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DECARBONISATION DYNAMICS

Mapping the UK transition to net zero

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60 SECOND SUMMARY

1 Like automation, decarbonisation will have different implications across sectors for the number and types of jobs available.

2 'Decarbonisation dynamics' are set to shape local labour markets in the next 10-30 years. We focus on three sectors that will play a critical role in reducing the UK's greenhouse gas emissions and are expected to decline or transform as a result: fossil fuels and energy production, emissions intensive heavy industry, and vehicle manufacturing.

3 There is clear variation across nations and regions, with London and the South having the lowest share of jobs impacted across all the industries that we consider. Jobs in the North, Midlands, Scotland and Wales will be more significantly impacted by these different 'decarbonisation dynamics' but the impacts will be felt most acutely in a handful of local areas.

4 Jobs in fossil fuel and energy production are most concentrated in local authorities across Scotland, the north and midlands. Some of these areas already have high renewable energy capacity but, in many areas, workers may lack sufficient opportunities to transition into green jobs. Only half of the areas with the top 20 highest concentration of employment in these industries are in the Government's priority levelling up category.

5 Jobs in heavy industry are most concentrated in parts of northern England, the Midlands and Wales. These jobs could be impacted by shifts to a circular economy as well as whether uncertain new green technologies – like carbon capture, utilisation and storage and low carbon hydrogen fuels – reach maturity in time. Only half of the top 20 areas are in the Government's priority levelling up category.

6 Jobs in vehicle manufacturing are most concentrated in parts of the Midlands and Wales. These jobs will be impacted by changes in manufacturing processes which will require different skills and may be less labour intensive as well as modal shifts in transport. Less than half of the top 20 areas are in the Government's levelling up priority category.

7 These challenges do not provide sufficient rationale to slow down the decarbonisation of the economy, but policy-makers must ensure that plans are in place so that workers in these areas are well positioned to benefit from the green jobs revolution or find work in other growing sectors.

8 We put forward two main recommendations for policy-makers. Firstly, that the UK Government should create a just transition fund to support local authorities with the highest share of employment in industries likely to be impacted by decarbonisation. This fund could be used to support green job creation or economic diversification. Secondly, that local authorities be given the means to pilot job security councils, which would

provide workers at risk of displacement with an end-to-end transition service. This should include experiments with new approaches to welfare such as a transitionary basic income.

BACKGROUND

The notion of a 'just transition' was incorporated into the 2015 Paris Agreement as a way of signalling the importance of minimising negative repercussions from climate policies and maximising positive social impacts for workers and communities. The transition to net zero will entail large-scale changes in business models and production processes.

Like automation, decarbonisation will have implications across different sectors for the number and types of jobs available. Several studies suggest that the employment impacts of the transition to net zero will be net positive. However, it is also expected that these effects will be felt unevenly across and within countries. For example, the European Investment Bank predict that green jobs, such as those in renewable energy and recycling, will be created in many regions, but that job losses are likely to be concentrated in a few, particularly those dependent on industries like fossil fuel extraction or car manufacturing.

The UK Government is investing in new green jobs as part of its strategy for post-Covid Recovery. According to the Net Zero Strategy, government investment will help create and support up to 440,000 highly skilled, high paid green jobs by 2030. The Ten Point Plan for a Green Industrial Revolution suggests that: "There will be electric vehicle technicians in the Midlands, construction and installation workers in the North East and Wales, specialists in advanced fuels in the North West, agroforestry practitioners in Scotland, and grid system installers everywhere". However, the UK Government is yet to publish a detailed granular analysis on what existing jobs and which local economies will be most impacted by the transition to net zero.

In this briefing paper we offer a new perspective on these questions. We don't attempt to estimate the net employment impacts of decarbonisation. This endeavour would require firm assumptions around the various technological pathways that will shape the future net zero economy – pathways that remain very uncertain.

Rather, we aim to illustrate where a several different 'decarbonisation dynamics', such as the decline of fossil fuel use and modal shifts in transport, could be most acutely felt. For many areas, these shifts could also create opportunities for hi-tech green job creation, but workers will need support to develop the skills needed to transition into these roles or, in some cases, to find work in other growing industries. Our hope is that by highlighting areas that could be at risk of being 'left behind', national and local governments can ensure that plans are in place, so they are well positioned to benefit from the green jobs revolution.

This paper is structured as follows: we provide an overview of our methodology, before outlining our key findings and recommendations for policy makers.

METHODOLOGY

The most polluting economic activities tend to contribute relatively little to total employment. According to the ILO and OECD, just a handful of industries account for 80 percent of total carbon dioxide emissions in OECD countries, while only employing about 10 percent of the workforce. Similarly, our analysis of UK greenhouse gas emissions and employment data suggests that around 4 percent of jobs account for more than two thirds of industry emissions.[i]

Table 1: Carbon dioxide emissions and employment of ten largest contributors to UK industry emissions (RSA analysis of UK Environmental Accounts and Business Register and Employment Survey 2019)

Industry division	SIC codes	Share of industry CO_2 emissions	Employment	Percent of total employment	CO_2 emissions per job[ii]
Electric power generation, transmission and distribution	35.1	25.1%	95,000	0.31%	0.86
Air transport services	51	13.0%	75,000	0.24%	0.57
Crude petroleum and natural gas	6	5.6%	13,000	0.04%	1.41
Coke and refined petroleum products	19	4.8%	9,000	0.03%	1.73
Freight transport by road and removal services	49.4	3.7%	299,000	0.96%	0.04
Manufacture of basic Iron & Steel	24.1-3	3.4%	33,500	0.11%	0.34
Water transport services	50	3.3%	14,000	0.05%	0.78
Cement, lime, plaster and articles of concrete, cement and plaster	23.5-6	3.1%	27,750	0.09%	0.36
Products of agriculture, hunting and related services	1	2.5%	458,000	1.47%	0.02
Other passenger land transport services	49.3	2.3%	248,000	0.80%	0.03
Total	-	66.9%	1,272,250	4.09%	-

One approach to identify what local economies are most likely to be impacted by the transition to net zero is to look at the emissions intensity of local economies. This can be done directly, by analysing local energy

[i] We exclude consumer expenditure emissions from our analysis

[ii] Mass of air emissions per annum in thousand tonnes

consumption data that is publicly available, or indirectly by estimating the average emissions intensity of jobs based on the industrial composition of local areas. During the exploratory phase of this research, we considered both approaches. The Department for Business, Energy and Industrial Strategy (BEIS) currently publish annual carbon dioxide emissions statistics at the local authority level. While the Office for National Statistics (ONS) release data on the greenhouse gas emissions for detailed Standard Industrial Classification (SIC) codes, which alongside local employment data could be used to estimate the how concentrated these emissions are in particular local authorities.

