Green Jobs and Skills in London: cross-London report

Final report

A WPI Economics and Institute for Employment Studies Report for Central London Forward, Local London, South London Partnership and West London Alliance

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Central London Forward (CLF) is a partnership of the 12 central London local authorities. We cover Camden, City of London, Hackney, Haringey, Islington, Kensington and Chelsea, Lambeth, Lewisham, Southwark, Tower Hamlets, Wandsworth and Westminster.

We work together with our member authorities and with other stakeholders to support inclusive and sustainable growth in central London; so that our economy thrives, and our residents benefit from the

opportunities this creates. CLF supports coordination and collaboration across the sub-region, we conduct research and help shape policy development, and we manage large-scale employment and skills programmes in central London.

About South London Partnership

The South London Partnership is a cross-political party sub-regional collaboration of five London boroughs: Croydon, Kingston upon Thames, Merton, Richmond upon Thames and Sutton.

Working together and with partners in and beyond our area, SLP champions and seeks to build on the many strengths of South London as a place for people to live, work and thrive. We are ambitious for our future – for the opportunities it can offer people and businesses and for the contribution we can make to London and the whole of the UK. Building on many years of collaborative working, SLP focuses on issues where working together can add value to what individual boroughs could achieve on their own.

About West London Alliance

The West London Alliance (WLA) is a public sector partnership between seven West London local authorities of Barnet, Brent, Ealing, Hammersmith & Fulham, Harrow, Hillingdon and Hounslow. Our team delivers initiatives in the sub-region, working across borough boundaries and focussing on the priority areas of: economy and skills, employment support, mobility and transport, housing, health and care, and digital.

About Local London

Local London is a partnership of 8 London boroughs of Barking & Dagenham, Bexley, Enfield, Greenwich, Havering, Newham, Redbridge, Waltham Forest in the north and east of the capital working to respond to a set of mutual issues and challenges. Representing around 2.5 million residents and nearly 100,000 businesses, we are a champion for this sub-region to ensure it benefits from existing and emerging opportunities. Our work is varied and wide-ranging. As a collective, our intention is to deliver outcomes which benefit all our member boroughs.

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Executive Summary

This report examines the potential scale and nature of green jobs across London in the coming decades. Further reports focus specifically on each of London's four sub-regions, also providing more detail on London's boroughs.

The green transition will have an impact across a whole range of jobs and sectors. The impacts will be complex, but the combination of stimulus created by investment, the efficiencies created by saving energy and low carbon technologies will result in a net increase in employment overall. Within this, the impact on green sectors themselves will be much larger, as reductions in employment in non-green sectors are offset by large increases in employment in green sectors.

Making this transition a success will depend on creating a workforce equipped to deliver it. If this is achieved, the transition also presents an opportunity to deliver on another London and national priority; ensuring that the recovery from the pandemic creates a fairer and more inclusive economy.

Within all of this, the role of local authorities is clear. Local authorities are at the forefront of planning and delivering the UK's action on climate change. London's role is also clear; it is already a hub for green jobs across the UK and delivering a just transition and inclusive growth in London is a prerequisite and driver for doing the same across the UK.

We have been commissioned by the four sub-regional partnerships in London[1] to form a shared understanding and establish a definition of 'green jobs' and 'green skills' based on best practice and what works in a London context. Based on this definition, this report summarises estimates for the number and nature of green jobs in the capital in 2020 and projections of the number of green jobs and requirements for green skills out to 2050. This quantitative scenario analysis provides a practical tool to shape green skills and employment provision, tailored to the needs of each sub-region within London. These numbers play a dual role; allowing policy makers and employers to understand the demand for green jobs and skills that are needed for green jobs, and informing the size and nature of green skills provision that will be needed from colleges, universities and the wider training sector.

The purpose of the definition for councils in London is practical; understanding what needs to be done to achieve environmental goals. We have therefore recommended a practical "mission-based" definition – green jobs are those jobs that facilitate meeting net zero and broader environmental goals. We have defined 11 specific sectors which are necessary to grow to meet these goals. We find that in several of these there is a substantial opportunity for the sub-regions of London to seize the opportunities of the green revolution and create jobs. In particular, green finance and other green services can be a source of jobs growth for London and underline the role the capital plays in the broader green transition.

Green jobs in London in 2020

We have used a combination of data from the Low Carbon Environmental Goods and Services Sector (LCEGS) dataset commissioned by the Greater London Authority and supervised machine learning from The Data City to estimate the quantity of green jobs. Based on this approach, we estimate there to be some 234,300 green jobs in the capital in 2020, representing 4.4% of total employment in London.[i] There are three sectors which represent more than eight in ten (82%) of total London green jobs. These are:

[i] Throughout this report our figures are Full-Time Equivalents, but we use the term job for convenience

- Green finance (50,700), representing 22% of total green jobs in London.
- Homes and buildings (58,200), representing 25% of total green jobs in London.
- Power (82,900), representing 35% of total green jobs in London.

While all subregions benefit from an increase in green jobs, the nature of these green job varies significantly between the sub-regions. For example:

- Central London Forward hosts a far higher number (and proportion) of "green finance" jobs than the other sub-regions;
- Local London has green jobs that are focussed around "power" and "homes and buildings" (see later for explanation of why);
- West London Alliance performs well across each of the sectors, with no outliers compared to the other sub-regions; and
- The South London Partnership performs well compared to other sub-regions, both in terms of numbers of jobs and the proportion of total jobs, that are taken by "green and blue infrastructure".

Digging deeper into the figures, they show that the City of London is an outlier, with around 60,000 green jobs, substantially more than any other borough. However, there are also notably high estimates in Westminster, Barking and Dagenham, Camden and Islington.

The value of the green economy in London in 2020

The green economy has substantial value to the London economy. Our mapping of the LCEGS dataset to the 11 green economy sectors we have identified allows us to report the total revenue each sector accounts for, in combination with our bespoke Data City company lists for the two sectors not covered by LCEGS. In total we estimate that the 11 green economy sectors accounted for around £42bn of sales in the financial year 2020/21, with the majority from Green Finance (£14bn), Power (£13bn) and Homes and Buildings (£9bn).

Green skills in London

We find that most jobs within green sectors in London are either high level managerial, professional or technical jobs, or skilled craft jobs. In comparison with all employment in London, skilled craft roles are heavily over-represented (19% of green jobs, compared with 6% of all jobs), and managerial and associate professional/technical jobs are also over-represented. There is also a high proportion of graduates in green sectors, reflecting the concentration of employment in managerial, professional and technical occupations.

Our research suggests that the green workforce has a lower proportion of female workers and is less ethnically diverse than the overall London labour market. We find that only one in three green workers are female, compared with 46% of all workers in London, and only 30% are from Black, Asian and Minority Ethnic backgrounds, compared with 36% of all workers. Widening access to green jobs will be important to ensure that the growth of the sector does not reinforce existing labour market inequalities.

Looking at the existing and potential flows into green sectors we find that:

- Green sectors draw in a relatively high proportion of workers from other sectors each year, and fewer entrants from full-time education (only 1% of green workers were in full-time education the previous year, compared with an average of 3% across all sectors). This suggests that attracting people already in work, and re-skilling them where necessary, will be a more important source of new skills for the sector than attracting those leaving full-time education.
- The number of workers in key green occupations but working outside the green economy is more than twice the size of the green workforce, with this potential supply greatest for consultancy and finance (five times the current workforce) and lowest for the homes, buildings and landscape sector (73% of current workforce).
- There were around 22,000 learners in further education in 2018/19 (the most recent full year for which data are available) studying courses that are related to green sectors, at Level 2 or above. The number of apprenticeship starts in relevant sector subject areas was slightly lower, at 20,000, with most in business, administration and law rather than construction or engineering.
- Turning to HE provision, the concentration of universities in London means there is a large number of graduates in relation to the size of the green workforce with degrees in relevant subjects. However, the supply in relation to the existing workforce is highest in business / finance and social studies courses and lower for engineering and physical/environmental sciences.

Projecting green jobs in London in the future

Based on a wide range of evidence on the scale and nature of the future demand for green jobs, we create central, low and high scenarios for each of the green job sectors out to 2050. The total number of green jobs projected under the central scenario rises from 234,000 in 2020, to 505,000 in 2030 and then a little over 1 million in 2050. This represents a 4.5-fold increase in green jobs in London over three decades.

By 2050, there are four sectors which provide nearly 9 in 10 (88%) of the total number of green jobs. These are:

- Green finance (387,000), representing 37% of total green jobs in London.
- Power (232,500), representing 22% of total green jobs in London.
- Homes and Buildings (151,700), representing 15% of total green jobs in London.
- Low Carbon Transport (147,200), representing 14% of total green jobs in London.

Under the high scenario, there are an additional 763,000 green jobs in London compared to the central scenario. However, for the low scenario, total green jobs in London are projected to be 438,000 lower than under the central scenario.

These numbers provide a good picture of the number of green jobs in London and the skills that might be needed. However, they are not additional jobs. In many cases, existing non-green jobs will be lost and replaced with green jobs. This has led many to be concerned about the risk of the transition leading to a net fall in jobs. Based on extending analysis by the CCC, our projections suggest that this will not be the case in London. In fact, the estimates suggests that there will be a small positive impact of a change to net zero policies on London employment, increasing net employment by around 50,000 jobs in 2030 and around 20,000 jobs in 2050.

Projecting London's green jobs skills-gap in the future

The central employment projections suggest an increase in the green-jobs workforce of around 27,000 per year to 2030. Overall, this represents an increase in the total green workforce of 116% from its current level. The numerical scale of the increase in green jobs is similar for the 20 years following that. The key issue is how this increase compares with the current level of skills provision, and how easy it will be for green businesses to meet their future skills needs.

To meet the projected expansion of the sector, green employers will need to support people already in the labour market to acquire the skills they need in these green jobs and recruit significant numbers of people entering the labour market with the requisite skills.

The scale of this requirement is significant. To meet it, green employers would need to attract half of all education leavers with potentially relevant skills, and an even higher proportion if Further Education (FE) leavers progress to Higher Education (HE) rather than entering the labour market. The current analysis of flows suggests that the sector recruits around 2,500 education leavers per year, so this suggests a more than ten-fold increase in business' recruitment from education over current levels.

The relationships between subject areas and the broader green sector are such that it is only advisable to look at the balance between future labour demand and current skills provision at a broad level of consultancy-based jobs and skills, and craft-based jobs and skills. The former covers the consultancy and finance sector, and the majority of the power sector, while the latter covers the homes, buildings and landscape, reduce, reuse, recycle, and the rest of the power sector. The balance of future demand and current supply in these are as follows:

- The number of consultancy-based jobs is projected to increase by around 13,400 per year over the coming decade, while current FE and HE provision is around 41,500 students per year, so future demand equals 32% of the annual output from education.
- The increase in craft-based jobs is projected to be similar, at around 13,600 per year, and provision is smaller, at around 23,000, so future demand is a higher proportion of current education provision than in the consultancy-based side, at 59%.

