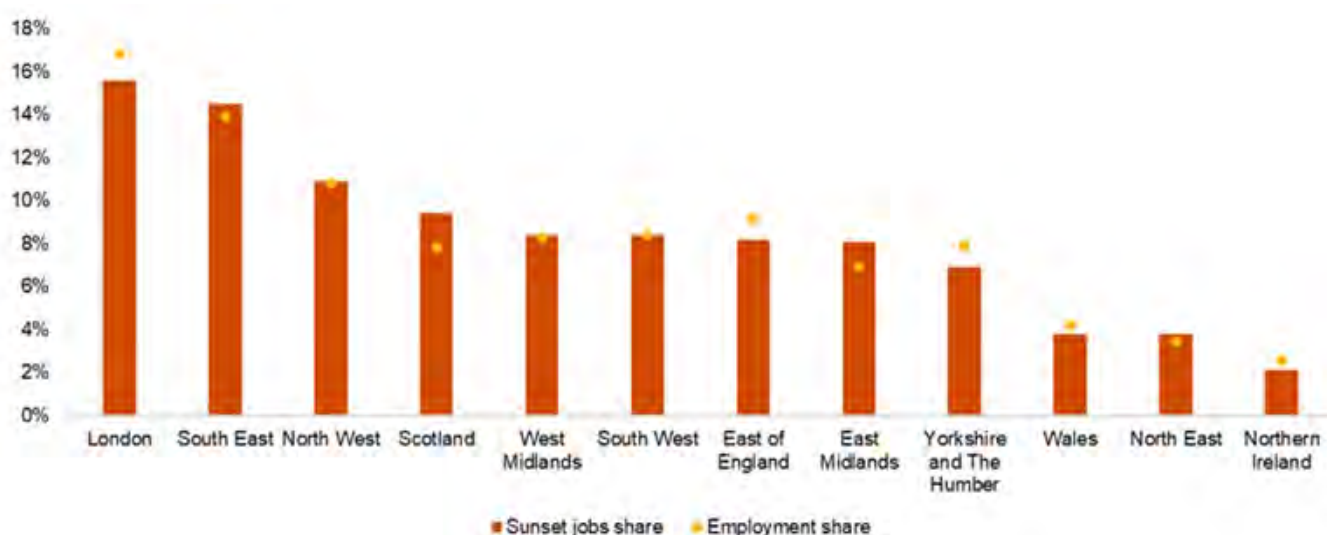
Chart 4 presents a comparison of the distribution of sunset jobs that we project disappear compared to the share of employment the respective region accounts for (in 2020). Since our methodology apportions a sector impact across regions, the regions with the largest relative impact typically have the highest concentration of employment in the high-impact sectors described above (namely the professional activities and electricity and gas sectors), and vice versa for the regions with the smallest relative impact:

- When considering workforce size, the largest relative impact is felt in **Scotland** and the **East Midlands**, which account for 9.4% and 8.1% of total sunset jobs respectively. In both of these regions, employment in the electricity and gas, and water and waste management sectors combined makes up 1.4% of

the total employment (the highest concentration of all regions in the UK).

- The smallest impacts are felt in **Northern Ireland**, accounting for 2.1% of total sunset jobs. Employment in this region is concentrated in relatively low-impact sectors, such as human health and social work, wholesale and retail trade, and education. This is also the region with the smallest workforce.
- With the exception of Scotland and the East Midlands, and for reasons explained above, the impact is directly correlated with the workforce size. As a result, **London** and the **South East** account for the largest proportion of sunset jobs, at 15.6% and 14.5% of total respectively.

Chart 4: Regional sunset jobs (proportion of total sunset jobs) by 2030 and employment share, 2020



Source: PwC analysis of ONS and ILO data

Pillar 4: Carbon intensity of employment

Overview of the Pillar

Pillar 4 compares Carbon dioxide (CO₂) in different UK regions and sectors to employment in the same UK regions and sectors. Inventories of greenhouse gas emissions are critical to monitor progress against domestic and international targets such as the Kyoto Protocol. CO₂ is the main greenhouse gas, accounting for 80% of greenhouse gas emissions in the UK in 2019.²¹ It is therefore important to track CO₂ trends in their own right. Emissions also matter for jobs. Emissions per employee give us an indication of how environmentally-friendly jobs are, independently of whether such jobs are considered green jobs or not, and also give an indirect indication of jobs that could lose out in the future as the green transition accelerates.²²

Indeed, as we show in the remainder of this section of the report, and consistent with Pillar 3, jobs in decline tend to be concentrated in the most carbon intensive sectors. As sectors and regions decarbonise, and as the UK moves towards net zero, we expect to see carbon intensity of employment reduce.

²¹ BEIS (2021). UK local authority carbon dioxide emissions estimates 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/996056/2005-19-local-authority-co2-emissions-statistical-release.pdf

²² It is important to caveat that while looking at emissions on a per employee basis also enables us to make allowance for the different sizes of UK regions and sectors, it is important to be aware that circumstances vary greatly across different UK regions and sectors, and in some cases are driven by many factors other than the working population.



Methodology and data used

Data on CO₂ emissions on a regional and sector basis does not exist. Instead, the ONS and BEIS publish data on: i) CO₂ emissions by sector section and group, and ii) CO₂ emissions by UK region. The latest data in these datasets is for 2019, despite their release dates being September and August 2021, respectively. As a result of this data limitation, we assume that sector emissions are apportioned across regions based on the regional share of UK CO₂ emissions from the second dataset. This is a limitation of our analysis and assumes that the regional concentration of emissions is the same for different sectors.

Having obtained CO₂ emissions on a regional and sector basis using this proxy, we divide by December 2019 seasonally adjusted employment data for each sector and region. This gives us our final output of carbon intensity of employment for each region, sector, and region-sector pair.

Overall findings

In Table 7 below we present the carbon intensity across sectors, regions, and sector-region pairs. There is considerable variation across sectors, so sectoral trends will drive improvement in this Pillar of the Barometer.

Table 7: Carbon intensity of employment in UK sectors and regions (tonnes of CO₂ emissions per employment), 2019

	North East	North West	Yorkshire and the Humber	East Midlands	West Midlands	East of England	London	South East	South West	Wales	Scotland	Northern Ireland	UK
Agriculture, forestry and fishing	63	33	43	17	23	20	438	27	11	12	14	11	22
Mining and quarrying	419	706	856	397	578	645	975	632	418	361	57	377	312
Manufacturing	32	26	24	23	23	35	58	35	28	30	40	33	30
Electricity, gas, steam and air-conditioning supply	359	477	733	453	675	1657	556	515	596	579	378	1615	569
Water supply; sewerage and waste management	28	20	25	28	18	19	25	17	19	18	23	25	21
Construction	9	6	6	7	6	5	4	5	5	8	7	8	6
Wholesale and retail trade; repair of motor vehicles	3	2	3	3	3	3	2	2	2	3	3	3	2
Transportation and storage	55	39	49	41	37	44	24	46	56	82	55	78	43
Accommodation and food service activities	2	1	2	2	2	2	1	1	1	1	1	2	1
Information and communication	1	1	1	1	1	1	0	0	1	1	1	1	0
Financial and insurance activities	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activities	2	2	2	2	2	1	1	2	1	3	2	3	1
Professional, scientific and technical activities	1	1	1	1	1	1	0	0	1	1	1	1	1
Administrative and support service activities	2	1	1	1	1	1	1	1	1	2	1	2	1
Public administration and defence; compulsory social security	3	3	3	4	4	4	2	3	3	3	2	3	3
Education	1	1	1	1	1	1	1	1	1	1	1	1	1
Human health and social work activities	1	1	1	1	1	1	1	1	1	1	1	1	1
Arts, entertainment and recreation	1	1	1	1	1	1	0	1	1	1	1	2	1
Other service activities	1	1	1	1	1	1	1	1	1	2	1	1	1
Activities of households as employers	2	2	N/A	1	2	1	0	0	0	2	1	N/A	1
All Sectors	12	9	10	11	10	10	5	8	9	12	10	14	9