However, emissions intensity may be a poor proxy for whether jobs in an industry will be lost or transformed. This is because most available statistics focus on scope 1 and 2 emissions, meaning an industry such as car manufacturing, which uses relatively low-emission production processes, is not captured by these measures, despite reduced car use and ownership being identified as key shifts that will need to take place, and which could lead to job losses. A key finding from the evidence review that informs our analysis is that 'decarbonisation dynamics' will play out in very different ways in different sectors. Decarbonisation will rely on different technological pathways and have a variety of impacts on employment, in some cases leading to job creation or transformation rather than job elimination (see Box 1). In agriculture for example, it will likely lead to increased demand for labour to support regenerative farming practices. In carbon-intensive industries such as steel, job losses are likely to be shaped by whether uncertain new technologies - like carbon capture, utilisation and storage (CCUS) or low carbon hydrogen fuels - reach maturity in time.

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Box 1: How can decarbonisation impact jobs? (Adapted from the United Nations Framework Convention on Climate Change's Just Transition of the Workforce report)

Decarbonisation, like automation, can have a range of different impacts on workers, many of which will require that they learn new skills in order to adapt to changes in processes or business models or find work in a new and emerging part of the economy.

1. **Job creation.** The expansion of low carbon products, services and infrastructure will create new jobs in many sectors of the economy, including in renewable energy production and infrastructure, housing energy efficiency and ecosystem restoration.
2. **Job substitution.** Some existing jobs will be replaced as a result of decarbonisation. Examples include from truck-based transportation logistics to rail, from internal combustion engine manufacturing to electric vehicle battery production and from landfill waste to recycling and refurbishing. These shifts may be gradual or sudden and will require that workers retrain to learn new skills.
3. **Job elimination.** Some jobs in polluting or extractive industries will be phased out or see their output massively reduced. The continued large-scale mining of coal and oil and gas exploration is not compatible with a net zero economy. While greater efficiency of materials and production processes, along with boosts in recycling of materials and reuse of products, could lead to substantial job losses in primary sectors.
4. **Job transformation and redefinition.** Many existing workers will simply have their jobs redefined as day-to-day workplace practices, skill sets, work methods and job profiles are greened. For example, plumbers and electricians can, in principle, be reoriented to carry out similar work in the green economy. While farmers will start to apply more climate appropriate growing methods.

These shifts will also interact with other forces such as automation and an aging population that also shaping the future of work. The intersection of these trends is outside of the scope of this briefing paper but will be explored in forthcoming RSA research.

Our methodology draws on a range of inputs to identify how key 'decarbonisation dynamics' will impact local labour markets in the next 10-30 years. This includes an analysis of UK greenhouse gas emission and renewable energy statistics published by the Department for Business, Energy and Industrial Strategy (BEIS), and local authority level employment data from the Business Register and Employment Survey (BRES).[iii] We focus on

[iii] Our analysis uses data from the 2019 BRES, which is the most recently accessible via ONS Nomis: https://www.nomisweb.co.uk/

three sectors that will play a critical role in reducing the UK's greenhouse gas emissions and which are expected to decline or transform as a result: **fossil fuel and energy production**, **heavy industry**, and **vehicle manufacturing**. We draw on insights from an evidence review and horizon scan to understand possible trajectories for employment in these sectors, before identifying relevant detailed Standard Industrial Classification (SIC) codes. We then use these SIC codes to estimate the share of jobs in local authorities that are likely to be impacted by these different 'decarbonisation dynamics'.

This briefing paper intends to complement an emerging body of research from the RSA's Future of Work and Regenerative Futures programmes. Our approach blends strategic foresight and data analysis to provide decision makers with a 'disruption radar'. The approach is also pragmatic given issues around existing data quality and availability. There are two main methodological caveats:

- The first caveat is that our analysis is constrained by SIC codes and that definitions of green industries don't neatly map onto SIC codes. For example, in energy production, SIC codes don't currently distinguish between fossil fuels and renewables or between internal combustion engine and electric vehicle manufacturing, meaning some of the areas we highlight in our analysis might already be leaders in green technologies. In some instances, we try to account for this by using separate indicators such as existing renewable energy capacity. But this is not possible for all the sectors we consider in our analysis. For this reason, it is important than this analysis is considered in the context of existing strategic planning that is taking place at the local level.
- The second is that our analysis is not exhaustive. 'decarbonisation dynamics' will also impact other sectors. A significant minority of the UK's emissions are concentrated in traditional industries such as retail (9 percent) and healthcare (8 percent). However, these are also two of the UK's largest industries, which would suggest that this is due to the scale of these operations and so decarbonisation will not have as widespread implications for workers. There are also sectors such as air travel and agriculture that are major contributors to emissions and could undergo significant change, which are outside of the scope of this briefing paper but worthy of further investigation.

We have focused on the sectors that the European Commission identified as most likely to decline or transform as part of their just transition planning.[iv] The UK Government's Net Zero Strategy also points out the necessity of transformation in these sectors, where it suggests that "it [decarbonisation] means no longer burning fossil fuels for power or heating; it means new ways of making concrete, cement, steel; it means the end of the petrol

[iv] According to the European Commission, sectors expected to decline include the mining of coal and lignite, extraction of crude petroleum and natural gas, and mining support service activities. While the sectors expected to transform are the manufacture of chemicals and chemical products, the manufacture of other non-metallic mineral products, the manufacture of basic metals, and the manufacture of motor vehicles, trailers and semi-trailers. https://www.europarl.europa.eu/RegData/etudes/STUD/2020/651444/IPOL_STU(2020)651444_EN.pdf

and diesel engine". Each of these sectors account for only around 0.5 percent of total employment in the UK but are considerably more concentrated in particular local areas.