These analyses show there is an urgent need to increase education provision in subjects and courses that are relevant for green jobs, and to support those in already in the labour market in non-green jobs to, retrain and upskill to acquire the skills that they need, in order to meet the rapid expansion of the sector over the coming decade. More of those taking these subjects and courses will also need to navigate themselves into the green sector.

Jobs at risk from decarbonisation and equalities impacts

Looking at carbon intensive industries, we find that London has 390,000 jobs that are most at risk from the transition, 7% of total employment (as compared to 11% nationally). The majority of these jobs in London are in three sectors; Construction (205,000), Land Transport (112,700) and Aviation (37,000).

Although it is not possible to get demographic data at a detailed industrial sector breakdown, we can establish the likely picture by using the broad section level SIC codes for each of eleven carbon

intensive areas. If we assume that the carbon intensive activity will be approximately in line with the broad SIC section it sits within, then the following picture emerges:

- 38% of people in employment in London in the sectors highly exposed to transition are identified as non-White versus 11% nationally. However, this is in line with London employment as a whole where 36% of people in employment identify as non-White;
- The national data suggest that the carbon intensive industries have relatively more male employees, with female workers accounting for only 18% of the employees. London data is not available for many of the SIC codes from the ONS unfortunately; and
- There is no strong pattern in the age of workers in the eleven carbon intensive sectors.

Overall, it is clear that, wherever the impacts of the transition fall, there are potentially significant changes to many people's jobs. As London's population is more diverse than that of the country as a whole (in terms of ethnicity and a range of other characteristics),[2] changes in London will also be likely to overlay on existing inequalities felt by these diverse groups and communities.

However, there is also a significant opportunity attached to the green transition. London is one of the most inequitable places in the UK, with huge inequalities in pay, qualifications, health and outcomes such as poverty and deprivation. The changes that we are about to see through the shift to green sectors provides an opportunity to turn those around. With the right skills provision, and support both for those needing to transition from non-green jobs and those not currently in work, the green sectors identified in this report could provide the higher-skilled, more productive, stable and better-paid work that many families in London need to be able to make ends meet. By doing so, as well as driving a just transition, these green jobs could also drive inclusive growth and tackle the underlying inequalities that have existed in London for decades. We hope that this report provides at least part of the evidence base that is needed to build an understanding of how this might happen.

1. Introduction

The Covid-19 pandemic has caused disruption on an unparalleled scale, altering day-to-day lives and leading to a deep economic recession. Much Government effort has understandably been focused on mitigating the social and economic impacts of the health crisis. However, while the world has turned its attention to responding to the pandemic, the need for urgent action to tackle the climate emergency has not disappeared. The existence of this dual challenge has been widely acknowledged; a broad range of organisations have called for the economic recovery from the Covid-19pandemic to be one which simultaneously addresses the climate emergency, and the UK Government has committed to this approach.

With the transition to net zero already on the Government's agenda – solidified through making a legal commitment in 2019 to achieving this target – this dual challenge also provides a timely opportunity. Last year the Government's Ten Point Plan for a Green Industrial Revolution outlined policies and investments to achieve this with explicit link to the recovery from the Covid-19 pandemic and job creation.[3]

A successful transition depends on a workforce equipped to deliver it. The prospect of new, 'green jobs' to drive net zero comes at a period of considerable change to ways of working, increased levels of workers considering a career change,[4] and increased unemployment.[5] Moreover, research shows there is considerable interest among the workforce in jobs with an environmental purpose.[6] In this respect, the transition also presents an opportunity to deliver on another national objective; ensuring that the recovery from the pandemic creates a fairer and more inclusive economy. A range of recent research has shown that inequality was a major issue for the UK and London prior to the pandemic and that the health, economic and social impacts of the pandemic have widened and deepened inequalities. Future changes, including the transition to net zero, present significant risks to many of the same groups that have already been hard hit. That makes managing the labour market impacts of the transition both a challenge and an opportunity.

Within all of this, the role of local authorities is clear. Local authorities are at the forefront of planning and delivering the UK's action on climate change. The Climate Change Committee has highlighted that over half of the necessary emissions cuts rely on local solutions, and a third of emissions are under the purview of local authorities, in areas such as buildings and transport planning, waste and environmental risk management.[7] Local authorities are already rising to the challenge, with three-quarters of councils having declared a climate emergency.[8] This includes almost all of London's councils, and the majority of these have published climate action plans detailing current and planned measures to meet the net zero goal, by or before 2050 (see Annex).

Together, this means that there is clear national and local consensus around the need to push forwards a greener economy that can address the combined challenge of the climate emergency and the substantial economic challenges raised by the pandemic, as well as driving more inclusive growth.

The role of London in this is also clear:

- By one definition, the green economy is worth £48 billion to the London economy each year, rising from £30 billion in 2014/15;[9] and
- London is also crucial to the UK's economic recovery, accounting for 24% of the UK's GDP,[10] despite only accounting for 13% of the UK's population.[11] In fact, for every person in London, the Government raises £4,000 more in revenue than it spends; making London one of only three regions to make a net contribution to the Exchequer.[12]

However, the pandemic has hit the capital hard on a number of measures.

- Economic activity fell by 7.2% in 2020.[13]
- At the start of 2021, employment levels in London had fallen by more than 6 percentage points compared to the start of the pandemic. This meant that there were around 240,000 fewer payrolled employees.[14]
- Despite the recent recovery in the labour market, payrolled employees remain down by close to 75,000 (nearly 2%) compared to a slight increase in payrolled employees across the UK overall.[15]

A recent WPI Economics report for Central London Forward explored this phenomenon further to show that - across a range of measures – London had been hit harder by Covid than other parts of the country, and that pre-existing inequalities were exacerbated by the pandemic. :[16]

This means that making this a success in London is vital for the capital itself, and the rest of the UK. To shape this green economic recovery, and grasp the opportunities to drive inclusive growth, local authorities across London need a firm understanding of the jobs that make up the green economy now, how the labour market might change in the future and what skills people will be required to contribute effectively to the changing economy. This will enable the four sub-regional partnerships, London's boroughs and other public authorities to:

- Develop local economic policies to drive growth in the green sector.
- Develop skills and employment policies to ensure all London's residents have access to the skills and support they need to enter and sustain good work.
- Develop a shared public narrative on green jobs and skills to emphasise and explain London's collective commitment to de-carbonisation.
- Provide an evidence base for communication with residents, careers advisers and community groups on what the green transition means for jobs and skills.

We have been commissioned by the four sub-regional partnerships in London[17] to form a shared understanding and establish a definition of 'green jobs' and 'green skills' based on best practice that works in a London context. Using this definition, we quantified the existing size and nature of the green economy in London, and then produced quantitative scenario analysis to provide a practical tool to shape green skills and employment provision, tailored to the needs of each sub-region within London. These numbers play a dual role; allowing policy makers and employers to understand the skills that are needed by green jobs, and for informing the size and nature of green skills provision that will be needed from colleges, universities and the wider training sector.

Given the range of existing definitions and approaches in place, chapter 1 considers the definition of 'green jobs' and 'green skills' and provides an overview of current Higher Education / Further Education skills provision in London. The research has been informed by desk-based research, along with extensive consultation with Skills & Employment Officers and Recovery Leads from across London boroughs, representatives of Central London Forward's Employment and Skills Board, Further and Higher Education institutions, London Councils, Greater London Authority economics and green skills leads and others including representatives of the Office for National Statistics, Green Alliance, and ReLondon.

2. Definitions of green jobs and skills

'Green jobs' and 'green skills' do not have respective standardised definitions, neither at a national nor global level. Instead, there are numerous existing definitions and approaches which seek to capture jobs or industries that undertake environmental activities. Among them are several officially-recognised statistics and definitions, as well as those specific to an organisation or study. The criteria for existing definitions differ on what industries or activities should be included, how to account for indirect jobs and supply chains, and whether certain industries (and jobs themselves) fall neatly under a 'green'/'non-green' split. We considered six approaches, outlined below.

Environmental Goods and Services Sector (EGSS) (UK)

The ONS produces National statistics for the Environmental Goods and Services Sector (EGSS), including an estimate of the sector's employment. The environmental sector is defined as: ***"areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources."*** [18] 17 industries are included in the definition, including waste, production of renewable energy, and environmental consultancy and engineering.

The EGSS approach is produced as an official statistic and is therefore robust and credible. In addition, it follows an international framework set out by the UN System of Environmental accounting, making it internationally comparable.

However, this approach also presents some key limitations; in particular, it excludes many new and emerging industries as it is based on Standard Industrial Classification (SIC) codes last updated in 2007. An example of an excluded sector is green finance, which is significant to London's green economy. In addition, the EGSS approach does not account for potentially substantial variation in environmental impact of different goods and services within the 'green' sector.

Low Carbon and Renewable Energy Economy survey (LCREE)

The Low Carbon and Renewable Energy Economy (LCREE) survey is a survey also undertaken by the ONS. The definition of the 'low carbon and renewable energy economy' is ***"economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide"***.[19] 17 sectors, different from the sectors in the EGSS definition, are included under the LCREE definition, including carbon capture and storage, hydropower and low carbon financial and advisory services. Again, this approach is from a credible source, and another benefit is that the LCREE accounts for low carbon and renewable energy activities across a range of sectors, meaning that many relevant 'green' activities are included even if the overall businesses is not in a 'green' sector.

The LCREE approach does exclude key environmental activities, however, including those involved in recycling or biodiversity. Like the EGSS approach, it also excludes green finance.

Low Carbon and Environmental Goods and Services Sector (LCEGS)

The Low Carbon and Environmental Goods and Services Sector (LCEGS) dataset captures environmental, renewable energy and low carbon activities in the UK. The LCEGS measure expands on the EGGS approach to capture ***"all activities that contribute and enable growth in the sector"*** – including companies' whole value and supply chains:[20] ***"Those elements which are excluded from EGSS which are produced for purposes that, while beneficial to the environment, primarily satisfy technical,***

human and economic needs or that are requirements for health and safety are included in LCEGS if they contribute to the sector"[21]

The methodology is designed to capture a much more complete measure of the green economy's characteristics, and specifically aims to address the limitations of measures based on outdated industrial classifications. It explicitly includes green finance, and therefore reflects important changes in the London economy well.