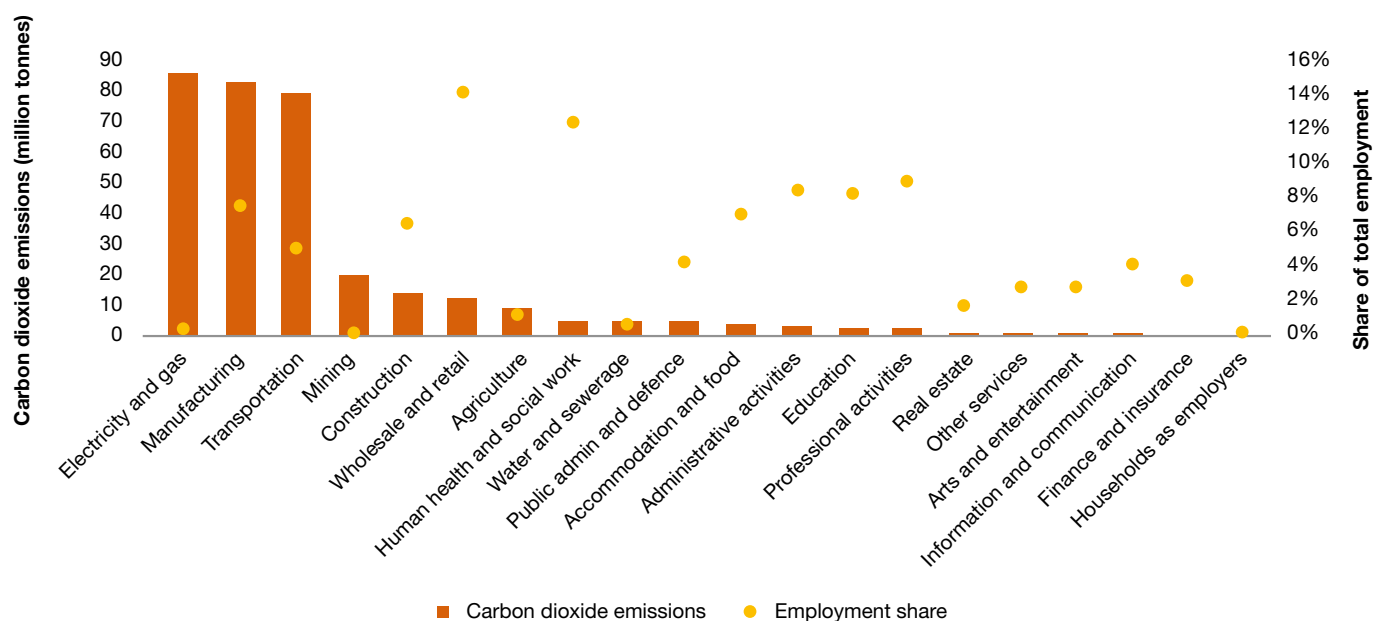
Source: PwC analysis of ONS and Department for Business, Energy, and Industrial Strategy (BEIS) data

Notes: We have provided a colour-coding according to where the largest negative impact is felt. Since carbon intensity is a 'negative' metric, sectors and regions with larger numbers of sunset jobs are highlighted in red.

High carbon intensity in London in sectors such as Agriculture and Mining is likely on account of the very small workforce sizes in this region, combined with a high regional apportionment of sector emissions. More detail on our methodology can be found in Appendix A.

Sectoral findings

Chart 5: Sectoral CO₂ emissions and employment share, 2019



Source: PwC analysis of ONS and BEIS data

Emissions in the **electricity and gas** sector are driven by emissions from fuel combustion for electricity generation in power stations. Electricity and gas has historically been the sector with the largest emissions, including in 2019, where it produced 84.2 million tonnes of CO₂ emissions (or 26% of the UK total). Over time, however, these emissions have been decreasing – as a result of a technology enabled resource efficiency, as well as a change in the mix of fuels used for energy generation. Since 2019 there has been a 96% reduction in coal use in generation, with gas (which has a much lower carbon content) and renewable sources being increasingly used instead.²³

Across the UK, the level of CO₂ emissions per employee in the electricity and gas sector is 569 tonnes, making jobs in this sector the most carbon intensive. The top occupations employed within the electricity and gas sector are engineering professionals (11% of total), electrical and electronic trades (9% of total), and customer service operators (7% of total).²⁴

²³ Digest of United Kingdom Energy Statistics, Table 5.1.1 Fuel input for electricity generation, 1970 to 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904820/DUKES_5.1.1.xls

²⁴ ONS (2020). Detailed occupations by industry, geographic and demographic variables biannually: 2011 to 2019. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/11453detailedoccupationsbyindustrygeographicanddemographicvariablesbiannually2011to2018>

Sectoral findings (continued)

The UK's **manufacturing** sector produced 81.1 million tonnes of CO₂ emissions in 2019 (or 25% of the UK total). Manufacturing is a CO₂ intensive process largely as a result of energy consumption, which may be used for the purposes of heating or cooling, mechanical energy, and so on. Compared to 1990 levels, manufacturing sector emissions have fallen by more than 40%.²⁵ Similar to the electricity and gas sector, some of this impact is attributable to technology enabled resource efficiency. The level of CO₂ emissions per employee in the manufacturing sector is 30.3 tonnes, making it the 4th most carbon intensive across the UK. Employment in the manufacturing sector is dispersed across 86 occupations, with the top occupations being process operatives, engineering professionals, and production managers and directors (each responsible for 6% of total).²⁶

Transportation sector emissions include freight and passenger transport, for private and business purposes. At a national level, CO₂ emissions in this sector have been decreasing over the last decade, despite an increase in the number of passenger vehicles and vehicle kilometers travelled over the same period.²⁷ This is due to lower petrol consumption by passenger cars outweighing an increase in diesel consumption, and improvements in fuel efficiency of both petrol and diesel cars.

Across the UK, the level of CO₂ emissions per employee in this sector is 43 tonnes. While this is the 3rd largest in the UK, it sits significantly below the electricity and gas sector (569 tonnes per employee) and the mining sector (312 tonnes per employee). This is on account of the relatively high employee count – which sits at 5% of the UK total. Over a third of occupations in the transportation sector are road transport drivers, with the next largest occupational share (elementary administration occupations) responsible for just 10% of total employment in comparison.²⁸

Mining is responsible for the 4th largest level of CO₂ emissions, at 6% of the UK total. When combined with a small workforce, however, (63,000 individuals, or 0.18% of the UK total, the smallest of all sectors in the UK with the exception of households as employers), it has the highest level of CO₂ emissions per employee. Over the past three decades, there has been a substantial decline in coal mining, and deep-mined coal in particular, with the last three deep mines closing in 2015. To illustrate this decline, greenhouse gas emissions have fallen from 21.8 Mt of CO₂ equivalent in 1990, to only 0.5 Mt of CO₂ equivalent in 2019.²⁹ The top occupations employed within the mining sector are engineering professionals (12% of total), production managers and directors (7% of total), and metal machining, fitting, and instrument making trades (6% of total).³⁰

25 BEIS (February 2021). UK local authority carbon dioxide emissions estimates 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957887/2019_Final_greenhouse_gas_emissions_statistical_release.pdf

26 At a 3-digit occupation code level. ONS (2020). Detailed occupations by industry, geographic and demographic variables biannually: 2011 to 2019. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/11453detailedoccupationsbyindustrygeographicanddemographicvariablesbiannually2011to2018>

27 BEIS (February 2021). UK local authority carbon dioxide emissions estimates 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957887/2019_Final_greenhouse_gas_emissions_statistical_release.pdf

28 ONS (2020). Detailed occupations by industry, geographic and demographic variables biannually: 2011 to 2019. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/11453detailedoccupationsbyindustrygeographicanddemographicvariablesbiannually2011to2018>

29 BEIS (February 2021). UK local authority carbon dioxide emissions estimates 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957887/2019_Final_greenhouse_gas_emissions_statistical_release.pdf

30 ONS (2020). Detailed occupations by industry, geographic and demographic variables biannually: 2011 to 2019. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/11453detailedoccupationsbyindustrygeographicanddemographicvariablesbiannually2011to2018>

Regional findings

On a regional basis, while Northern Ireland, Wales, and the North East have the lowest absolute level of CO₂ emissions in the UK, their smaller than proportional workforces mean they have the highest CO₂ emissions per employee:

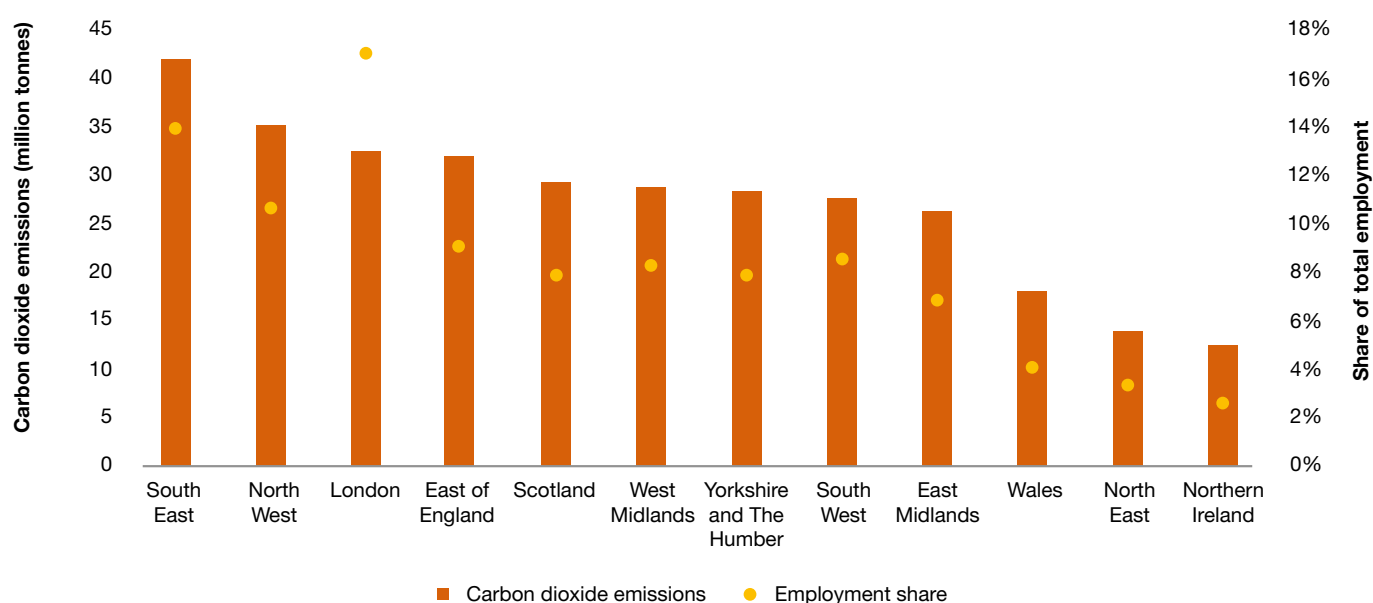
- **Northern Ireland** has the highest CO₂ emissions per employee in the UK, at 13.6 tonnes. As noted in Pillar 2, employment in Northern Ireland is concentrated in relatively low-impact sectors, such as human health and social work, wholesale and retail trade, and education. Rather than sector composition being a key driver, however, per employee emissions are high in Northern Ireland predominantly because there is limited availability of natural gas in this area, which results in combustion of more carbon intensive fuels instead, such as coal, burning oil, and gas oil.³¹
- Similar to Northern Ireland, **Wales** also has a higher proportion of emissions from 'other' fuels than the rest of the UK, though to a lesser extent. Wales has the 2nd highest CO₂ emissions per employee in the UK,

at 12.3 tonnes. Wales – similar to the **North East** (the 3rd highest CO₂ emissions per employee in the UK, at 11.6 tonnes) – also arguably has high emissions per employee as a result of the industrial mix present – as large industrial bases with large utilities sectors.

- **London** has the lowest CO₂ emissions per employee, at 5.3 tonnes, despite having the 3rd largest level of absolute CO₂ emissions in the UK. A combination of a residential (rather than industrial) landscape and high population density results in lower emissions when spread across the workforce.

These findings all have implications for green jobs. There is arguably more potential for green energy sectors to grow in those areas in which combustion of more carbon intensive fuels is high. Indeed, as shown by our findings for Pillar 5, Northern Ireland and Wales are also perceived as being the least environmentally friendly by employees.

Chart 6: Regional CO₂ emissions and employment share, 2019



Source: PwC analysis of ONS and BEIS data

Pillar 5: Green workplaces

Overview of the Pillar

As demonstrated by Pillars 1-3, there is growing demand for green jobs (in both the green economy and across wider sectors) and jobs in decline as the process of transitioning to a green economy accelerates. Pillar 4 shows where CO₂ emissions are highest relative to levels of employment, which gives an indication of whether high-carbon intensive sectors (e.g. electricity and gas and water and sewerage) can expect the highest impact in terms of employment.

Taken alone, however, these insights are limited in what they can tell us about how existing jobs will change – whether through the lens of the activities conducted as part of a role; the

sustainability of workplaces; or the education and training provided by employers. Pillar 5 seeks to fill these gaps, utilising employee sentiment to give an extra layer of insight.

This Pillar is the part of the Barometer which shows how much progress is being made by all employers to turn workplaces as green as they can be, even if the jobs involved do not meet a strict definition of being green jobs.

Methodology and data used

Pillar 5 is based on a bespoke PwC online panel-survey sent to 2,085 respondents in October 2021.³² Respondents were asked whether they consider the activities currently conducted as part of their jobs (and importantly, not concerning their employer as a whole or their personal life) to be environmentally friendly, and whether they expect this assessment to change over the next 1-2 years. These activities span across a number of environmental outcomes – for example, a retailer might reduce waste by using limited packaging materials; a manufacturer might reduce resource use by adopting efficient production processes; or a hotelier might reduce pollution by using eco-friendly cleaning products. Using the responses to these questions, we generate a ‘score’, which is referred to in the remainder of this section.³³

We include insights from all areas of the survey below. An overview of the questions is provided in on the right hand side of this page with full detail of our methodology for Pillar 5 provided in Appendix B.

PwC Green Jobs Survey – Themes covered

While the ‘scores’ for Pillar 5 are centered around the environmentally friendliness of jobs, respondents were also surveyed across a range of other aspects of the green transition, as follows:

- To what extent three key aspects of the definition of a green job is currently an objective of their job, and whether this is likely to change over the next 1-2 years:
 - Producing and providing environmentally friendly products and services;
 - Adapting work processes to become more environmentally friendly or use fewer resources; and
 - Supporting the green economy directly.
- To what extent employers are making workplaces green, by:
 - Providing training, education, and/or communications in relation to green practices; and
 - Encouraging employees to adopt sustainable work practices (including, for example, the provision of cycle to work schemes, encouragement for employees to switch off unused devices, reduce business travel, or the opportunity to invest pensions in funds that support the environment).
- Whether they expect their job to still exist once the economy has transitioned to net zero.

³² We note that our sample size is too small to make inferences on a sector-region pair granularity. We therefore report results for sectors and regions, but not for the intersection between the two. We recognise this as an area for improvement in our methodology over time.

³³ Scores can be interpreted as follows. 100 – Respondents’ consider their job to be very environmentally friendly across all relevant environmental outcomes, and over the next 1-2 years there will be a significant improvement in environmental friendliness across all relevant environmental outcomes. 0 – Respondents’ consider their job to be not at all environmentally friendly across all relevant environmental outcomes, and over the next 1-2 years there will be a significant worsening in environmental friendliness across all relevant environmental outcomes.

Overall findings

- Only 5% of individuals self-identified as currently having a “green job” when asked if improving the environment was the main objective of their role.³⁴ However, when asked about improving the environment as one of a number of objectives of their job, this number increases dramatically – to 65% of individuals. This suggests that many existing jobs are undergoing “greening” even if they do not fall under a core definition of a green job.
- 88% of individuals believed that their jobs were environmentally friendly across at least 1 of 8 environmental outcomes we asked about. Only 6% of individuals believed that their jobs were not environmentally friendly, and an additional 6% believed their jobs had a neutral impact.
- Across the UK, 5.3% of individuals believed that their job would not exist following the transition to net zero. Assuming this is representative of the UK as a whole, this equates to 1.73 million jobs using the latest employment estimates from the ONS.³⁵
- When asked about their workplaces, only 47% of respondents stated that they had received training, education, and/or communication in relation to green practices. 56% of respondents stated that their employer encouraged them to adopt sustainable workplace practices (for example cycle to work schemes, reduced business travel, or encouragement to invest in green pensions). When taken together with results from other sources, suggesting that 65% of individuals are more likely to work for a company with strong environmental policies, this demonstrates that there is a large opportunity for businesses to improve staff engagement through environmental initiatives.³⁶

Sectoral findings

When asked about the potential for jobs to be environmentally friendly across 8 environmental outcomes (waste, emissions, pollution, biodiversity harm, resource use, water use, recycling, and energy consumption), responses indicate that the **real estate** and **water, sewerage and waste** sectors are the most environmentally friendly sector in the UK, as shown by Table 8. Interestingly, however, when asked about the provision of schemes such as cycle to work, green pensions, or reducing business travel, real estate is also the sector associated with the least sustainable workplace practices. Occupations in these sectors include customer service operators, business professionals, and administrative occupations for real estate; and health professionals, science and research professionals, and skilled agricultural and related trades for water and sewerage.

Our survey suggests that employees from **professional, science and technical activities** sectors (for example, consultants, lawyers, engineers, and scientists) have the most sustainable workplaces, when asked about the provision of schemes such as cycle to work, green pensions, or reducing business travel with employers encouraging practices such as recycling, reduced business travel, and green pensions. Employees in this sector, alongside the **IT, finance and insurance**, and **public administration** sectors also have the highest level of communications, education, and training in relation to green practices from employers.