KEY FINDINGS

Energy

Our analysis of energy 'decarbonisation dynamics' includes all industries related to the extraction, refinement and processing of fossil fuels as well as the production, distribution and transmission of gas and electricity (see Table 2). Assessing the impacts of the transition to net zero on these industries is more straightforward than for some of the other sectors we consider in this briefing paper. The technological pathway is clearer: burning fossil fuels is not the future.

This is expected to lead to job losses in these industries but will be offset by significant job creation in renewables. For example, the International Energy Agency (IEA) predicts that globally the shift to renewable energy will create 14 million jobs by 2030 but that employment related to fossil fuels will decline by around 5 million. The challenge, however, is that these jobs might not all be created at the same time, and in the same places, as where jobs are lost.

Table 2: Carbon dioxide emissions and employment in fossil fuel and energy production industries (RSA analysis of UK Environmental Accounts and Business Register and Employment Survey 2019)

Industry division	SIC codes	Share of industry CO_2 emissions	Employment	Percent of total employment	CO_2 emissions per job
Electric power generation, transmission and distribution	35.1	25.1%	95,000	0.31%	0.86
Crude petroleum and natural gas	6	5.6%	13,000	0.04%	1.41
Coke and refined petroleum products	19	4.8%	9,000	0.03%	1.73
Manufacture of gas; distribution of gaseous fuels through mains and steam and air conditioning supply	35.2-3	0.8%	39,900	0.13%	0.06
Mining support services	9	0.1%	18,000	0.06%	0.01
Mining of coal and lignite	5	0.1%	1,500	0.00%	0.14
Total	-	36.4%	176,400	0.57%	-

The UK Government hopes to create 440,000 green jobs by 2030, many of which are expected to be in renewable energy generation. According to research commissioned by the Local Government Association

(LGA), nearly half (46 percent) of low-carbon jobs will be in clean electricity generation and providing low-carbon heat for homes and businesses. These jobs will range from manufacturing wind turbines, deploying solar panels, constructing nuclear reactors, installing heat pumps and maintaining infrastructure. Jobs related to the research and development of low carbon alternative fuels such as hydrogen are also expected to experience growth. For example, BP is developing plans to create the UK's largest low carbon hydrogen hub in Teesside.

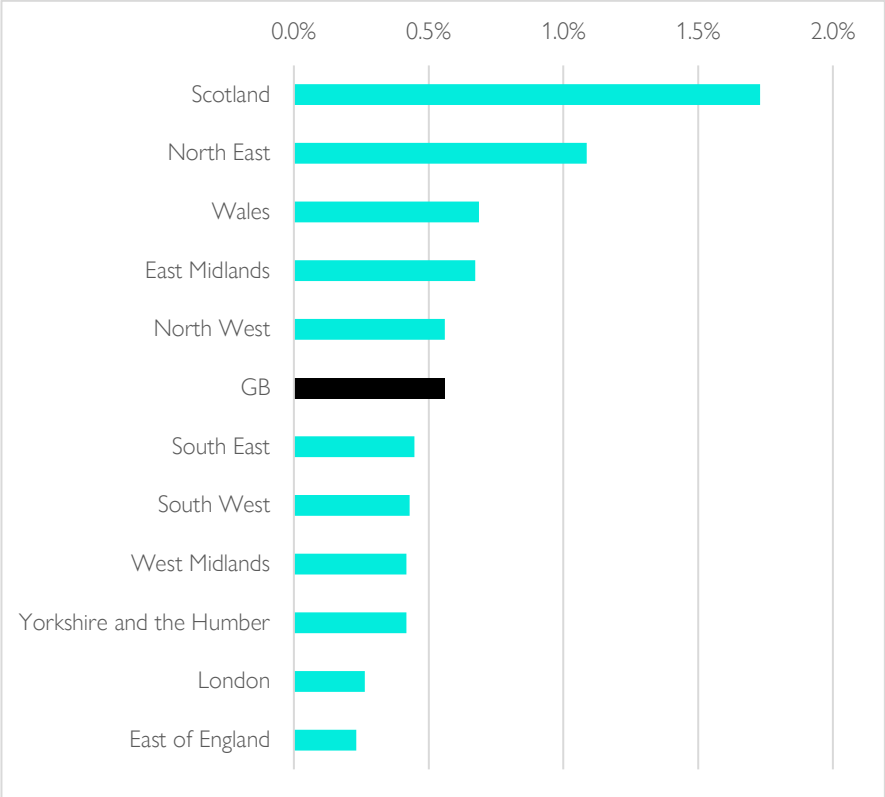
However, there will be a decline in demand for fossil fuels. This is a necessary part of the transition, which will put some workers at risk of unemployment. According to the Net Zero Economy pathway developed by the International Energy Agency (IEA) there should be no new coal mines or oil and gas fields will beyond those that have already been approved for development. The UK Government's Net Zero Strategy also recognises that reliance on fossil fuels will have to drop considerably. While the UK Government's Green Jobs Taskforce report suggests that in sectors such as oil and gas "workers will need to adapt and transition to new sectors".

There is some evidence that suggests the skills and knowledge needed for roles in polluting industries are broadly applicable to green jobs. For example, the Confederation of British Industry (CBI) have argued that the skills needed for the UK's offshore oil and gas sector are relevant to the development of wind turbine manufacturing. The UNFCC point out that there are also similarities in occupational profiles between oil drilling and geothermal development. While engineers, electricians, and IT specialists employed in fossil fuel power stations could adapt to operating renewable power plants with relative ease.

What is less clear is whether the transition to renewable energy will create green jobs in the same locations where jobs relating to fossil fuels and energy production are lost. Bill Gates has pointed out that "most of America's wind power is in the middle of the continent, not in coal country". While the European Investment Bank suggest that green jobs in construction and retrofit have will have a relatively even geographic distribution while power generation projects will be concentrated in specific regions with suitable natural resources.

According to our analysis, there is a clear regional dimension to this challenge in the UK, with fossil fuel and energy jobs much more concentrated in Scotland and the North East than London and the South East.