Task-based definitions

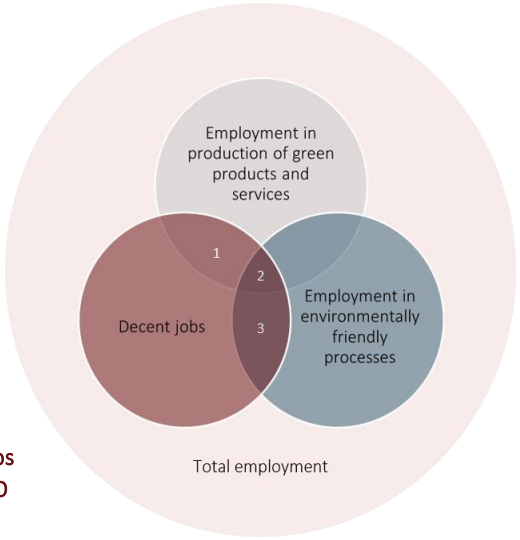
A recent research angle has been to try to identify the tasks within jobs that can be classified as green, such as work by Vona et al. (2018).[22] The method breaks away from a definition that defines a job as either green or non-green, instead considering all jobs to be on a continuous spectrum of 'greenness'. This is determined by a job's time dedicated to green activities relative to time devoted to non-green activities.[23] This approach allows a nuanced understanding of how the labour market is 'greening' over time, including where portions of jobs are becoming more (or less) green. It is also well-suited to identifying implications for skills policy as it focuses on how activities undertaken in jobs are changing.

The application of this approach in a UK context is difficult because the level of detail in the job task data that is available in America (studied by Vona et al.) is not available in the UK. This meant that this approach is outside of the scope of this project. However, we note that the GLA are currently undertaking a project to explore this approach in the UK context that may be a useful companion to our work.

International Labor Organization and decent jobs

The International Labour Organization (ILO) defines green jobs as jobs in any sector or business which ***"…reduce the consumption of energy and raw materials, limit greenhouse gas emissions, minimize waste and pollution, protect and restore ecosystems and enable enterprises and communities to adapt to climate change. In addition, green jobs have to be decent."***[24] This requirement stems from the ILO's recognition of the importance of a just transition (see box 1) in efforts to decarbonise the economy.

Figure 1: The International Labor Organization's approach to defining green jobs



Sections 1, 2 and 3 represent green jobs according to the ILO criteria.

Source: Adapted from ILO

By including "decent jobs" as a requirement, this definition integrates desirable outcomes beyond just environmental goals, highlighting the dual opportunity presented in greening the economy. This also aligns with the inclusion of a Just Transition in the UK's green policy agenda, as well as London's agenda itself.[25] However, this dimension also adds complexity to applying the definition to measure the number of green jobs, and excluding poorer green jobs from counts means these cannot be monitored and thus potentially addressed by decision-makers.

Box 1: Just Transition

Though the linking of environmental protection with creating employment and good working conditions has been stated by trade union movements for over 20 years, the concept of a Just Transition has become an integral part of the environmental agenda more widely in recent years, notably included in the Paris Agreement (2015) and in the UK's green policy landscape regarding upskilling required for the transition, good quality jobs and equipping people to benefit from net zero.

Though the concept is used in a range of frameworks and agendas, the general principle centres around moving towards a more sustainable economy while creating decent work and ensuring that a transition to a more sustainable economy does not leave communities behind.

It is important to consider the distributional impacts of a net zero transition in a London context. Looking at the sectoral employment breakdown we find that the Central London Forward sub-region has the highest proportion of overall employment but also the highest proportion of jobs in sectors such as finance that account for very low proportions of London's emissions. There are concentrations of industrial activity in other areas of London – for example 12% of jobs in the West London Alliance sub-region are in transportation and storage, an industry which across the capital accounts for over a third of London's GHG emissions. Meanwhile, the Local London area has the highest proportion of manufacturing and construction jobs; manufacturing accounts for 12% of the capital's GHG emissions.

Sources: UN Framework Convention on Climate Change (UNFCC)[26], UNFCC[27], Green Jobs Taskforce[28], GOV.UK[29], Just Transition Commission[30], GLA Economics[31], WPI Economics analysis

"Mission-based" definition following Green Jobs Taskforce

The recently published report from the independent Green Jobs Taskforce, established by the UK Government, reviews definitions of green jobs and finds that setting a single definition of a 'green job' that can be applied to the whole economy is a complex task. The Taskforce decided to take a broad approach, which goes beyond simply looking at low carbon sectors, and to focus on a sectoral approach linked to the policies and activities required to meet the country's environmental goals.

They therefore use the following definition of a green job: ***"employment in an activity that directly contributes to - or indirectly supports - the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks."*** We refer to this approach as a "mission-based" definition as it defines green jobs with respect to achieving environmental policy goals.

The Green Jobs Taskforce identify seven sectors / policy areas, prioritising those that are crucial to meeting net zero and where the evidence is clearest**; Power, Business and industry, Homes and buildings, Transport, Natural resources, Enabling decarbonisation and Climate adaptation**.[32]

The advantage of this approach is that it allows analysis based on the definition to account for the full range of economic transformation needed to deliver the UK's environmental goals, and the evolving nature of the transition to net zero. Skills policy developed from this definition can therefore be directly linked to the achievement of environmental policy goals. On the other hand, a mission-based approach could result in an evolving definition over time as policy changes. From a statistical point of view this is a significant disadvantage as comparisons over time will be harder, but from a practical point of view this would reflect evolving policy. Another consideration is ensuring that the definition is

not so broad that it becomes less useful while not being so narrow that important supporting activity is excluded.

A London sub-regional partnership definition of green jobs

The majority of the feedback from our stakeholder sessions when presented with the approaches outlined above was that the need for a common definition of green jobs for London boroughs arises from the practical questions that arise for policy makers – how will the labour market change during the net zero transition, what do skills providers need to plan for and what support do they need, and what programmes and policies are required to support citizens and make a strong green economy?

Hence for the purpose of this work we have developed a mission-based definition which prioritises practicality and a strong link to both net zero and broader environmental goals, making it clear to understand and apply to policy. We could also use modern methods described below to identify the specific London companies that fall within such a definition to produce something that really speaks to the work of boroughs across London.

With practicality, applicability and political salience in mind, we have adapted the approach employed by the Green Jobs Taskforce to better reflect London's labour market and business makeup, informed by our literature review and stakeholder engagement. The adapted list of sectors / policy areas is presented in Box 2 on the following page. This uses many of the Green Jobs Taskforce sectors but specifically splits areas with a net zero focus from a broader environmental focus and separately identifies Green Finance and the areas of climate change research & development, strategy, policy, monitoring & planning, and climate adaption. Crucially, this adapted list of sectors is tailored to the unique shape of the economy in the capital, its needs in terms of adapting the transition and greater climate risk, as well as the role it can play in helping the rest of the UK and the rest of the world in mitigating against catastrophic climate change.

For the purposes of this work, the definition of 'green skills' is based on the skills needed for the jobs identified within the various policy areas identified above.

Box 2: Mission-based definition: proposed sectors for a London based definition

Net zero focus

1. **Homes and buildings:** Including retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen boilers.
2. **Low carbon transport:** Including low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling.
3. **Power:** Including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology.
4. **Industrial decarbonisation, hydrogen and carbon capture and storage**: Including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation.
5. **Green Finance:** The concentration of financial activity in Central London means that in our context Green Finance could be a key area to identify separately.
6. **Climate change research & development:** Including private sector, academic and public research.
7. **Climate change strategy, policy, monitoring and planning:** Including public, private and NGO sector strategy and policy, outreach to citizens, environmental monitoring and use of planning system to achieve net zero.
8. **Climate adaption:** Including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation.

Broader environmental goals (may have some impact on climate change goals)

9. **Reducing localised pollution:** Including air pollution, water pollution and noise; London has ambitious goals across all three of these areas.
10. **Reduce, reuse, recycle:** Including waste management and circular economy.
11. **Green infrastructure:** Within a London context this will focus on urban green infrastructure, and include activity aimed at increasing biodiversity directly or through offsetting.

Source: WPI Economics

3. Green jobs and skills in London today

Quantifying green jobs in London

This chapter uses the mission-based definition to examine the number and type of green jobs in London today (throughout the remainder of this report our figures are Full-Time Equivalents, but we continue to use the term job for convenience). To quantify the gross number of jobs in London in the eleven green sectors we use two sources:

- **The Low Carbon Environmental Goods and Services (LCEGS) sector dataset:** This dataset is prepared by the consultancy kMatrix and commissioned regularly for London by the Greater London Authority.[33] This dataset includes a broader set of activities than official definitions such as the ONS EGSS and LCREE data, including green finance, and includes the supply chain for green activities as well as the activities themselves.[34] However, we could not map our Climate Adaptation and Green and Blue infrastructure sectors sufficiently well so used the Data City tool discussed below. This dataset includes all green jobs, including in firms that are not wholly part of the green economy.
- **The Data City Real-Time Industrial Classification tool:**[35] This guided machine learning tool allows us find companies working within specific fields, based on the way companies describe themselves on their websites. We worked with the Data City team to provide an initial "training set" of companies and keywords, and then iteratively improve the results by guiding the machine learning algorithm on which companies should be excluded or included. This tool allows us to identify data for the two sectors that the LCEGS data does not and identify a broad range of companies within each sector that are operating within London. As it is a tool geared towards finding companies, it is more limited in its ability to identify green jobs within firms that are not fully within our definition of the green economy.

More details on these datasets and their pros and cons can be found in our interim report, attached as an annex.

To allocate the jobs identified within LCEGS to our sectors we have:

- Mapped data from the 2017/18 LCEGS dataset to our green jobs categories, using "level 3" data from this dataset which looks at 127 distinct industrial activities.
- Estimated 2020 job figures using UK growth rates from the most recent LCEGS estimates.[36] London figures for the period 2018/19 to 2020/21 have not been published yet, so we have currently assumed that growth for London has been in line with UK growth rates.

Based on this approach, Table 1 summarises the main results in terms of the numbers of green jobs in the capital in 2020. It shows that we estimate there to be some 234,300 green jobs in the capital, representing 4.4% of total employment in London. Based on historical estimates from kMatrix for the Greater London Authority, we estimate this is around a 50% increase from 2010. There are three sectors which represent more than eight in ten (82%) of total London green jobs. These are:

- Green finance (50,700), representing 22% of total green jobs in London.
- Homes and buildings (58,200), representing 25% of total green jobs in London.
- Power (82,900), representing 35% of total green jobs in London.