Our survey suggests that on average, employees in the **electricity and gas** sector consider improving the environment to be a primary objective of their jobs more than employees in any other sector. These respondents sit across a broad range of occupations – including skilled metal, electrical and electronic trades, and skilled construction and building trades. This aligns with our findings from Pillar 1, where the electricity and gas sector was responsible for one of the highest relative number of green job advertisements, at 21.1% of total job advertisements in the sector.

³⁴ Based on the working definition of green jobs employed by the barometer, as detailed in Appendix A.

³⁵ Based on the seasonally adjusted employment level for July to September 2021. ONS (2021). Employment in the UK: November 2021. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/employmentintheuk/november2021>

³⁶ Reuters (2020). Employees want climate-positive action from companies. Here's how they can deliver. <https://www.reuters.com/sustainability/employees-want-climate-positive-action-companies-heres-how-they-can-deliver>

One third of respondents surveyed from the **mining** sector believed that their job would not exist following the transition to net zero. Interestingly, these respondents were all process, plant and machine operatives. Other occupations such as health and care associates, and those from skilled metal and electronic trades believed their jobs would still be relevant. This links back to Pillar 3 – even though some jobs (and sectors) will be in decline following the transition to a green economy, with the right reskilling or upskilling, employees will be able to reallocate to new “green” job openings in other, growing, sectors that may require relevant skills from existing jobs.

When asked about the potential for jobs to be environmentally friendly across a range of indicators (waste, emissions, pollution, biodiversity harm, resource use, water use, recycling, and energy consumption), responses indicate that the mining sector is also the least environmentally friendly sector in the UK, as shown by Table 5; and has the least training, education, and/or communications from employers with regards to green workplace practices.

Table 8: Environmentally friendliness of jobs by sector, October 2021

	All regions
Agriculture, forestry and fishing	69
Mining and quarrying	58
Manufacturing	62
Electricity, gas, steam and air-conditioning supply	63
Water supply; sewerage and waste management	70
Construction	68
Wholesale and retail trade; repair of motor vehicles	65
Transportation and storage	64
Accommodation and food service activities	62
Information and communication	69
Financial and insurance activities	67
Real estate activities	71
Professional, scientific and technical activities	67
Administrative and support service activities	66
Public administration and defence; compulsory social security	64
Education	64
Human health and social work activities	63
Arts, entertainment and recreation	68
Other service activities	N/A
Activities of households as employers	N/A

Source: PwC

Notes: For interpretation of scores, please refer to Footnote 34



On a regional basis, our survey finds that employees' perceptions with regards to the environmentally friendliness of their workplaces are consistent with the carbon intensity of employment (as per Pillar 4).

When asked about the potential for jobs to be environmentally friendly across 8 environmental outcomes (waste, emissions, pollution, biodiversity harm, resource use, water use, recycling, and energy consumption), our survey suggests that jobs in **Yorkshire and the Humber** are the least environmentally friendly in the UK, as shown by Table 9. Responses indicate that this region has the least training, education, and/or communications from employers with regards to green workplace practices. These responses are primarily from respondents in the manufacturing sector (for example, labourers, machine operators, and administrative occupations) and the wholesale and retail sector (for example, sales representatives and managers).

Conversely, responses indicate that jobs in **London** are the most environmentally friendly region in the UK, as shown by Table 9. On average, employees in London consider improving the environment to be a primary objective of their jobs more than employees in any other region in the UK. Workplaces in London are also perceived as being the most sustainable compared to any other

region in the UK. This is consistent with our findings for Pillar 1 – where the region had the highest absolute number of green job advertisements – and Pillar 4 – where the region had the lowest CO₂ emissions per employee.

Although our survey suggests that jobs in the **North East** are slightly more environmentally friendly than the UK average, as shown by Table 9, 9% of respondents from this region believed their jobs would not exist following the transition to net zero. This is equivalent to over 120,000 jobs.³⁷ Consistent with our findings for Pillars 3 and 4, this includes occupations such as process, plant and machine operative in the manufacturing sector. We must also note that although we have a representative sample for our survey, it is nonetheless relatively small – in total there are 78 respondents across the whole of the North East. For these reasons, the results should be interpreted with care.

Table 9: Environmentally friendliness of jobs by region

	All regions
North East	66
North West	65
Yorkshire and The Humber	63
East Midlands	66
West Midlands	64
East of England	65
London	67
South East	65
South West	66
Wales	63
Scotland	64
Northern Ireland	64

Source: PwC

Notes: For interpretation of scores, please refer to Footnote 34

³⁷ Based on seasonally adjusted provisional employment estimates for June 2021. ONS (2021). JOBS05: Workforce jobs by region and industry. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/workforcejobsbyregionandindustryjobs05>

What Next?

This section describes information on potential further updates to the Green Jobs Barometer.



The multi-Pillar analysis gives insight into how UK sectors and regions are performing in different (inter-connected) economic variables related to jobs and employment in the context of the green transition.

More generally, the Barometer gives easy access to reliable data within a clear analytic framework, which can guide debate, discussion and focused research. The success of the Barometer depends on its ability to drive those conversations that matter to take action in a fast-changing world. This will be achieved by making the Barometer grow and mature over time. It has been updated with the most relevant and updated data across the five Pillars, and will continue to be updated on a regular basis moving forward. It is important to measure and monitor performance but also to detect potential future trends – for instance, vacancy data can be a predictor of changes upcoming in labour markets in the real economy.

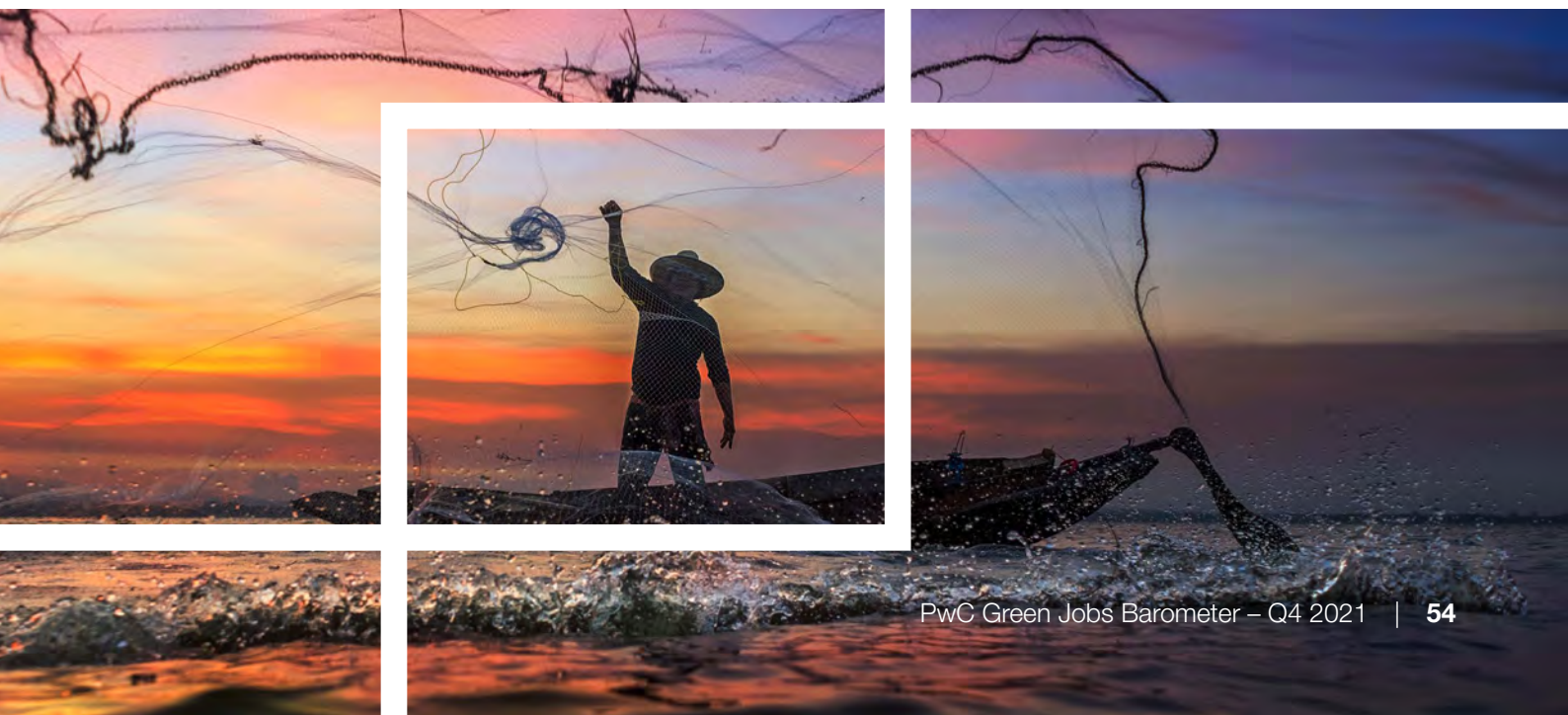
Along with new data over time, further updates of the Barometer will bring improvements in terms of analysis and functionality. The obvious improvement is that it will be able to monitor progress across the five Pillars over time, by sector and region, and UK wide.