Figure 1: Employment in fossil fuel extraction and energy production by region (RSA analysis of Business Register and Employment Survey 2019)



However, it is important to look beyond broad regions since this will be a particularly acute challenge for some local authorities. Aberdeen City has the highest concentration of employment in these industries (11 percent), with many workers employed in the oil and gas industry. Stockport has the next highest concentration of employment, with many workers employed in gas supply and distribution (6 percent). Falkirk (Grangemouth), New Forest (Fawley) and North Lincolnshire (Lindsey) all have major oil refineries. More generally, looking at the top 20 local authorities with the highest share of employment suggests that these impacts of 'decarbonisation dynamics' on these industries will be felt most acutely in a small group of local areas across Scotland, the North and Midlands.

There is some relationship between employment in these industries and the Government's levelling up priority categories. 0.7 percent of workers in the Government's levelling up priority 1 category are employed in these industries, compared to 0.6 and 0.4 percent in the other categories. Although some of the local authorities in the top 20 are not considered levelling up priorities.

To understand where areas may already have strengths in renewables, and where workers may be better positioned to transition into similar green jobs, we consider how these local authorities rank in terms of their

renewable energy capacity. Some of these areas already have a high capacity, particularly those located in parts of Scotland. South Lanarkshire (ranked 5th in the UK) has strengths in onshore wind, Aberdeenshire (ranked 14th) has strengths in onshore and offshore wind, and Perth and Kinross (ranked 21st) has strengths in onshore wind and hydropower. Stockport, Blaby, Warwick and Gloucester have some of the lowest renewable energy capacity in the country.

Other areas identified in our analysis, such as Hinkley and Bosworth and Hartlepool, have nuclear power plants, which will continue to form part of the UK's energy mix and so jobs in these areas will not be significantly impacted by decarbonisation. While Selby ranks 1st in terms of renewable energy capacity, as the Drax powerplant now runs mostly on biomass rather than coal. However, there is increasing controversy surrounding the carbon neutrality of this energy source.

Table 4: Local authorities with the highest share of workers employed in fossil fuels and energy production (RSA analysis of Business Register and Employment Survey 2019; BEIS Renewable Electricity by local authority statistics; HM Treasury Levelling Up Fund – list of local authorities by priority category)

Local authority	Region	Percent employed in fossil fuels and energy production	Employment in fossil fuels and energy production	Levelling up priority	Renewable electricity: installed capacity (MW)	Renewable electricity: installed capacity (rank)
Aberdeen City	Scotland	11.3%	19,600	2	63	157
Stockport	North West	5.8%	8,300	1	21	248
Aberdeenshire	Scotland	5.6%	6,300	3	751	14
Blaby	East Midlands	4.8%	3,000	3	19	256
Hartlepool	North East	4.0%	1,250	1	71	137
Warwick	West Midlands	4.0%	3,500	3	29	225
Sunderland	North East	3.3%	4,000	1	46	183
Perth and Kinross	Scotland	2.9%	2,000	3	602	21
Hinckley and Bosworth	East Midlands	2.9%	1,300	3	55	167
Falkirk	Scotland	2.8%	1,900	1	60	161
Selby	Yorkshire and the Humber	2.6%	1,000	2	2,720	1
Gloucester	South West	2.4%	1,600	1	16	266
South Lanarkshire	Scotland	2.3%	2,750	1	1,251	5
New Forest	South East	2.2%	1,600	3	69	141
North Lincolnshire	Yorkshire and the Humber	2.1%	1,650	1	295	34
Nottingham	East Midlands	2.1%	4,200	1	35	209
East Lothian	Scotland	1.8%	600	2	186	54
Pembrokeshire	Wales	1.8%	900	1	229	45
Ipswich	East of England	1.7%	1,250	2	15	273
Cardiff	Wales	1.7%	3,750	1	62	158

Heavy industry

Steel is critical to much of the UK's infrastructure, from railways to wind turbines. Cement, lime and plaster are key products for the built environment. Chemical manufacturing provides essential inputs to many industries, including pharmaceuticals. Our analysis of 'decarbonisation dynamics' here focuses on most emissions intensive SIC codes within these industries (see Table 5). A key finding from our evidence review is that jobs losses in

these industries are likely to be shaped by whether uncertain new technologies like carbon capture, utilisation and storage (CCUS) reach maturity in time. The shift to a circular economy will also have impacts on employment in these industries, as greater reuse, repair and recycling is expected to reduce demand for raw materials.

Table 5: Carbon dioxide emissions and employment in emissions intensive heavy industry sectors (RSA analysis of UK Environmental Accounts and Business Register and Employment Survey 2019)

Industry division	SIC codes	Share of industry CO_2 emissions	Employment	Share of employment	Co_2 emissions per job
Manufacture of basic Iron & Steel	24.1-3	3.4%	33,500.00	0.11%	0.34
Cement, lime, plaster and articles of concrete, cement and plaster	23.5-6	3.1%	27,750.00	0.09%	0.36
Manufacture of petrochemicals	20.14+20.16+20.17+20.6	1.8%	17,600.00	0.06%	0.34
Industrial gases, inorganics and fertilisers (all inorganic chemicals)	20.11+20.13+20.15	1.1%	9,250.00	0.03%	0.40
Manufacture of glass, refractory, clay, other porcelain and ceramic products, Stone, & abrasive products	23.1-4 & 23.7-9	0.9%	53,500.00	0.17%	0.06
Manufacture of dyestuffs, agro-chemicals	20.12+20.2	0.3%	6,000.00	0.02%	0.17
Manufacture of other chemical products & man-made fibres	20.5	0.2%	19,000.00	0.06%	0.03
Total	-	10.9%	166,600	0.54%	-

According to the UK's Green Jobs Taskforce report, the ideal outcome for these industries is "where technologically possible, and within the necessary timeframe, is to decarbonise by retooling existing workplaces". The Government's Industrial Decarbonisation Strategy outlines how emissions will need to reduce by at least

two-thirds by 2035 and 90 percent by 2050 and highlights the potential of carbon capture, utilisation and storage (CCUS) and low carbon hydrogen fuels to enable this. Researchers from the Grantham Institute for Climate Change at the LSE argue, that these technologies could be 'just transition-positive' by reducing the employment impacts on communities from the potentially rapid shutdown of industries. According to the Net Zero Strategy, CCUS could also create up to 50,000 jobs by 2030.