Table 1: Number of green jobs in London, 2020

Sector	Definition	London	
		Numbers of jobs	% of total employment
Climate adaptation	Including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation	2,500	0.05%
Climate change Research and Development	Including private sector, academic and public research	3,700	0.1%
Climate change strategy, policy, monitoring and planning	Including public, private and NGO sector strategy and policy, outreach to citizens, environmental monitoring and use of planning system to achieve net zero	4,100	0.1%
Green and blue infrastructure	Within a London context this will focus on urban green infrastructure, and include activity aimed at increasing biodiversity directly or through offsetting.	1,600	0.03%
Green finance	Structured financial activity that's been created to ensure a better environmental outcome	50,700	0.9%
Homes and Buildings	Retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen boilers	58,200	1.1%
Industrial decarbonisation, hydrogen and carbon capture	Including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation	900	0.02%
Low Carbon Transport	Low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling	13,700	0.3%
Power	Including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology;	82,900	1.5%
Reduce, reuse, recycle	Waste management and circular economy	14,500	0.3%
Reducing localised pollution	Reduction of air pollution, water pollution and noise; London has ambitious goals across all three of these areas	1,600	0.03%
Total		**234,300**	**4.4%**

Source: WPI Economics calculations based on data supplied by kMatrix on their Low Carbon Environmental Goods and Services methodology and The Data City, and ONS Business Register and Employment Survey for total employment by sub-region

Note: Our total green jobs estimate is slightly lower than that identified by kMatrix for London as we do not include some activity in the water sector and waste collection where it does not fall within the scope of our mission-based definition

The estimates for jobs in Climate Adaptation and Green and Blue Infrastructure have been taken from analysis of these sectors through supervised machine learning undertaken with Data City. These may be underestimates as the method is limited in its ability to identify green jobs within firms that are not fully within our definition of the green economy.

Sectoral breakdown across London

The following sections provide more detail on each of these areas; giving context around the current state of each of the sectors, their relevance for London and the key policy and practical considerations which are likely to drive future growth (or otherwise) in each sector.

Homes and buildings

Sector	Definition	Number of jobs	% of total employment
Homes and Buildings	Retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen boilers	58,200	1.1%

The need to decarbonise the building stock has been described as the greatest challenge of decarbonisation. There are a range of reasons for this, including the sheer scale of the operational task of retrofitting all buildings, the current ubiquitous use of gas to heat homes, as well as the relatively underdeveloped nature of the use of heat pumps. In London, homes and workplaces are responsible for 78% of the capital's carbon emissions.[37]

A relatively strong degree of progress in reducing emissions in the years up to 2015 has been followed by a period of stagnation. A programme of deep building decarbonisation is, at best, in early stages of development. This is clearly demonstrated by the fact that current estimates suggest retrofits of around 30,000 homes a year nationally, whilst some 30,000 a week are needed to get to net zero.[38]

London has a strong commitment to tackling emissions from buildings, and there are a number of actions set out by the GLA as well as London's local authorities in their climate action plans.[39] The Government has provided local authorities with funding in the form of the Sustainable Warmth competition to facilitate action at a local level, however, this is highly limited in its funding and scope given the scale of the challenge. [40]

The Heat and Buildings Strategy sets out £5000 grants over the next 3 years for the installation of heat pumps, with further money public buildings and social housing, and consults on market-based regulations on manufacturers to increase heat pump sales. It emphasises no or low-regrets actions now to help drive innovation and scale the market for low carbon heating, with further key strategic decisions to be taken in the coming years – this includes a 2026 decision on the role of hydrogen in heating.[41]

Low carbon transport

Sector	Definition	Number of jobs	% of total employment
Low Carbon Transport	Low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling	13,700	0.3%

Surface transport is the largest sectoral source of carbon emissions across the UK according to the CCC, and there was no progress in reducing overall emissions between 1990 and 2020. Strengthening take up of electric vehicles (EVs) is a key element of any successful strategy to address these emissions, and this is a change that is happening rapidly, albeit from a low base. Registrations of Battery Electric Vehicles (BEVs) are up 87.9% on last year, and now represent almost 10% of all new vehicle registrations (Sept 2021 YTD).[42]

The take up of EVs is underpinned by a relatively clear long-term policy roadmap which will see the sale of new petrol and diesel vehicles banned from 2030. Furthermore, London has made significant positive progress in deploying charging infrastructure needed to support the shift.[43]

Table 2: Delivery plan of modelling of infrastructure requirements and current infrastructure availability in London, according to ZapMap

	EV Infrastructure Taskforce requirements for 2020 (Delivery Plan modelling)	Actual charge points in London (ZapMap data, August 2020)	Requirements for 2025 (Delivery Plan modelling)
Total rapids	200 - 400	c.450	2,300 - 4,100
Total fast and slow	3,400 - 4,700	c.5,600	33,700 - 47,500

Source: London Electric Vehicle Infrastructure delivery plan

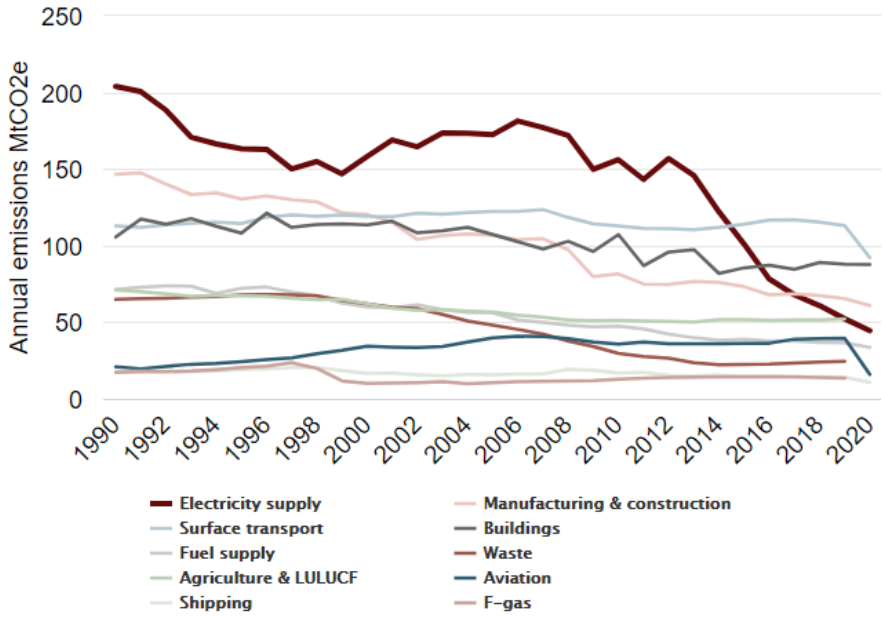
Greater use of alternatives to cars are also essential to deliver this change. Even with a very substantial increase in the deployment of EVs, at least a 10% modal shift towards public transport is needed to meet climate targets.[44] In London, strengthening of public transport such as through Crossrail has the potential to facilitate the shift away from cars.

Power

Sector	Definition	Number of jobs	% of total employment
Power	Including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology	82,900	1.5%

The decarbonisation of the UK's power sector is the greatest success story to date in terms of emissions reduction. The graph below (figure 1) shows the radical reduction in emissions from this sector since the late 2000s, relative to stubbornly high emissions from other areas.[45]

Figure 1: Estimations of UK emissions by sector



Source: CCC progress report 2021[46]

Over the coming years, the key target in this space for policymakers is phasing out of the use of coal by 2024 as well as unabated natural gas by 2035, as confirmed by the Government in its Net Zero Strategy Achieving the latter would involve a radical acceleration in the development of new renewable and low carbon energy generation, with the Government aiming for 40GW of offshore wind by 2030, and committing to a decision on a new nuclear reactor by the end of this Parliament.[47] Coming with this is a need for a more flexible and resilient energy system, with transmission and storage being carried out as effectively as possible.

In London, as well as some power generation, a substantial element of this sector is likely to be the latter elements in terms maintaining and upgrading the grid, as well as supporting battery storage and demand side response at a local level. In addition, London will be host to many of the head office functions of companies in each of these sectors, which will host employees in a range of roles working to support the expansion in renewables across the country.

Industrial decarbonisation, hydrogen and carbon capture

Sector	Definition	Number of jobs	% of total employment
Industrial decarbonisation, hydrogen and carbon capture	Including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation	900	0.02%

Decarbonising this area, particularly heavy industry, is a significant challenge in tackling climate change. Many of the processes involved in this space are highly energy intensive, and this energy has often historically been fossil-fuel based. Technologies needed to address this, including the use of hydrogen (particularly clean hydrogen) and CCUS are proven in and of themselves, but not yet commercialised and deployed at scale. The Government's industrial decarbonisation strategy emphasised the need for greater use of energy efficiency measures, such as heat retention, in the 2020s plus the testing of battery and hydrogen-based industry as well as CCUS. In the 2030s, this technology rolled out more broadly based on learnings of this kind of testing, according to the strategy.[48] As part of the Net Zero Strategy, the Government announced an Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) scheme to provide funding for new business models.[49]

While the numbers in London are small at the moment, almost certainly due to the relatively high cost of land in the capital, stable growth will result in at being a sizeable area of employment over the coming decades.

Green Finance

Sector	Definition	Number of jobs	% of total employment
Green finance	Structured financial activity that's been created to ensure a better environmental outcome	50,700	0.9 %

Climate change poses a number of risks to the financial system, and there is a need for activities which protect companies and institutions both in terms of:

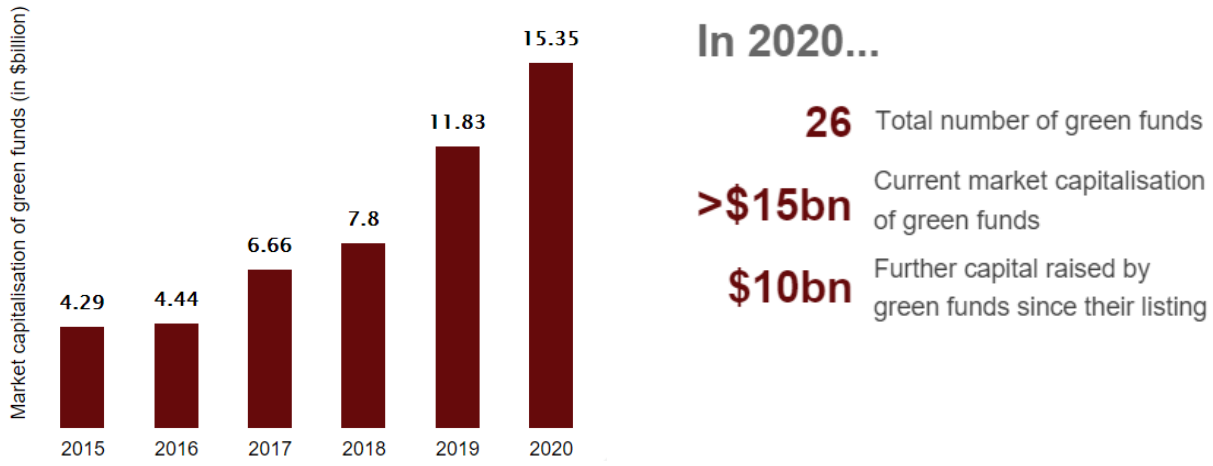
a) **Physical risks** – weather and climate based events which cause damage to a company or financial institution's assets (eg real estate investments), and wider financial or economic consequences of this damage .

b) **Transition risks –** policies to reduce emissions over the coming decades could affect the viability of certain sectors, e.g. fossil fuel companies, and if these companies and institutions don't transition away from these activities in a timely and orderly way, this could have sudden negative financial impacts.