This is also significant when presenting the data aggregated at the level of the UK because, whereas regions and sectors are compared to each other, the UK as a whole does not have a comparison point for the first period of coverage by the Barometer. Linked to the question of comparisons, further updates will also add reference points in two ways: i) by defining targets for specific Pillars (e.g. specifying explicitly the ambition in terms of number of green jobs in specific regions, based on government and other economic goals);³⁸ and by ii) bringing reference points from international experience where specific targets cannot be defined.

With the above improvements, the Barometer will allow to track performance comprehensively across several dimensions:

- Over time, with respect to performance in previous years;
- Relative to other regions and sectors in the UK (which it currently already does) and relative to performance in similar countries; and
- Relative to a long-term target, which will allow a more concrete monitoring of transition progress.

³⁸ This will be made possible by engaging in further conversations with Government and other stakeholders.



The Barometer will continue to monitor the number of green jobs across sectors and regions and, in future releases, the “green skills density”³⁹ of different occupations. We expect that over time the diversity of green jobs will evolve from being carbon and net zero focussed to having a broader green focus on natural resource management, biodiversity and other nature-based solutions. This will give us a wider array of jobs that are considered green, but with different ‘shades’.

The online platform linked to the Barometer will also grow over time with additional research, whose findings will be published in the form of short articles, blogs and additional pieces of supporting evidence. This is important because the Barometer gives a high-level view of performance, and the more focused pieces of analysis will give the level of granularity needed for certain types of policies and questions related to workforce planning. The ongoing work already allows identifying research areas that are considered priority:

- **Adaptable jobs:** An area where the Barometer can expand over time is in identifying jobs completely destroyed in relation to those that can be reallocated. Research by the ILO finds that over 71% of workers whose jobs are affected by the green transition have the potential to be reallocated to new jobs with the right training and upskilling.⁴⁰ In further data updates of the Green Jobs Barometer survey data will seek to identify those jobs (as per employees’ perceptions) that are more likely to become obsolete (given their current mix of work tasks and activities) and, of those, which jobs use skills that are relevant for other occupations – or similar occupations in other sectors.
- **Career Pathways:** A related challenge is ensuring that the green recovery, the economic recovery which prioritises net zero and decarbonisation efforts, works for everyone by giving wide and fair access to upskilling opportunities and jobs. Therefore, future

research on green jobs will look at how to facilitate just transitions by creating career pathways towards green jobs, an endeavour that requires having clear taxonomies of the skills related to green jobs and other emerging growing sectors, and how close the skillsets of sunset jobs are in order to make the transition.⁴¹ As part of extended analysis for Pillar 1, we will showcase the most transferable skills from jobs in decline which map to green careers.

- **Quality of green jobs:** analysis of career pathways often focuses on determining those job transitions that are considered viable from the point of view of skills (it is easier to transition to jobs that do not require radically different sets of skills). Attention is also increasingly paid to job transitions that are feasible in the context of market, regulatory or geographical barriers that limit job mobility. Further work will also pay attention to identifying “desirable job” transitions: those where workers are expected to move to better jobs that are also more productive for the economy. The International Labour Organisation promotes the definition of green jobs as those that promote decent work.⁴² The quality of work and jobs is not sufficiently captured in the first edition of the Barometer.

The regional and sectoral insights provided by the Barometer can inform different policy areas. Future research linked to the Barometer will also draw recommendations for policy and businesses. A couple areas of action include:

- **Upskilling:** in order to inform policy as to the type of skills provision needed for a greener economy, Government and organisations must first understand the type of roles that are likely to be growing in number – and the skills that will be required to carry out those roles effectively. The Barometer will continue to monitor the number of green jobs across sectors and regions and, in future releases, the “green skills

³⁹ In the initial version of the Barometer, the green job creation analysis of Pillar 1 involves a binary classification of green versus non-green jobs. In future updates, there will be different shades of green, based on the activities and skills associated with specific types of jobs and occupations.

⁴⁰ International Labour Organisation (2019). Skills for a green future: A global review. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_732214.pdf

⁴¹ Research by PwC in the summer of 2021 shows that of the more than 371,000 jobs that could be created between 2017 and 2030, over 60% are forecast to be jobs requiring ‘mid-level skills’, whilst high and low skilled jobs will make up 18% and 19% of total jobs created respectively.

⁴² For instance, many current recycling jobs, for instance, recover raw materials and thus help to alleviate pressure on natural resources. However, the jobs involve a working practice that is often dirty and dangerous, causing significant damage to human health.

density” of such jobs. Identifying the key ‘growth’ occupations, and those at risk, will give more focus to subsequent, more granular analysis to identify the key skills associated to those occupations and how far they allow seamless transitions to new jobs and roles – to align individual’s skills with demand from growth sectors.

- **Place-based policies:** as the Green Jobs Barometer matures over time, the indicators summarising performance for each Pillar will increasingly use more granular data for their computation. The monitoring of these data will allow local stakeholders in the regions to formulate the right initiatives and policies for their own priorities.

Our research highlights the cross-cutting nature of the green transition in the UK and the potential opportunities and challenges associated with it. The transition to a green economy requires complex transformation efforts across all parts of the economic system, such as strategic workforce planning, sector and place-based policies or re-imagining lifelong learning systems. This means that the Barometer is not the end, but the beginning of a sustained effort to create the right evidence for policies conducive to a more prosperous and sustainable future.

Whilst there is no silver bullet to a successful green transition, understanding the impacts of this transition on skill levels, geography and occupations is key to ensuring that all actors have the correct resources to support greening efforts, at the right time. As the 26th UN Climate Conference of the Parties this year has reminded us, now is the perfect time to bring together political will and sector knowledge to set the stage for the green transition.



Appendix A: Approaches to defining green jobs



Defining ‘green jobs’

Internationally, there is no general consensus or agreement on what the definition of green jobs should be. As the Barometer combines several distinct Pillars of analysis, we adopt a standardised and workable definition of ‘green jobs’ which can be utilised within each respective Pillar.

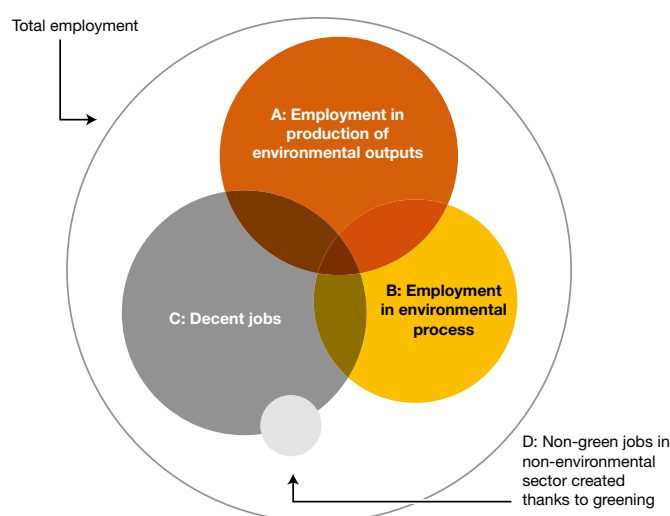
The necessity for a standardised definition arises out of a need to make those respective Pillar findings comparable to one another. The definition also has to be workable as respondents to the questionnaire survey need to recognise what is meant by ‘green job’ while minimising the potential for subjectivity which could potentially confuse the respondent and obscure their responses.

The majority of attempts to define green jobs occur as a result of efforts to measure the green economy, usually in a specific national context. Most practical applications have viewed green jobs through an sectoral lens – identifying green jobs as employment in sectors that are judged to produce green products and services with variations in scope and thresholds. An example of this approach is the UK ONS’ Low Carbon and Renewable Energy Economy (LCREE) survey which only captures the responses of businesses engaged in low carbon

and renewable energy. Institutional definitions are often broader, including employment in archetypal green sectors such as environmental protection and regulation as well as sectors which more broadly operate in an environmentally friendly manner.

As trends towards green and circular economies have gained momentum, the need to collect statistical data and make policy choices linked to these data has precipitated many national governments to employ their own definitions of green jobs. While these definitions have contributed to the evolving consensus around green jobs, they are not considered canonical amongst researchers and practitioners. Acknowledging the absence of such consensus, the International Labour Organisation (ILO) have made significant conceptual contributions to standardising approaches to defining green jobs.

Figure A1: Schematic relationships between total employment, green jobs and decent work



Source: UNEP, ILO, IOE, ITUC: Green jobs: Towards decent work in a sustainable, low-carbon world (Nairobi, UNEP, 2008).