Many dimensions of the future net zero economy are uncertain. According to the IEA, around 60 percent of heavy industry emissions reductions in 2050 will come from technologies that are not ready for market today. The Industrial Decarbonisation Strategy also recognises that "many low carbon technologies are in earlier stages of development, and not yet deployed regularly at a commercial level. Low carbon manufacturing will also be more expensive for some sectors, leading to an increase in their costs, and therefore risking a reduction in their competitiveness".

It is of course possible that technologies such as CCUS will become more viable in the future, but there are other pathways to decarbonisation here, which could have more significant impacts on workers. For example, green steel could involve new production processes that have different skill requirements or are less labour intensive. US-based start-up Boston Metals, a spin out of the Massachusetts Institute of Technology (MIT), has devised a new way of making steel without emissions. Powered by renewable electricity, Molten Oxide Electrolysis (MOE) converts iron ore into liquid metal and oxygen by separating oxides at high temperatures. Crucially, this process relies on small modular production units rather on huge blast furnaces and can be scaled up in line with demand.

These industries are also expected to be impacted by the shift to a circular economy. The current economic model could be described as linear: extract, manufacture, use and discard. While in the circular economy, products are designed to have longer lifecycles, be serviced and repaired, reused or recycled. Aside from the potential greenhouse gas emission reductions, circular economy approaches can have wider environmental benefits by reducing demand on natural resources. The shift to a circular economy is not expected to lead to a net loss of employment activity. While traditional manufacturing firms will see a decline in demand for their products, new jobs will be created in repair, recycling and remanufacturing. According to the ILO, the manufacture of steel will experience the greatest decline in absolute terms, with 28m jobs lost globally. However, they expect 31m jobs will be created in the processing of secondary steel into new steel. Similar dynamics are expected to take place across many manufacturing sectors, glass and glass products.

Decarbonising cement has been described as the 'hard problem' of tackling climate change. Where production processes prove hard to decarbonise, or materials too difficult to recycle, there may be a shift to alternative building materials and away from cement. McKinsey highlight how cross-laminated timber is attracting attention in this respect. Made by gluing wooden panels together, cross-laminated timber can provide an adequately fire-resistant building material that can reach large dimensions. While this material is increasingly being used in many

construction projects, McKinsey suggest that it will only be able to partially address this challenge; the annual increment needed to replace cement entirely would reportedly be about 80 percent of the recognised supply of forest in Russia.

According to our analysis, employment in emissions intensive manufacturing is more concentrated in regions outside of London and the South, particularly Yorkshire and Humber, Wales and the North East. There is also some relationship here with the Government's levelling up priority categories. 0.8 percent of workers in priority 1 areas are employed in these industries, compared to 0.6 percent in priority 2 and 0.3 percent in priority 3. Half of the local authorities in the top 20 are also considered priority levelling up areas.

Figure 2: Employment in emissions intensive heavy industry by region (RSA analysis of Business Register and Employment Survey 2019)

Port Talbot, which is home to the UK's largest steelworks, ranks top. In second place is North Lincolnshire, which is where UK's other major steelworks is located (Scunthorpe). Clackmannanshire has a small cluster of glass manufacturing. While Stoke-on-Trent is a centre of ceramics.

More generally, looking at the top 20 local authorities with the highest share of employment suggests that the impacts of decarbonisation on these industries will be felt most acutely in a handful of local areas across Wales, the North and Midlands. Most of these areas are also in the Government's priority 1 or 2 levelling up categories. Some of these areas also have renewable energy capacity, which may also provide opportunities for workers to

transition, including onshore wind in Port Talbot. While North East Lincolnshire has the largest offshore wind capacity in the country.

Importantly, the viability of CCUS, which could protect jobs in these industries, will vary considerably across different local areas. According to the Industrial Decarbonisation Strategy, larger industrial clusters are expected to be the areas where CCUS is most likely to be financially viable, but CCUS is "less certain" in more dispersed sites, which also lack the infrastructure needed for the deployment of carbon dioxide transportation pipelines. Some of these sites are not only located far away from proposed CCUS infrastructure but are also located in areas of natural beauty such as the Peak District.

Table 6: Local authorities with the highest share of workers employed in emissions intensive heavy industry (RSA analysis of Business Register and Employment Survey 2019; BEIS Renewable Electricity by local authority statistics 2019; HM Treasury Levelling Up Fund – list of local authorities by priority category)

Local authority	Region	Percent employed in heavy industry	Employment in heavy industry	Levelling up priority	Renewable electricity: installed capacity (MW)	Renewable electricity: installed capacity (rank)
Neath Port Talbot	Wales	8.7%	4,355	1	225	47
North Lincolnshire	Yorkshire and the Humber	5.5%	4,225	1	295	34
Clackmannanshire	Scotland	4.5%	680	2	50	175
Amber Valley	East Midlands	4.3%	2,280	2	14	291
Stoke-on-Trent	West Midlands	4.3%	5,195	1	39	199
Redcar and Cleveland	North East	3.5%	1,405	1	176	57
Hartlepool	North East	3.5%	1,080	1	71	137
High Peak	East Midlands	3.2%	1,085	1	9	318
Halton	North West	3.2%	2,115	2	134	76
Stockton-on-Tees	North East	3.1%	2,655	1	105	96
Wyre	North West	3.0%	985	3	34	213
Flintshire	Wales	3.0%	2,250	2	117	89
St. Helens	North West	2.7%	1,705	1	24	238
Rotherham	Yorkshire and the Humber	2.5%	2,510	1	89	112
Ryedale	Yorkshire and the Humber	2.5%	735	2	23	239
Cheshire West and Chester	North West	2.3%	4,035	2	127	81
Vale of Glamorgan	Wales	2.3%	970	2	96	102
North East Lincolnshire	Yorkshire and the Humber	2.2%	1,505	1	1,497	3
Rushcliffe	East Midlands	2.2%	965	3	76	133
East Riding of Yorkshire	Yorkshire and the Humber	2.2%	2,945	2	643	19

Vehicle manufacturing

This industry accounts for a similar share of employment (0.5 percent) as the other sectors considered in our analysis but ranks much lower in terms of its contribution to industry emissions (0.4 percent). However, jobs in these industries are likely to be impacted by both the introduction of new technologies such as electric vehicles as well as modal shifts in the way that people travel and how businesses transport goods. As a recent study by

Volkswagen concludes, it is likely that that these shifts will bring with them, "a complex, interconnected mixture of job creation, job upgrading and job cuts".