Furthermore greening the finance sector has the potential to create financial capital which can support the green transition. Analysis by Boston Consulting Group (BCG) for the Association of British Insurers found that – underpinned by the right policy framework – insurers and pension funds could invest around £900 billion in delivering net zero.[50]

Currently, alongside the LCEGS data, a number of things point to strong growth potential for green finance in the UK. One of these is data from the London Stock Exchange (LSE) which shows the growth in green funds listed on the LSE, now with a capitalisation of $15bn. [51]

Figure 2: Market capitalisation of green funds ($ billion)



Source: London Stock Exchange, November 2020

In addition to this, the rollout of mandatory Task force on Climate Related Financial Disclosures (TCFD) requirements will accelerate the need to carry out financial analysis to support these disclosures. Furthermore, the Government has set out a range of further measures to support sustainable investing, including the implementation of a UK green taxonomy, and plans to consult on the mandatory disclosure of climate transition plans. All of this is likely to result in the growth of the green finance sector, and jobs as a result.[52]

As well as being a major source jobs in the capital, green finance is a vital way in which London can help deliver an orderly transition away from fossil fuels both in the rest of the UK and in the world. The unique financial ecosystem in the capital means it is well placed in terms of resources and expertise to play such a role.

Climate change research & development, strategy, policy, monitoring and planning

Sector	Definition	Number of jobs	% of total employment
Climate change Research and Development	Including private sector, academic and public research	3,700	0.1%
Climate change strategy, policy, monitoring and planning	Including public, private and NGO sector strategy and policy, outreach to citizens, environmental monitoring and use of planning system to achieve net zero	4,100	0.1%

Related to green finance, there are a range of other services that help to facilitate the green transition. These are broad in nature, many of them are part of the professional services sector which is often also clustered around financial services, such as strategic and environmental consulting, and others are aligned to or fit neatly into the NGO sector. Furthermore, as evidence by the significant

impact that innovation has on the different pathways in the CCC Sixth Carbon Budget, different companies that focus on Research and Development in this space are also an essential element of a strategy to hit our climate targets.

Each of these sectors has prominence in London and, much like green finance, are central to the capital's role in delivering the low carbon transition.

Climate adaptation

Sector	Definition	Number of jobs	% of total employment
Climate adaptation	Including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation	2,500	0.05%

In addition to climate change mitigation, climate change adaptation is gaining importance as an issue for the UK. In its updated Climate Change Risk Assessment (CCRA) from June this year, the CCC notes that the gap between the risk that the UK faces from climate change and the level of adaptation underway has widened since its previous risk assessment in 2017.[53] Much of the effects of climate change, particularly those between now and 2050, will not be significantly altered by how the UK reduces emissions.[54] As a result, adaptation is essential across the country.

Protecting London's building stock from the effects of climate change will be a particular issue, including, for example, protecting buildings from extreme heat, as well as adapting to challenges posed by the reduced supply and increased demand for water. However, this will require a step change in the sector, which at present is heavily dominated by firms involved in flood risk management

As well as adapting, the sector will also need to grow significantly in London to meet the growing need to manage flood risk. While the whole country faces rising flood risk, London faces a specific challenge in the context of the long-term viability of the Thames barrier.[55] Furthermore, mapping by NASA suggest that much of London – particularly South and East London - could be regularly underwater by the end of the decade.[56] Natural flood risk management, large scale flood risk engineering schemes, as well as property flood resilience will need to play a bigger role, and all these have a potential to be a source of employment.

Reducing localised pollution

Sector	Definition	Number of jobs	% of total employment
Reducing localised pollution	Reduction of air pollution, water pollution and noise.	1,600	0.03%

Localised air, noise and water pollution have well publicised detrimental impacts to the health of the population and in the case of water pollution, aquatic life.[57] The London Environment Strategy

outlines an ambition for the capital to have the best air quality of all major world cities by 2050. Some measures are already in place to meet ambitious targets set out by the Mayor, such as the Ultra-Low Emission Zone (ULEZ), which contributed to a 44% reduction in nitrogen dioxide in ULEZ areas.[58] Furthermore, actions to curb emissions under a number of other areas – such as industrial decarbonisation, transport, and blue and green infrastructure – will contribute to localised pollution outcomes alongside their decarbonisation goals. However, aspects such as the volume of road transport in the capital, the density of the population and urban infrastructure make localised pollution – particularly air pollution – a key area of concern. Some actions to tackle this issue are outlined below.

The Mayor's Air Quality Fund consists of £22 million over 10 years to support 11 projects to improve air quality.[59] These include zero emissions zones, encouraging active travel and assessing construction equipment to ensure construction projects are undertaken with clean equipment.[60] Published borough-level climate action plans outline 33 actions on air quality (compared with 404 for low-carbon transport and 295 in retrofit, for example). A third of these are in implementation of anti-idling policies for vehicles. Five are in the creation or piloting of clean air neighbourhoods and clean air zones, supporting communities to improve local air quality, while another five are in council actions regarding developing air quality action plans.

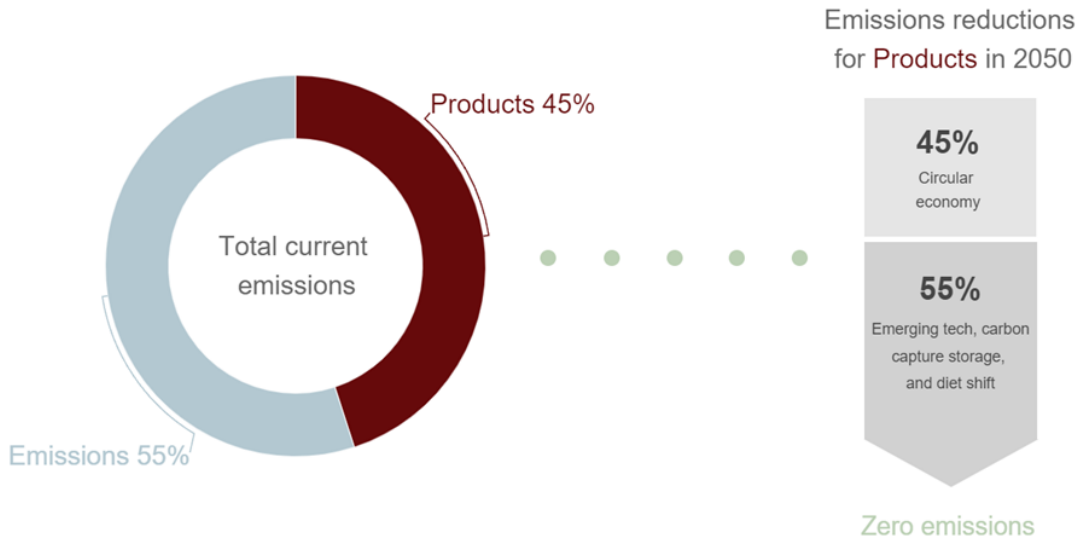
Growth in jobs may not be particularly strong in this sector. Much of the environmental improvement comes from new regulations that influence other sectors and individual behaviour. For example, ULEZ regulations incentivise the production and purchase of new, cleaner cars – with associated new jobs likely to be in the broader automotive sector and therefore predominantly outside London. However, the requirement to monitor strong air quality targets and to tackle water pollution alongside other goals to increase biodiversity mean that we can still expect some growth in this sector.

Reduce, reuse, recycle

Sector	Definition	Number of jobs	% of total employment
Reduce, reuse, recycle	Waste management and circular economy	14,500	0.3%

Tackling consumption-based emissions must be central to tackling climate change (see below). Success will require a shift towards the circular economy, as well as technologies such as CCUS.

Figure 3: Greenhouse gas emissions from products and agriculture



From London Waste and Recycling Board and Ellen Macarthur foundation[61]

In London, ReLondon (previously the London Waste and Recycling Board) have a business plan to work with local authorities and other partners to reduce waste through two key programmes:

- Resource London – is focussed on partnering with local authorities to reduce levels of waste as far as possible and ensure that most of what remains is recycled. This is delivered through a range of services including advice and support, facilitating innovation, as well as capacity building.
- Circular London – this aims to accelerate the growth of the circular economy in London through a broader set of partners, supporting and engaging with both big corporates and SMEs to encourage them to more circular practices, and showcasing innovative circular products and services.

The jobs in this sector that are demonstrate a range of roles. They include jobs in the traditional waste sector which are changing as they become more geared towards reducing waste, and greater recycling. In addition, they include jobs in a range of other sectors – such as electricals - that are helping to shift that sector to more circular practices, such as making repair of products easier and more affordable.
Green and blue infrastructure

Sector	Definition	Number of jobs	% of total employment
Green and blue infrastructure	Within a London context this will focus on urban green infrastructure, and include activity aimed at increasing biodiversity directly or through offsetting.	1,600	0.03%

Green and blue infrastructure includes nature-based features integrated in urban areas – such as green roofs, trees, rivers and ponds. These play a number of vital roles in the climate challenge, including carbon sequestration and improving air quality.[62] Many examples of such infrastructure exist across both central and outer London boroughs, London Wetland Centre is one example of blue and green infrastructure in London, spanning over 100 acres.[63] London's Royal Parks cover over 5,000 acres in the capital, including St James's Park, Greenwich Park and Richmond Park.[64] The Royal Parks

charity undertakes a range of conservation and biodiversity enhancement as part of park maintenance.

As well as contributing to carbon storage and improving habitats for wildlife, blue and green infrastructure will be an important part of climate resilience. Trees and urban water bodies support urban cooling, and green roofs and other sustainable urban drainage systems help to reduce the risk of surface water flooding.[65]

Further increasing green spaces and biodiversity in the capital are part of the capital's environment and climate strategies. The Mayor's £12 million Greener City Fund supports the commitment to make London a 'National Park City', where over half the city's area will be green by 2050. Funding includes community tree planting and green space grants and strategic green infrastructure projects, including large scale green space projects and greening the built environment.