As illustrated in Figure A1, the two most commonly used and widely accepted characteristics for evaluating whether jobs are green are: outputs – i.e the provision of goods or services, typically from within ‘green’ economic sectors and subsectors, that benefit the environment, and; processes – i.e. where production processes are made more environmentally friendly by ‘green’ occupations and job functions. This is consistent with the working definition used in the Barometer study.

The inclusion of quality or ‘decent jobs’ is an essential contribution to a framework for evaluating green jobs and ensuring a just transition as jobs with green outputs or processes do not automatically constitute quality work. The recycling of electronic waste, for instance, has some obvious beneficial environmental outputs such as the recovery and conservation of finite natural resources. However, in the context of developing countries, the recycling of electronic waste often involves the use of corrosive chemicals and toxins which are known to damage human health.

This study acknowledges that ‘decent work’ is not explicitly articulated in the working definition of green jobs.



Our working definition of green jobs used to create the Barometer

For the purposes of this report, and following an approach developed by the City of Sydney⁴³, we define green jobs as those in which a substantial share of the activities are performed to intentionally improve environmental outcomes (ie. 'green activities').⁴⁴

Using this definition, green jobs fall under three key categories:

1. Producing and providing environmentally friendly products or services. These are goods and services which have a direct positive impact on the environment. Examples include the production of solar panels or other forms of renewable energy, or collecting and processing recycled waste. This category also includes environmentally friendly versions of traditional products and services, for example electric cars or energy efficient light bulbs.

2. Adapting work processes to become more environmentally friendly or using fewer natural resources. This includes activities to research, develop, or use technologies and practices that lessen the environmental impact of your job. Examples might include beer brewed in solar-powered breweries, or operations that are managed from wind-powered offices.

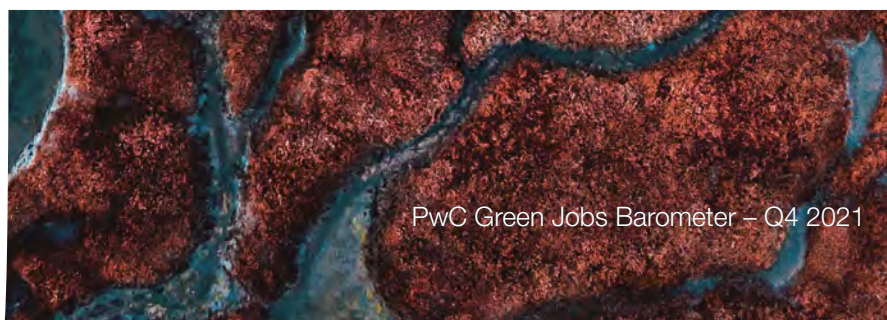
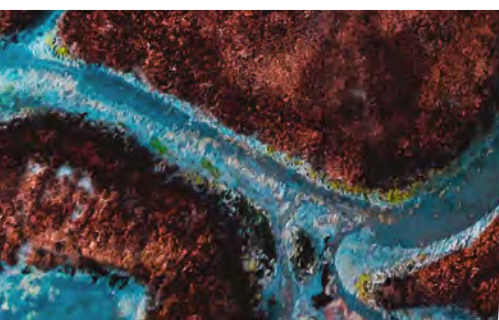
3. Supporting the green economy indirectly. These are activities that may not directly benefit the environment, but which might advise or encourage other people or organisations to do so. This could include environmental advisors in business, consulting, law and accounting. This also incorporates research and education – for example, the discovery through research of a new production process may help organisations to reduce their impact on the environment, while education to increase the pool of workers with green skills supports companies to improve environmental performance.

⁴³ City of Sydney (2019). Building a strong green and circular economy for Sydney. <https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/green-economy-study>

⁴⁴ For example, a driver of a traditional form of public transport would not be considered a green job as their primary purpose is to transport a person from one location to another, with their impact on reducing pollution and carbon emissions a secondary benefit. Waste management services, including collecting rubbish to recycle, however, are green jobs as their primary purpose is to reduce pollution as well as improve recycling outcomes. This definition also provides a threshold to exclude jobs with only a small share of activities that are green. For example, a solar cell engineer designing solar panels is a green job, however a facilities manager at a bank who is also responsible for recycling the company coffee cup lids is not.



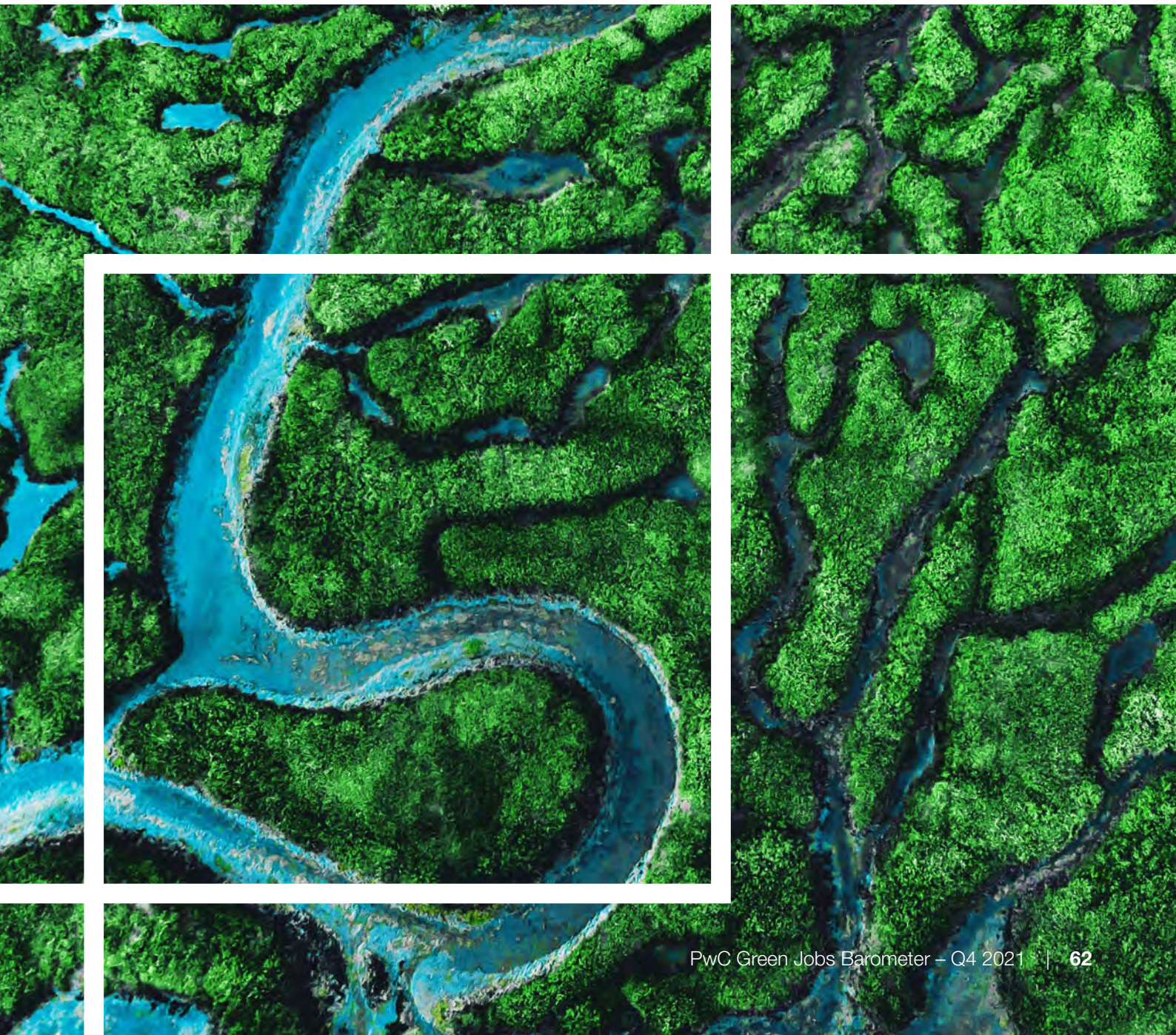
Appendix B: Methodology



Pillar 1: Green job creation

Job advertisement data

One of the challenges for understanding the number of green jobs in the UK is a lack of data. Many sources – such as the ONS' Low Carbon and Renewable Energy Survey (LCREE) – cover a relatively narrow range of jobs, often those that are deemed to be low carbon or related to renewable energy. These sources tend not to include broader definitions of 'green' such as recycling and the protection of biodiversity.



In order to overcome these limitations, we commissioned Geek Talent to analyse more than 11.2 million unique job vacancies advertised over 12 months, from July 2020 to June 2021. In Pillar 1, we report the “green intensity” of jobs in each sector as the total number of green job advertisements in the sector, divided by the total number of job advertisements in the sector.