Last year, the UK Government announced that 2030 will mark the end of the sale of new petrol and diesel cars. The shift to electric vehicles is expected to create new jobs. For example, Chinese firm Envision plans to boost annual capacity of the UK's first 'gigafactory' from 1.7GWh to 38GWh. The existing site in Sunderland currently makes batteries for the Nissan Leaf. The installation of charging points will also create jobs across the country. According to the ONS, employment in these sectors increased from 11,600 in 2018 to 16,000 in 2019.

However, they note that it is not clear whether this increase relates to the creation of new jobs or a transfer from the manufacture of petrol and diesel cars. The European Commission argue that potentials for net gains in this sector will depend on whether countries have the capacity to become net exporters of electric vehicles and maintain local production of batteries. In the West Midlands, Metro Mayor Andy Street has suggested that it is "mission critical" to secure a similar 'gigafactory' for the region, which could reportedly create 6,000 jobs but will require attracting investment from the private sector.

Workers in the sector will need to upskill or reskill to adapt to new production processes but there are also reasons why these processes are expected to be less labour intensive and require fewer workers. Firstly, electric vehicles have substantially fewer moving parts than internal combustion engine vehicles, which is expected to have significant impacts on some component manufacturers. As Lawrence Burns, former Vice President of Research and Development at General Motors, puts it: "You don't have an exhaust system, so you don't have all those parts and the catalytic converter that goes with it. You don't have the transmission. The transmission has an enormous number of parts — torque converters and clutches and gears". Secondly, elective vehicles are expected to have longer lifespans than today's cars due to reduced vehicle wear. KPMG suggest that modular designs mean that an electric car could have its batteries, electronics and interior replaced as needed while the powertrain and frame continue to operate.

Even more fundamentally, the transition to net zero will require a shift away from car use and ownership and towards other modes of transport, including public transport, walking, cycling and more novel forms of micro-mobility such as e-scooters. As the UK Government's Transport Decarbonisation Plan suggests "a decarbonised transport network does not simply mean changing how we power our vehicles". The arrival of Mobility as a Service (MaaS), which is often associated with autonomous vehicles would represent a shift away from car ownership and towards more on-demand modes of vehicle rentals and transport, resulting in less cars on the road. The UNFCC argue that modal shifts in transport will lead to job losses in car manufacturing, while public sector transportation, infrastructure construction and maintenance and the bicycle sector will all experience growth.

Looking at the 20 local authorities with the highest concentration of employment in these industries, Stratford-on-Avon, in Warwickshire, ranks top. This is where Aston Martin's headquarters are located. In second place is Knowsley, where Halewood manufactures cars for Jaguar Land Rover and transmissions for Ford. More generally, the impacts of decarbonisation on vehicle manufacturing will likely be felt most acutely in areas across the Midlands and Wales. However, some parts of London and the South East will also likely be impacted. The relationship between this decarbonisation dynamic and the Government's levelling up priority categories is less clear than for the other sectors we have considered. 0.6 percent of workers in priority 1 categories are employed in the industry, compared to 0.4 percent in the other two categories. Few of these areas have high renewable energy capacity.

It is important to note that, like for heavy industry, larger industrial clusters may actually be those that are best positioned to benefit from the shift to net zero. Sunderland is already a leader in electric vehicle battery production. However, many of the areas we have identified have smaller clusters of vehicle manufacturing, but which nonetheless provide a significant share of employment for local communities. In some places, like Bridgend, manufacturers have recently announced major closures. The majority of workers in these industries across other parts of Wales are employed in the manufacture of parts and accessories for motor vehicles, which may no longer be needed for all electric vehicles. In Merthyr Tydfil, 71 percent of workers in vehicle manufacturing are employed in the manufacture of vehicle parts and accessories. In Blaneau Gwent, Merthyr Tydfil, Telford and Wrekin, Torfaen and Carmarthenshire this figure is greater than 90 percent.[v]

[v] RSA analysis of BRES 2019

Table 7: Local authorities with the highest share of workers employed in vehicle manufacturing (RSA analysis of Business Register and Employment Survey 2019; BEIS Renewable Electricity by local authority statistics 2019; HM Treasury Levelling Up Fund – list of local authorities by priority category)

Local authority	Region	Percent employed in vehicle manufacturing	Employment in vehicle manufacturing	Levelling up priority	Renewable electricity: installed capacity (MW)	Renewable electricity: installed capacity (rank)
Stratford-on-Avon	West Midlands	10.4%	8,100	2	95	103
Knowsley	North West	8.7%	6,500	1	11	305
Sunderland	North East	8.3%	10,000	1	46	183
Solihull	West Midlands	7.8%	11,100	3	8	326
South Derbyshire	East Midlands	5.9%	2,000	3	32	217
Barking and Dagenham	London	5.2%	3,000	1	9	321
Coventry	West Midlands	5.1%	8,450	2	29	224
Blaenau Gwent	Wales	4.7%	900	1	33	214
Woking	South East	4.7%	2,250	3	6	351
North Warwickshire	West Midlands	3.9%	1,900	2	42	191
Swindon	South West	3.5%	4,100	3	195	51
South Staffordshire	West Midlands	3.3%	1,300	2	58	164
Merthyr Tydfil	Wales	3.0%	700	1	5	354
Nuneaton and Bedworth	West Midlands	2.8%	1,350	2	7	334
Bridgend	Wales	2.8%	1,600	1	144	73
Chichester	South East	2.6%	1,700	3	75	135
Oxford	South East	2.6%	3,200	3	9	322
Telford and Wrekin	West Midlands	2.5%	2,200	3	49	176
Torfaen	Wales	2.4%	900	1	13	296
Carmarthenshire	Wales	2.2%	1,600	1	238	43

NEXT STEPS

The employment impacts of decarbonisation are widely expected to be net positive. A review of 30 studies conducted by the ILO and IILS concluded that meaningful job creation has either been achieved or are possible through the pursuit of climate policies, with most studies indicating net employment gains of 0.5-2 percent globally.