Borough-level actions are critical to increasing and improving green and blue infrastructure. There are 237 total actions under climate resilience and biodiversity across published climate action plans . Action to plant trees in the borough is the most common under the 'Resilient and Green' theme, totalling 42 actions (and included in over 8 in 10 boroughs' climate action plans), with 16 actions in the delivery of sustainable drainage systems (a third of boroughs have included these actions in their climate action plans). Other actions include enhancing biodiversity in green spaces, creating new and maintaining existing green spaces and integrating and building blue and green infrastructure.

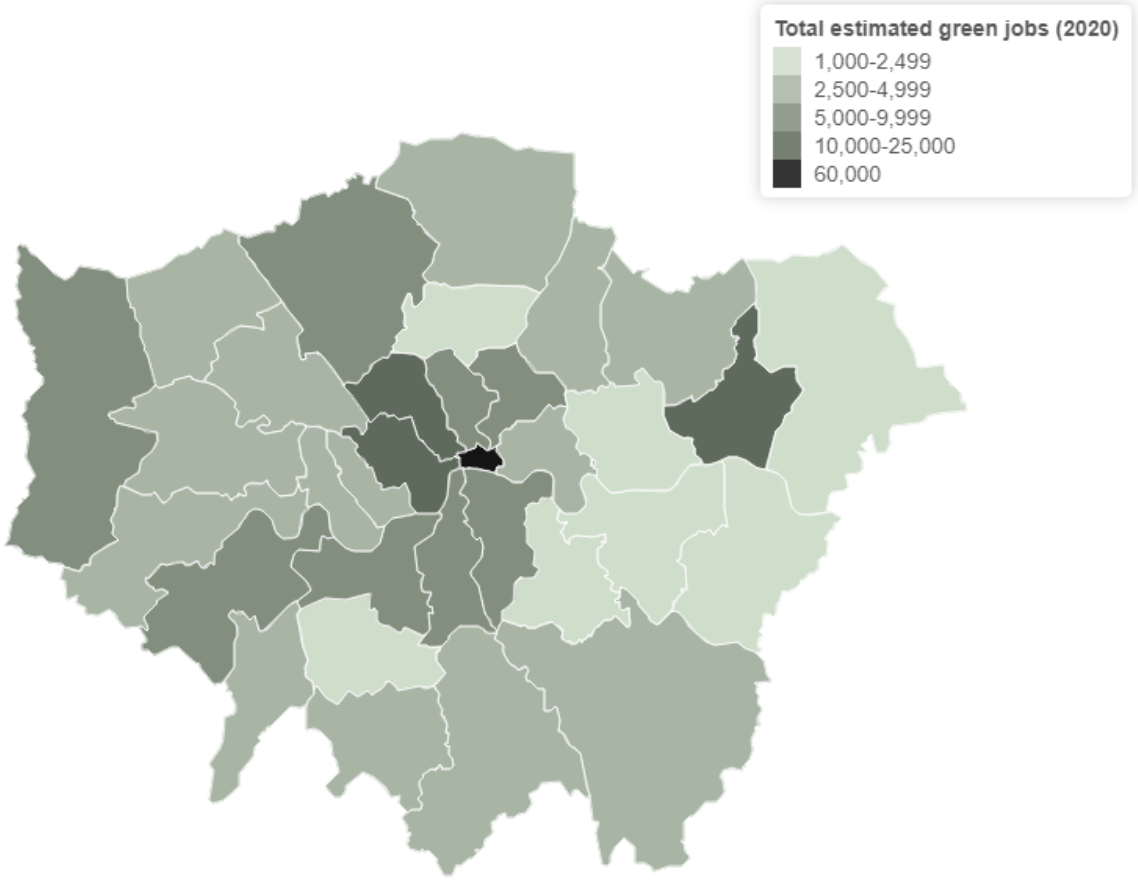
Green jobs by borough and sub-region

We are also able to calculate sub-regional and borough level data for our 11 green jobs sectors (based on the location of the job rather than where workers live). Table 3 (following pages) provides results by London's sub-regions. It shows that, while all sub-regions benefit from an increase in green jobs, the nature of these green job varies significantly between the sub-regions. The separate reports for each of the four sub-regions of London will go into greater detail as to the reason underlying the some of the current differences between the predominance of various sectors within the four areas of London. Some key ones include:

- Both the Power and Home and Buildings sectors are both overrepresented in the Local London area of North East and East London. However, these sectors are substantial sources of green employment in all sub-regions.
- Green finance is heavily dominant in the Central London Forward area. This is overwhelmingly due to the fact that the financial services clusters in the City of London, Canary Wharf and the West End are all in the CLF area.
- Although small numbers overall – Reduce, Reuse, Recycle is about twice as large in terms of proportion overall employment in Local London and South London as West London and central London.
- The South London Partnership performs well compared to other sub-regions that are taken by "green and blue infrastructure", both in terms of numbers of jobs and the proportion of total jobs.

Digging deeper into the figures, Figure 4 shows the estimate of green jobs by borough. The City of London is an outlier, with around 60,000 green jobs, substantially more than any other borough. However, there are also high estimates in Westminster, Barking and Dagenham, Camden and Islington.

Figure 4: Total estimated green jobs by London local government district , 2020

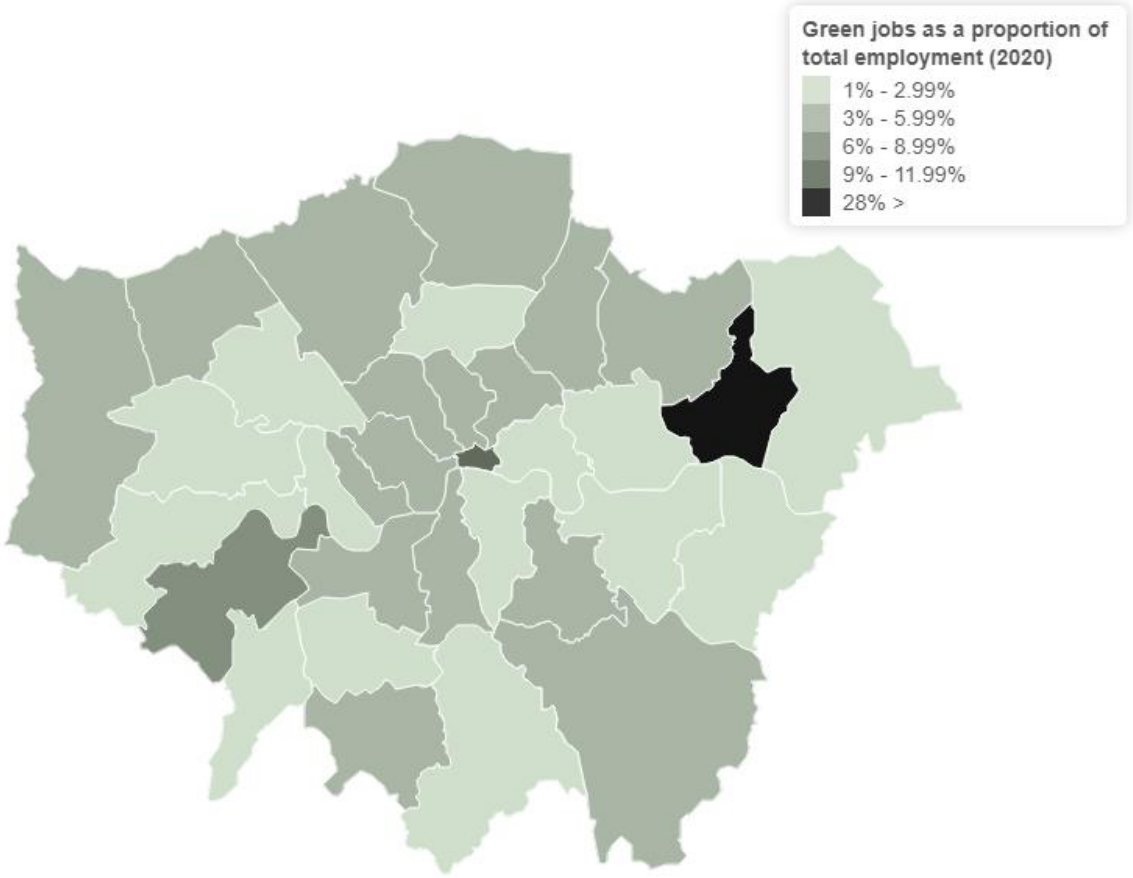


Source: WPI Economics calculations based on data supplied by kMatrix on their Low Carbon Environmental Goods and Services methodology and The Data City.

However, this picture is influenced by the relatively high proportion of jobs in London that are based in the centre of the city. When we look at the proportion of green jobs in each borough (see Figure 5, a notable picture emerges. One borough, Barking and Dagenham, has a much higher proportion of green jobs than any other borough, with over one in four jobs (28%) being in green industries. Barking and Dagenham has a high number of jobs in the Homes and Buildings and Power sectors, with activities such as the Council-run B&D Energy district heating network likely to explain this.

The City of London has a relatively high (12%) proportion of jobs in green industries. However, Westminster (3%) is actually slightly lower than the average across London (4%). Richmond-upon-Thames is one of the highest amongst the remaining boroughs, at over 6% of employment in green jobs.

Figure 5: Estimated green jobs as a proportion of total employment by London local government district, 2020



Source: WPI Economics calculations based on data supplied by kMatrix on their Low Carbon Environmental Goods and Services methodology and The Data City, and ONS Business Register and Employment Survey for total employment by borough.