Geek Talent source data from job advert aggregators from which we calculate the proportion of jobs advertised that are ‘green’.

The first step in our analysis was to differentiate between ‘Green’ and ‘Non-Green’ jobs. As there is no formally accepted definition of what constitutes a ‘green’ job, we created a working definition for our analysis following an approach developed by the City of Sydney⁴⁵, as outlined above, we define green jobs as those in which a substantial share of the activities are performed to intentionally improve environmental outcomes (ie. ‘green activities’). This definition serves as a basis for creating a green job typology, which informs the search strategy to identify these jobs.

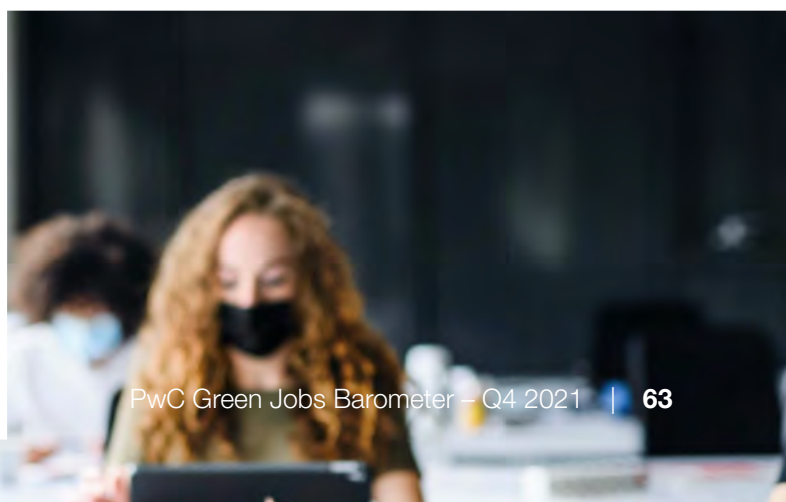
Using our green job typology as a framework for evaluation, we analysed a number of comparable studies⁴⁶ and extracted an initial set of keywords/skills with a high degree of green job association – a requisite for performing subsequent text analysis.

The keywords/ skills captured from this stage were validated and refined against a random sample of job advertisements, leveraging our text analysis approach to identify both skill clusters associated with green jobs (which led us to additional inclusion words/word pairs), and words which yielded a high rate of false positives. The resulting output was a list of keywords/ skills which could be used to evaluate the corpus of UK jobs advertisements and retrieve adverts belonging to green jobs. Employing ‘term frequency-inverse document frequency (TF-IDF) to evaluate our keywords against job descriptions, we were able to statistically measure the relative importance of those words within any given description and rank those descriptions based on their score.

The application of this approach was used iteratively. This enhanced the quality of the resulting data and resulted in a set of keywords/skills with an observable association with green jobs as we defined them. An example of such quality controlling was in the identification of and controlling for words which could be best described as ‘greenwashing’ jobs that were not otherwise green – ‘sustainability’ and ‘carbon’ were two such words.

⁴⁵ City of Sydney (2019). Building a strong green and circular economy for Sydney. <https://www.cityofsydney.nsw.gov.au/surveys-case-studies-reports/green-economy-study>

⁴⁶ ibid



The resulting output is a metadata comprising two populations – ‘Green’ and ‘Non-Green’ job advertisements which were then analysed at the regional, sector and occupational level.

The most notable limitation observed within this methodology is the relative absence of data for the agriculture and mining sectors contained within the aggregator platforms. It is apparent that both sectors use a combination of specialist advertising platforms and have a higher incidence of non-domestic advertising for UK roles (this is particularly true in agriculture where seasonal labour represents a significant proportion of job advertising). In addition, agricultural employment is characterised as having an atypical age demographic compared to other sectors with the median age of farm holders being 60 years^{47]} and a low level of staff turnover owing to the high levels of individual farm holding ownership.⁴⁸

In a similar fashion to the approach employed for agriculture in Pillar 5, it was necessary to enhance the data pertaining to agriculture and mining sectors to increase the robustness of inferences made from analysis of these. A qualitative evaluation of the wider metadata showed that there was scope to reallocate jobs from other sectors based on the functional profiles of their job descriptions. For example, agronomists could be reprofiled from the ‘professional, scientific and technical’ activities sector into agriculture and administrative occupations that related to mining could be reprofiled from ‘professional, scientific and technical’ activities to mining. Once the potential to employ this approach was qualitatively validated, a keyword taxonomy was created for each respective sector which allowed us to perform TF-IDF text analysis on the green job subpopulation – this approach was essentially identical to that used to identify green jobs from the wider metadata and was similarly used iteratively to improve accuracy.

⁴⁷ DEFRA (2016). Agricultural labour in England and the UK. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/771494/FSS2013-labour-statsnotice-17jan19.pdf

⁴⁸ Of the 105 thousand holdings in England, 97% were run by ‘sole holders’ and 3% by limited companies or institutions (equivalently for the UK as a whole). *ibid*



Pillar 2: Wider benefits from green jobs

Creating an Input-Output model

We developed a bespoke input-output model using the UK Input-Output tables for 2016, published by the ONS⁴⁹.

We first used regional GVA and consumption to expand the UK Input-Output table into an inter-regional table that reflects trade between regions. To do this we applied the location quotient approach developed by Flegg et al (1995)⁵⁰. Location Quotients are useful when deriving Input-Output tables for a smaller jurisdiction from an Input-Output table ('IOT') of a larger, benchmark country. They allow us to limit the overstatement of regional multipliers that usually comes from deriving Input-Output tables without any LQ adjustment.

We first calculated the Simple Location Quotient ('SLQ'). The SLQ is a ratio which tells us the concentration of a sector in the specified region (e.g. North East) in comparison to a larger reference region, in this case the UK. This is calculated per sector as follows:

$$SLQ_i = \frac{GVA_{i, North\ East}}{GVA_{North\ East}} / \frac{GVA_{i, UK}}{GVA_{UK}}$$

For example if sector *i* had a value of 2, this would mean that sector *i* in the North East is twice as large as a share of the UK's economy so sector *i* is effectively self-sufficient. We cap these Simple LQs at 1, so that we only adjust sectors which are relatively underrepresented in the selected regions compared to the UK, and use these to scale final demand by rows. Note that instead of using employment shares, as the original papers do, we use GVA shares instead.

We then calculated two adjustment factors based on Flegg et al (1995) and Flegg et al (1997)⁵¹ respectively:

$$\lambda_{1995} = \frac{GVA_{North\ East}}{GVA_{UK}} / \left[\log_2 \left(1 + \frac{GVA_{North\ East}}{GVA_{UK}} \right) \right]^\beta$$

$$\lambda_{1997} = \left[\log_2 \left(1 + \frac{GVA_{North\ East}}{GVA_{UK}} \right) \right]^\delta$$

Our chosen adjustment factor λ is the average of λ_{1995} and λ_{1997} above, where $\beta=5$ as in Flegg et al (1995) and $\delta=0.25$ as in Flegg et al (1997).

49 ONS (2020). UK input-output analytical tables, 2016. <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltables-detailed>

50 Flegg A. T., Webber C. D., and Elliott M. V. (1995) 'On the appropriate use of location quotients in generating regional input-output tables', *Regional Studies* 29, 547–61.

51 Flegg A. T. and C.D. Webber. (1997) On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply, *Regional Studies*, 1997, vol. 31, issue 8, 795-805.

Again, note that instead of using employment shares, as the original papers do, we used GVA shares instead.

Using these adjustment factors, we then calculate LQ_{ij} as follows:

$$\text{If } i = j: LQ_{ij} = \underline{\lambda} * SLQ_i$$

$$\text{If } i \neq j: LQ_{ij} = \underline{\lambda} * \frac{SLQ_i}{SLQ_j}$$

where i = buying (column) and j = supplying (row)

Like above with the SLQs, we cap these pairwise Location Quotients at 1, so that we only adjust sectors which are relatively underrepresented in the selected region versus the UK. These LQs are used to scale intermediate demand.

We note that an adjustment was made to the location quotient for household spending in certain sectors (such as 'Other service activities', 'Real estate activities' and 'Electricity, gas, steam and air-conditioning supply' sectors) in order to reduce errors below the -50% level. This was then incorporated into an adapted version of the UK input-output table.



Calculating multiplier effects

An input-output table provides information on what a typical business in the supplier's sector requires for producing one unit of output. It allows us to trace the typical input requirements through the entire supply chain for production activities in each sector, and calculate the total value of production stimulated.