However, as our analysis illustrates, these impacts are likely to be felt unevenly across the UK and most acutely in particular local areas. This should not provide sufficient rationale to slow down the decarbonisation of the economy. Rather the onus should be ensuring areas are well positioned to benefit from these shifts. In some cases, workers will need support to develop the skills needed to transition into hi-tech green jobs. In others, local economies may need to diversify and create good jobs in other growing industries.

We put forward two main recommendations for how to ensure a just transition for workers in communities that will be most affected by the shift to net zero.

1. A just transition fund: we recommend that as part of the 'levelling up' agenda, the UK Government should create a just transition fund to target financial support towards local authorities with the highest share of employment in industries likely to be impacted by decarbonisation. This could be used to support green job creation or diversification into other future industries.
2. Job security centres: we recommend that national and local governments work together to pilot job security centres in these local authorities to provide workers at risk of displacement with end-to-end transition services. This should include experiments with new approaches to welfare such as transitionary basic income.

We conclude by highlighting the importance of involving workers in decision making around the future of their local economies and need for better labour market foresight to assess the impacts of decarbonisation as technological pathways unfold.

A just transition fund

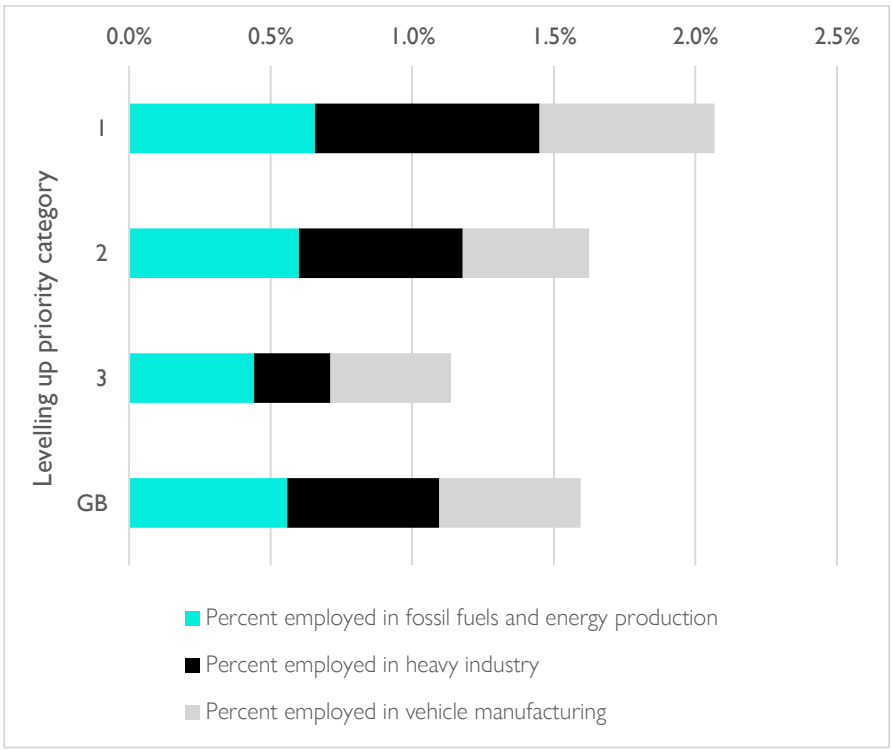
The UK Government has already announced a slate of investment policies to support the transition to net zero, many of which are targeted at the workers and communities identified in our analysis. For example, both the Scottish and UK Government have invested in the Aberdeen Energy Transition Zone, which will help to position the region as an exemplar for low carbon development and support the transition of existing oil and gas workers to renewable energy sectors. While £1bn is available through the CCUS infrastructure fund to support the development of this technology at four major industrial clusters by the mid-2030s, including potentially South Wales and Humberside. However, support to help local economies transition to net zero is not widely available across all the areas identified in our analysis, many of which also have a significant share of employment

in industries that are likely to decline or transform. Critically, there is nothing to support these areas to diversify into other future industries if their potential for green job creation is limited.

We recommend that the UK Government should create a just transition fund to support a range of initiatives that would aid job creation in these areas. This could mirror the fund established by the European Union to help prevent regional disparities increasing as a result of shift to net zero. The EU's Just Transition Fund has a range of uses, including supporting investment in emissions reduction or green technologies, improving digital connectivity or regenerating former industrial sites. A key finding from research carried out by the Institute for Sustainable Development and International Relations (IDDRI) on coal transitions is that there is no one size fits all approach to economic development for regions that need to decarbonise. Pathways could also involve strengthening local entrepreneurial networks or soft attractiveness factors for tourism. For example, in the Czech Republic, the Lower Vitkovice, a former coal mine and blast furnace site has been converted into an educational, cultural and social events hub. The site was decommissioned in 1998 and is now one of the biggest tourist attractions in the country.

In terms of how the funds would be administered, this could follow a similar process to the levelling up fund, whereby local authorities would bid for infrastructure investment or other projects that would support a just transition. At times, these two issues are equivocated, but as our analysis shows the relationship between them is less clear. While in general workers in levelling up priority areas are more likely to be employed in industries that are likely to decline or transform due to decarbonisation, many of the areas highlighted earlier in our analysis, where these impacts will be most acutely felt, are not in the Government's priority 1 category.

Figure 3: Employment in selected industries that are likely to decline or transform due to decarbonisation by levelling up priority category (RSA analysis of Business Register and Employment Survey 2019 and HM Treasury Levelling Up Fund – list of local authorities by priority category)



To access the EU's Just Transition Fund, members states must submit territorial just transition plans, which outline specific intervention areas based on the social and economic impacts of the transition, including expected job losses and the transformation of emission intensive industrial facilities. The EU have devised a range of weighted allocation criteria, including industrial emissions from carbon intensive activities, employment in industry, coal and lignite, and oil and natural gas, and the level of economic development committed to reaching net zero by 2050.