Table 3: Estimated green jobs by sub-regional partnership, 2020

	Central London Forward		Local London		South London Partnership		West London Alliance	
	Numbers of jobs	% of total employment	Numbers of jobs	% of total employment	Numbers of jobs	% of total employment	Numbers of jobs	% of total employment
Climate adaptation	2,400	0.1%	<100	0.0%	<100	0.0%	<100	0.0%
Climate change Research and Development	1,800	0.1%	700	0.1%	500	0.1%	600	0.1%
Climate change strategy, policy, monitoring and planning	2,300	0.1%	600	0.1%	400	0.1%	600	0.1%
Green and Blue infrastructure	700	0.0%	<100	0.0%	800	0.2%	200	0.0%
Green finance	50,100	1.6%	200	0.0%	100	0.0%	300	0.0%
Homes and Buildings	30,700	1.0%	10,500	1.5%	6,200	1.3%	9,300	0.9%
Industrial decarbonisation, hydrogen and carbon capture	400	0.0%	200	0.0%	100	0.0%	200	0.0%
Low Carbon Transport	8,700	0.3%	1,300	0.2%	1,100	0.2%	2,400	0.2%
Power	42,700	1.4%	14,900	2.1%	7,900	1.7%	15,200	1.5%
Reduce, reuse, recycle	6,400	0.2%	3,300	0.5%	1,900	0.4%	2,400	0.2%
Reducing localised pollution	700	0.0%	300	0.0%	200	0.0%	300	0.0%
All green jobs	**146,900**	**4.8%**	**32,100**	**4.8%**	**19,200**	**4.1%**	**31,500**	**3.2%**

Source: WPI Economics calculations based on data supplied by kMatrix on their Low Carbon Environmental Goods and Services methodology and The Data City

The value of the green economy in London

The green economy has substantial value to the London economy. Our mapping of the LCEGS dataset to the 11 green economy sectors we have identified allows us to report the total revenue each sector accounts for, in combination with our bespoke Data City company lists for the two sectors not covered by LCEGS. In total we estimate that the 11 green economy sectors accounted for around £42bn of sales in the financial year 2020/21, with the majority from Green Finance (£14bn), Power (£13bn) and Homes and Buildings (£9bn). This accounts for around 3.5% of total turnover in the London Economy.[66]

The value of the green economy in London has been growing over the last decade. Although we do not have a time series of our analysis, we anticipate that growth measured by our definition would be closely related to the estimates made by kMatrix for the Greater London Authority. Their analysis suggests that sales from the green sector have increased by around 65% since 2010/11 in London, as compared to around 50% in the rest of the UK. The comparatively fast growth of green finance has been the main driver of this quicker growth.[67]

Table 4: Total sales in London in green economy sectors[ii]

	Total sales - 2017/18	Projected sales - 2020/21
Climate adaptation	£0.4bn	£0.4bn
Climate change research and development	£0.5bn	£0.6bn
Climate change strategy, policy, monitoring and planning	£0.5bn	£0.6bn
Green and blue infrastructure	£0.2bn	£0.2bn
Green finance	£12.7bn	£14.1bn
Homes and Buildings	£8.3bn	£9.2bn
Industrial decarbonisation, hydrogen and CCUS	£0.1bn	£0.1bn
Low Carbon Transport	£1.9bn	£2.2bn
Power	£11.3bn	£12.5bn
Reduce, reuse, recycle	£1.8bn	£2.1bn
Reducing localised pollution	£0.2bn	£0.2bn
Total	**£38bn**	**£42bn**

Sources: WPI calculations based on kMatrix Low Carbon and Environmental Goods and Services estimates and Data City calculations for climate adaptation / green and blue infrastructure

[ii] Note: We have had to project total sales from 2017/18 figures for LCEGS as more up to date figures for London had not been published by the time of writing. We uprated 2017/18 figures in line with national growth, as reported in kMatrix (2021) - https://kmatrix.co/uk-lcegs/

Green skills in London

Following from the analysis of green jobs, we now look at green skills. The importance of doing so is clear. If the capital is to take advantage of the opportunities that the transition to a net zero economy provides, each of the green sectors highlighted will need to have access to a workforce with the requisite skills to fulfil the jobs that develop. Doing so will require us to understand what these skills are, and how training and education will need to adapt to meet these changing skills needs. If this is delivered, London could grasp the opportunity and become a world-leader in many of these sectors. If it is delivered alongside attempts to bridge skills inequalities and programmes to support those needing to transition from jobs in carbon-intensive industries, it would also go a long way to ensuring a just transition and inclusive growth.

The best place to start to understand the skills needed for green jobs, is to consider the skills of those currently employed in these jobs. We have done this using the Labour Force Survey. To connect our definition of the green jobs sectors to the Labour Force Survey data on skills, we identified the most common SIC codes within each sector. Table 5 shows the three most common within each of our sectors. This illustrates both that there is a good matching with codes one would expect (e.g. electrical installation in Low Carbon Transport or plumbing, heating and air-conditioning installation in Homes and Buildings) and the shortcomings of SIC codes. Many companies we have identified have classified themselves as "Other business support services activities not elsewhere classified". Firms active in elements of the green finance sector are often listed within management consultancy, as many of their activities may be assisting companies to understand the implications of their activities and investments.

Table 5: Top three most common SIC codes identified within each green sector

Climate adaptation	
Environmental consulting activities	21
Engineering related scientific and technical consulting	11
Management consultancy activities other than financial	11
Green and blue infrastructure	
Other business support service activities n.e.c.	11
Landscape service activities	8
Environmental consulting activities	8
Low Carbon Transport	
Electrical installation	29
Retail sale via mail order houses or via Internet	19
Other business support service activities n.e.c.	12
Reducing localised pollution	
Environmental consulting activities	37
Other professional, scientific and technical activities n.e.c.	25
Engineering related scientific and technical consulting	16

Climate change strategy, research & monitoring	
Environmental consulting activities	75
Management consultancy activities other than financial	59
Other business support service activities n.e.c.	38
Homes and Buildings	
Plumbing, heat and air-conditioning installation	59
Other business support service activities n.e.c.	27
Electrical installation	16
Power	
Production of electricity	409
Other business support service activities n.e.c.	140
Management consultancy activities other than financial	82

Green Finance	
Management consultancy activities other than financial	20
Other business support service activities n.e.c.	14
Financial intermediation not elsewhere classified	12
Industrial decarbonisation, hydrogen and CCUS	
Engineering related scientific and technical consulting	11
Other business support service activities n.e.c.	8
Management consultancy activities other than financial	8
Reduce, re-use and recycle	
Collection of non-hazardous waste	34
Recovery of sorted materials	31
Treatment and disposal of non-hazardous waste	30

Source: WPI Economics and The Data City analysis

Using this list of common SIC codes we have investigated:

- *Occupational patterns of employment*, which provide indicators of the broad skill levels of those employed in green jobs.
- *Qualifications*, both in terms of the highest level of qualifications that employees have received, and also subject types for vocational training. This allows us to get a more detailed picture of specific types and areas of qualifications that might be needed.
- *Demographic characteristics*, this allows us to understand the demographic make-up of the current workforce in green jobs, and to identify whether these sectors are currently broadly representative of the wider workforce.

For many of the sectors, Data City identified businesses being in broad, catch-all sectors; therefore we identified key occupations that were most prevalent in the clearly defined SIC codes and use these occupations to analyse the green sectors. A detailed explanation is given in.

As can be seen above, many of our green sectors have companies with common SIC codes; in particular Environmental Consulting Activities, Business and other management consultancy activities, Engineering activities and related technical consultancy, Other research and experimental development on natural sciences and engineering and Other professional, scientific and technical activities not elsewhere classified. Therefore, for the purposes of the skills analysis we combine the eleven areas into four areas where occupation types are similar:

- Power;
- Homes, buildings and landscape (including Green and Blue Infrastructure and Low Carbon Infrastructure);
- Reduce, reuse, recycle; and
- Consultancy and finance (all other sectors).

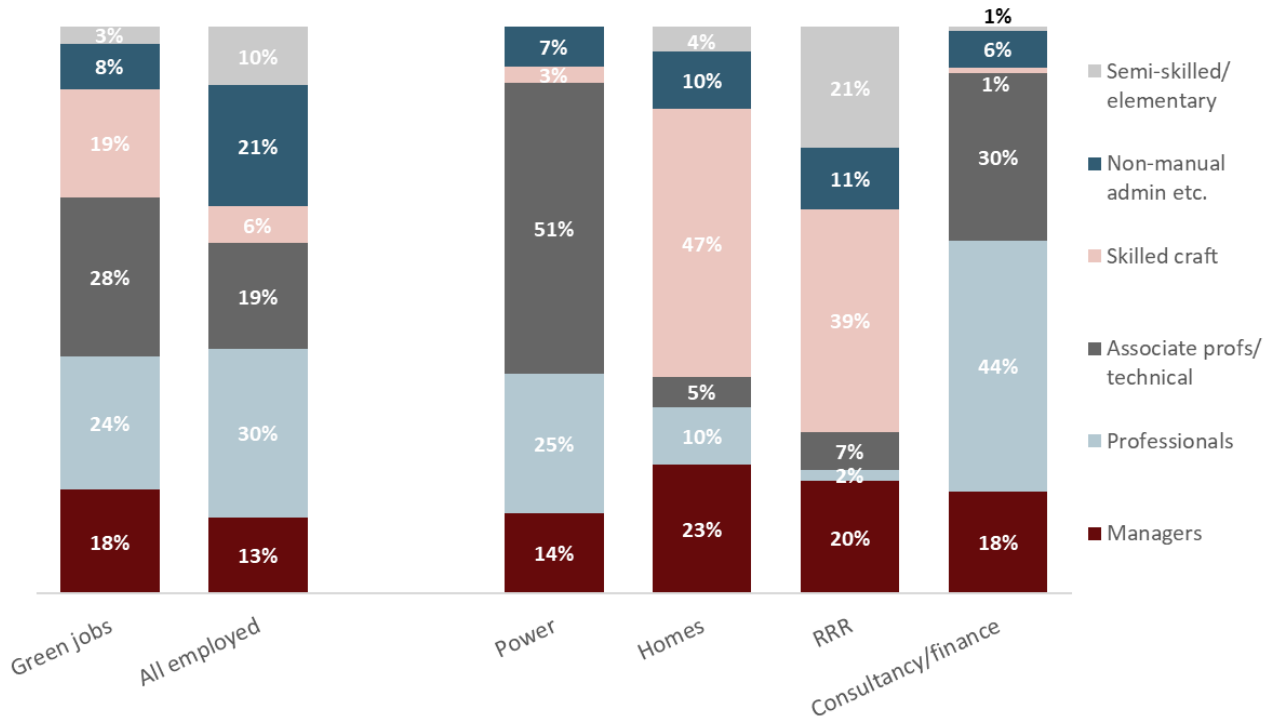
The analysis uses the Labour Force Survey (LFS), with all four quarters in a calendar year combined to boost sample sizes, and examines proportions within the green sectors, which are then applied to the numbers from the Data City/LCEGS analysis, rather than using estimates from the LFS.

Occupational patterns of employment

Current employment in green jobs in London is predominantly high-level employment in managerial, professional and associate professional jobs, with an over-representation in skilled craft occupations. Lower-level non-manual jobs, and those in semi-skilled and elementary occupations are underrepresented. Figure 6 shows that nearly three quarters of employment in green jobs is in managerial, professional or associate professional occupations, compared with 62% of all employment in London; within this broad group, professional occupations are under-represented compared with total employment (24% and 30% respectively) while managerial and associate professional jobs are over-represented. Nearly one in five workers in green jobs (19%) are in skilled craft occupations, three times the proportion across all jobs in London of 6%.