In addition to the above, an input-output table also provides data on the share of revenue that constitutes profit and wages for each sector. We can apply this ratio to the total production value stimulated, and hence estimate the total GVA in the supply chain by sector associated with this. Additional statistics on employment provide information on the number of people that work in any particular sector. As we know the output stimulated in each sector, we can estimate the production value to job ratio. We can then apply this to the total production value stimulated in the supply chain. This allows us to estimate the number of jobs supported in the supply chain – The indirect employment. A similar procedure was carried out for tax and employee compensation contributions.

These steps are repeated to calculate the induced contribution, but through using wage data to estimate how much production is stimulated in the supply chain that supports the products employees buy, e.g. accommodation, food and entertainment.

For the multipliers, we derived Type I and Type II multipliers for output, GVA and employment – to do this we firstly constructed a technical matrix, A. The A matrix shows detailed purchases per unit of output by the purchasing sector (column) from the various domestic supplying sectors. It is calculated by dividing the entry in each row by the total gross output for its respective column.

To calculate Type I multipliers, we used a technical matrix, A1, in which each cell in row i and column j represents the value of sector i's output required to produce a unit of output in sector j.

To calculate Type II multipliers, we also included an additional notional sector, "endogenous labour". It involves adding a new row that is composed of the ratio between compensation of employees ('CoE') and total output, and a column that consists of the ratios of private consumption on each sector's output to an estimated total household income. This is the technical matrix A2.

From the A matrices, we want to calculate the Leontief matrices.⁵² To do this we first constructed the I – A matrix, where I is the identity matrix with the same dimensions as A.

For Type I multipliers, we invert the I – A matrix, excluding the column for private consumption and row for compensation of employees, yielding the L1 = (I – A1)⁻¹. This yields a matrix of output multipliers.

To calculate the Type I multipliers, we take each sectors column vector of output multipliers from L1:

$$l_i = \begin{pmatrix} l_{i1} \\ \vdots \\ l_{in} \end{pmatrix}$$

Where i = buying (column) and n = number of rows.

We then calculate the 1 x n row vector of GVA-to-output ratios across buying (column) sectors:

$$x = \left[\frac{GVA_1}{Output_1} \quad \dots \quad \frac{GVA_n}{Output_n} \right]$$

To calculate the GVA effect for each sector, we multiply:

$$x \cdot l_i = (GVAEffect)_i$$

The Type 1 GVA effect for each sector is then calculated as the ratio:

$$\text{Type I GVA Multiplier for sector } i = \frac{GVAEffect_i}{GVA_i/Output_i}$$

Repeating the steps above, but instead with a row vector of employment-to-output ratios for each buying (column) sector yields Type 1 Employment multipliers.

⁵² Also known as the Leontief Inverse

$$y = \left[\frac{\text{Employment}_1}{\text{Output}_1} \quad \dots \quad \frac{\text{Employment}_{92}}{\text{Output}_{92}} \right]$$

$$y \cdot l_i = (\text{EmploymentEffect})_i$$

Type I Employment Multiplier for sector $i = \frac{\text{Employment Effect}_i}{\text{Employment}_i / \text{Output}_i}$

For Type II multipliers, we invert the I – A matrix, including the column for private sector consumption and row for compensation of employees, yielding $L2 = (1 - A2)^{-1}$. As explained above, the Type II multiplier matrix L2 differs from L1 because it includes induced effects, in addition to direct and indirect effects. This induced effect is from the additional spending of employees.

Repeating the same steps above to calculate sector GVA-to-output ratios, GVA effects and GVA multipliers above using L2 instead of L1 yields Type II GVA multipliers, and similarly for Type II Employment multipliers.

Pillar 3: Sunset jobs to disappear

We build on previous analysis from the International Labour Organisation (ILO).⁵³ The ILO develop a multi-regional input-output model (EXIOBASE v3) to analyse transactions between 163 sectors across 44 countries. Using this model, the ILO quantify the employment impact (job creation and job destruction) of the transition to an ‘energy sustainability’ scenario (associated with global warming of 2°C) compared to a ‘do nothing’ scenario (associated with global warming of 6°C). The ILO take sector-level results and apply the occupational structures for each sector to derive occupational-level results. Full detail of the ILO methodology can be found in Annex 5 of their report.⁵⁴

Using the ILO sector-level results for job destruction, we conducted a number steps to generate the number of sunset jobs. These steps are detailed below.

First, we conducted a mapping of Exiobase to SIC sectors. Since there does not exist a correspondence table between Exiobase and UK SIC (2007), this involves a number of sub-steps:

- Exiobase classifies sectors according to the statistical classification of economic activities in the European Community (NACE Rev. 1.1); and
- Using European Commission correspondence tables, we have mapped NACE Rev. 1.1 to NACE Rev. 2.⁵⁵ NACE Rev. 2 and UK SIC (2007) are identical to a 4-digit level.

Based on discussion with the ILO, we selected a sample of broadly UK-similar countries from the total sample of 44, based on:

- Sectoral makeup;
- Labour intensity of each sector;
- Production matrices (ie. what is produced within and out of the country); and
- Transition starting period.

This resulted in a reduced sample of 30 countries. Employment by each sector is calculated as a percentage of total employment for each of these countries respectively, using ILOSTAT data.⁵⁶ These shares are averaged across the sample to proxy a ‘sample’ sector share.

The ‘sample’ sector share calculated in the previous step is then applied to the total number of jobs as of 2017 (the base year used by the ILO) taken from the ILO report. This year gives us the total number of jobs per sector for our sample set of countries. ILO sector-level results for job destruction for the sample is used to get the % of jobs destroyed of total, per sector.

⁵³ International Labour Organisation (2019). Skills for a green future: A global review. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_732214.pdf

⁵⁴ Ibid.

⁵⁵ European Commission. NACE Rev.2 – Correspondence tables. https://ec.europa.eu/eurostat/web/nace-rev2/correspondence_tables

⁵⁶ ILOSTAT. Employment by economic activity.

Pillar 4: Carbon intensity of employment

Data on CO₂ emissions on a regional and industry basis does not exist. Instead, the BEIS publishes data on: i) CO₂ emissions by sector section and group, and ii) CO₂ emissions by UK region. The latest data for both of these sources is 2019. As a result of this data limitation, we assume that sector emissions are apportioned across regions based on the regional share of UK CO₂ emissions from dataset 2). This is a limitation of our analysis and assumes that the regional concentration of emissions is the same for different sectors.

Having obtained CO₂ emissions on a regional and sector basis using this proxy, we divide by December 2019 employment for each sector and region, which has been seasonally adjusted. This gives us our final output of carbon intensity of employment for each region, sector, and region-sector pair.

57 BEIS (2021). UK local authority and regional carbon dioxide emissions national statistics: 2005 to 2019. <https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019>

58 ONS (2021). JOBS05: Workforce jobs by region and industry. <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/workforcejobsbyregionandindustryjobs05>



Pillar 5: Green workplaces

In collaboration with PwC Research, our in-house market research specialists, we have designed an online panel survey utilising employees' insights on their perceptions of their own jobs.

We based the survey on a representative sample of 2,085 employees. Quotas for each sector and region are set using data from the ONS and UK Labour Force Survey (August 2021). A variety of screening questions were included to: 1) understand the demographics of the survey population; and 2) ensure that respondents are either employed full-time, part-time, or self-employed and have been in their role for at least 6 months.

We asked respondents the following questions:

1. To what extent do you consider your job 'environmentally friendly' across the following areas?

- Amount of waste e.g. Use of limited packaging materials as part of my job
- Amount of carbon emissions e.g. Driving an energy efficient vehicle as part of my job
- Amount of pollution e.g. Using eco-friendly products as part of my job
- Amount of biodiversity harm e.g. Using biodegradable bags as part of my job
- Amount of resource use e.g. Adopting efficient manufacturing processes as part of my job
- Amount of water usage e.g. Minimising water usage as part of my job
- Amount of recycling e.g. Using recycled inputs into production as part of my job
- Amount of energy consumption e.g. Considering the supply chain impact as part of my job, or using renewable energy sources as part of my job

Respondents could choose from the following options:

- Not at all environmentally friendly
- Not particularly environmentally friendly
- Neutral
- Somewhat environmentally friendly
- Very environmentally friendly
- Not applicable
- Don't know

2. Over the next 1-2 years, to what extent do you think the impact of your job on the above environmental areas could change?

Respondents could choose from the following options:

- Potential significant worsening
- Potential moderate worsening
- No change
- Potential moderate improvement
- Potential significant improvement
- Not applicable
- Don't know

We created a combined 'score' for the above answers according to the responses – whereby a maximum score of 100 indicates that the respondents job is very environmentally friendly, and over the next 1-2 years there will be a significant improvement in environmental friendliness. Similarly a minimum score of 0 indicates that the respondents' job is not at all environmentally friendly, and over the next 1-2 years there will be a significant worsening in environmental friendliness.

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