However, a recent discussion paper also highlights, that another option would be to only consider industrial employment in high carbon intensity regions. This could "do away with an unnecessarily complex allocation method, which is arguably not achieving the goal of compensating countries for their expected transition efforts". Similarly, as we have argued earlier in this paper, emission levels or intensity may be a poor proxy for the level of transformation an industry is likely to undergo as it decarbonises.

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Box 2: How much could a just transition fund for the UK cost?

The EU Just Transition Fund has an overall budget of €17.5bn for 2021-2027. One way of estimating the approximate Government investment needed for an equivalent scheme for the UK is to pro-rate these costs based on the number of workers across the sectors covered in this briefing.

According to our analysis of the European Labour Force Survey (EU-LFS), across the EU27 there are 8.7m workers employed in all the sectors that we consider in our analysis, compared to around 800,000 in the UK. Notably, this figure is higher than the estimate from our analysis of the BRES. There are several possible reasons for this. Our analysis of the BRES uses more detailed SIC codes based on our analysis of carbon emissions, which are not available through the publicly available EU-LFS. However, including these in our analysis would only increase the total employment from around 500,000 to 570,000. The BRES also does not include data for Northern Ireland and excludes some self-employed workers and so provides a less suitable point of comparison in this instance.

Basing the fund on this formula would require total investment of around **£1.36bn**. This is less than the £1.7bn (of £4.8bn) already allocated through the levelling up fund, which included £20m each for Aberdeen City Centre Masterplan and Sunderland's Housing Eco-system. Over 100 infrastructure projects that aim to regenerate town centres, upgrade local transport and support cultural assets were funded from this initial round. With £1bn already being made available for CCUS infrastructure and £250m for clean steel, the allocation of just transition funding for local areas should be assessed both in relation to need and receipt of existing investment to help build back better, and greener.

Job security centres

A job security centre, as set out in previous RSA research, is a reimagining of Jobcentre Plus into a universal, end-to-end transition service. Job Security Councils were first developed in Sweden in the 1970s, in response to massive job losses among white-collar workers in the wake of an oil crisis. These non-profit organisations are set up through collective agreements between employers and trade unions. In anticipation of redundancies, they provide an end-to-end transition service that includes information about labour markets, as well as career coaching and access to training opportunities or business start-up support to help workers find new jobs.

The RSA has previously recommended that the DWP, BEIS and DfE work with the Jobcentre Plus to pilot a range of new transition services under the banner of a job security centre. With the devolution of skills funding, this list of stakeholders should also include key local actors, such as local authorities, local enterprise partnerships

and key social innovators operating in a given place. Any pilot should also include the use of new technologies, such as platforms that leverage AI and labour market data to offer personalised coaching to displaced workers. Bob by Bayes Impact, is an example of exactly this kind of platform, deploying a chatbot interface and live labour market information to offer free tailored support for jobseekers in France, Belgium and the UK. Job security centres would also link up with existing Government and industry initiatives around skills and training for the green jobs revolution. For example, users of the service could be recommended for one of the 16,000 Green Skills Bootcamps that are expected to be available across the country in the 2021-22 financial year.

In the long-term, the job security centre would represent a more universal service than the Jobcentre Plus and is needed to mitigate the potential negative impacts of other future of work trends such as digitisation and automation. The need for such a service was further illustrated by the Covid-19 pandemic when the National Careers Service and regional LEPs operating across Berkshire, Buckinghamshire, Oxfordshire and the South West came together to create a Regional Redeployment Service focused on redeploying recently redundant workers into sectors where jobs demand is surging.

While individuals will be expected to periodically adapt to a changing labour market in the future, one of the largest barriers to reinventing themselves will be the loss of earnings from taking time off work to retrain. Yet this might present significant barriers to the short-term too – some workers might cling on to unviable jobs when enrolment in a transition service might prove the better long-term bet.

Therefore, there is also a case for providing a transitional basic income alongside any retraining incentives, so that workers who enrol at the job security centre are compensated more generously than existing out-of-work benefits. For example, in our previous research we have suggested that a transitionary basic income of £2,500 could operate alongside existing Universal Credit entitlements. This approach could be similarly targeted to workers who enrol at a job security centre transition service. The OECD argue that this can strengthen incentives for workers in sectors that are less likely to be viable in the long-term to look for new jobs. The European Commission also emphasise the role that stronger social safety nets can play in supporting workers to transition away from their previous employment and towards future industries.

Conclusion: towards better planning for decarbonisation

Decarbonisation may have a profound impact on some communities, particularly where these industries have provided steady and well-paid jobs to workers, as well as a sense of identity. It is therefore critical that local authorities have power over how these funds can be used and that affected workers are actively involved in the decision-making process around the restructuring of their local economy. This is considered a key lesson from other just transition initiatives such as those in Germany and Canada that aimed to build a consensus around the phasing out of coal. For example, the Taskforce on a Just Transition for Canadian Coal Power Workers and Communities travelled to 15 communities across Alberta, Nova Scotia, New Brunswick, Saskatchewan to engage with workers and their families, local employers and business representatives, trade unions and local authorities.

Alongside our main recommendations, there is a need for better labour market intelligence across the board. Standard Industrial Classification (SIC) codes that form the backbone of official statistics need to better distinguish between green and polluting industries. While new datasets, such as those compiled from online job vacancies, could provide rich insight on what new green jobs are emerging, where they are located, and what skills they require, and therefore which workers are currently well placed to transition.

It is also critical that as the pathways to net zero become clearer, policy makers continue to reassess how decarbonisation will impact workers and adjust their plans accordingly. To understand the past and present, we need better data. But to understand possibilities for the future we must turn to the tools of strategic foresight. Our approach blends these two modes of analysis to provide decision makers with a 'disruption radar' of sorts. While our analysis helps to highlight that potential risks are unlikely to be evenly distributed across the country, further research and analysis is needed. We need a decarbonisation observatory to conduct detailed modelling on how a range of different technological pathways could impact jobs and local economies as well as keep track of which pathways seem most likely as the future unfolds.

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