However, there are very different patterns between the sectors within green jobs overall. Jobs in the power sector are predominantly associate professional/technical, while half of jobs in homes, buildings and landscape, and 29% of jobs in reduce, reuse, recycle, are skilled craft manual jobs, and 43% of jobs in consultancy and finance sectors are professional.

Figure 6: Occupational breakdown of green jobs overall, and by broad sector, London, 2020



Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Detailed occupations

The following sections highlight the five largest detailed occupations (SOC 4-digit unit groups) in each of the four broad green sectors in London, and also the five largest in the country, where these differ from the patterns in London.

Power – employment in the power sector in London is heavily over-represented in associate professional jobs, accounting for 51% of all jobs compared with 24% of all jobs across the sector nationally. In the UK, 25% of jobs in power are in professional occupations, the same proportion as in London, and 15% are in skilled craft occupations, compared with 3% in London. Table 6 shows the five largest occupational unit groups in the power sector in London, with business and related associate professionals (business systems analysts, data analysts etc.) accounting for nearly half of all jobs.

Table 6: Largest occupations within Power; proportions of total employment in sector

Occupation	London	UK
3539 'Business and related associate professionals n.e.c.'	46%	5%
2136 'Programmers and software development professionals'	11%	2%
2135 'IT business analysts, archtcts and systms designers'	7%	1%
1132 'Marketing and sales directors'	7%	1%
7220 'Customer service mngrs and supervisors'	6%	3%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Homes, buildings and landscape – skilled trades and managerial occupations are the two largest occupational areas in homes, buildings and landscape, with managers over-represented in London, and skilled trades under-represented, compared with the sector nationally. This pattern is also reflected in the largest individual occupations within the sector. Production managers in construction account for a larger share of employment in London than in the country as a whole, while plumbers and gardeners/landscapers are under-represented. However, general construction workers are over-represented in London.

Table 7: Largest occupations within Homes, Buildings and Landscape; proportions of total employment in sector

Occupation	London	UK
5241 'Electricians and electrical fitters'	14%	14%
5113 'Gardeners and landscape gardeners'	10%	17%
5314 'Plumbers and heating and ventilating engineers'	8%	14%
1122 'Production mngrs and directors in construction'	8%	4%
5319 'Construction and building trades n.e.c.'	6%	4%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Reduce, reuse, recycle – managerial occupations account for twice the proportion of employment in reduce, reuse, recycle in London compared with the country as a whole (20% and 10% respectively), while the proportions in skilled craft occupations, and in semi-skilled and elementary occupations, are broadly similar in London and the UK. However, when looking at detailed occupations, there are distinct patterns within the manual occupations, with electrical and maintenance fitters over-represented in London, and vehicle technicians under-represented.

Table 8: Largest occupations within reduce, re-use and recycle; proportions of total employment in sector

Occupation	London	UK
5241 'Electricians and electrical fitters'	13%	4%
9236 'Vehicle valeters and cleaners'	8%	3%
1259 'mngrs and Prprtrs in other services n.e.c.'	7%	1%
5231 'Vehicle technicians, mechanics and electricians'	6%	15%
5223 'Metal working production and maintenance fitters'	5%	6%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Consultancy and finance – the occupational profile of these green sectors in London is broadly similar to that in the UK, with the proportions in managerial and professional occupations being slightly higher in London, and a larger over-representation in associate professional occupations (30% in London compared with 23% in the UK). At a detailed level there is greater variation, and management consultants and business analysts account for nearly twice as much employment in London as in the country as a whole (14% and 8% respectively), while marketing associate professionals are also heavily over-represented in these sectors in London (5% compared with 2% nationally).

Table 9: Largest occupations within Consultancy and Finance; proportions of total employment in sector

Occupation	London	UK
2423 'Management consultants and business analysts'	14%	8%
3543 'Marketing associate professionals'	5%	2%
3545 'Sales accounts and business development mngrs'	5%	3%
2424 'Business and financial project mngmnt professionals'	4%	3%
3539 'Business and related associate professionals n.e.c.'	3%	2%

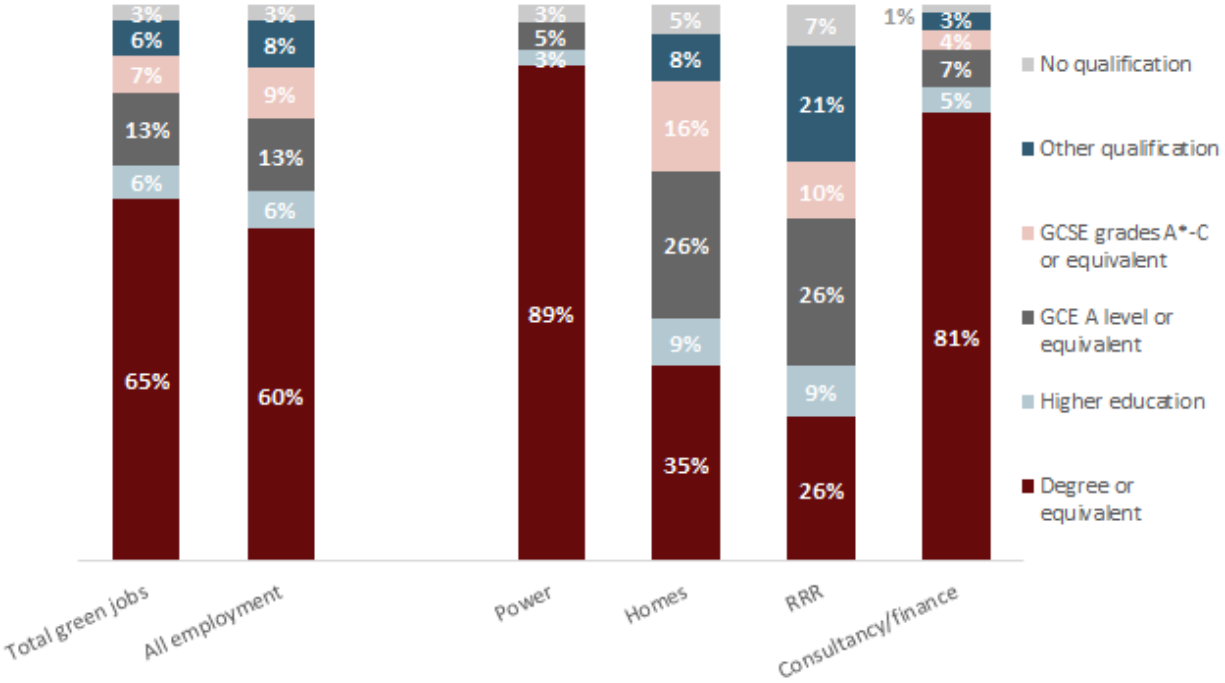
Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Qualifications

There is a slightly higher proportion of graduates among workers in green jobs compared with all workers in London, reflecting the higher proportions of managerial and associate professional occupations within green sectors. Across all green sectors, 63% of workers have a degree, compared with 60% of all workers, and there are fewer workers in green jobs with qualifications below A-levels or equivalent (NVQ Level 3).

In terms of their qualification profiles, there are clear distinctions between the power and consultancy/finance sectors on the one hand, and the homes, buildings and landscape, and reduce, reuse, recycle sectors on the other hand. At least four fifths of workers in the former sectors are graduates, compared with around one in three workers in the latter sectors. There are high proportions of workers with A-levels or equivalent qualifications, or other vocational qualifications, in the homes, buildings and landscape, and reduce, reuse, recycle sectors.

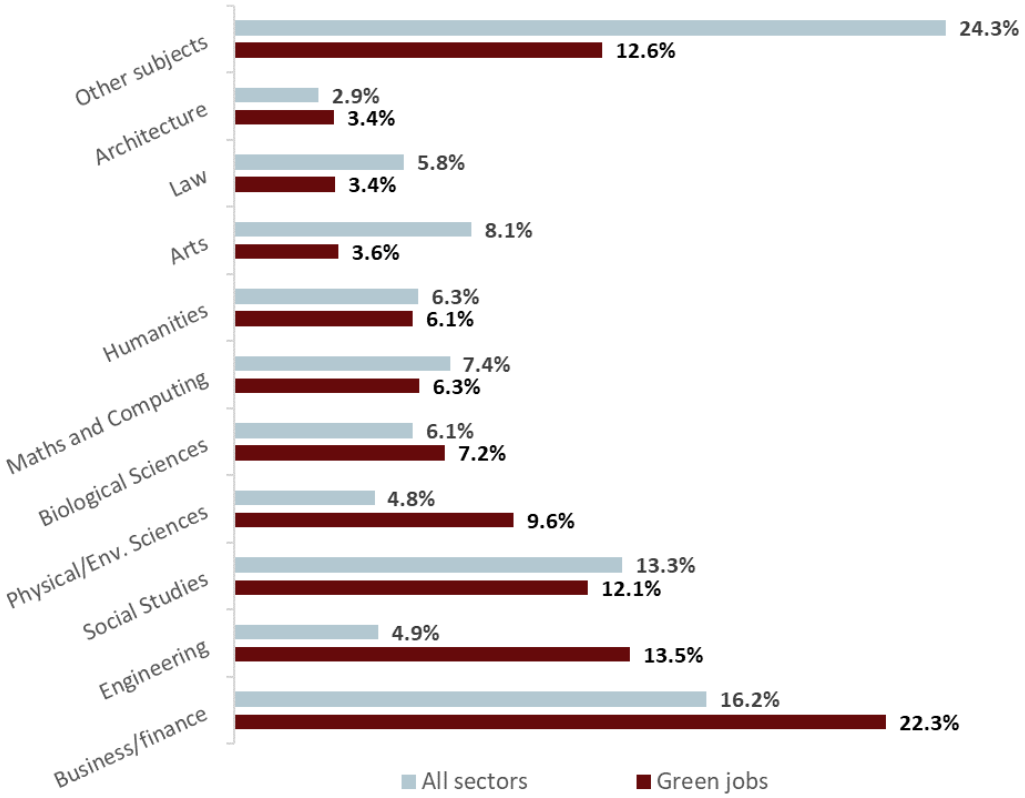
Figure 7: Workers in green sectors by level of highest qualification, London, 2020



Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Data are available in the LFS on the degree subject of graduates. Graduate workers in green jobs are much more likely than other graduate workers to have an engineering degree, or one in physical or environmental sciences – 14% of graduates in green jobs have an engineering degree, compared with 5% of all graduate workers in London, and 10% of graduates in green jobs have a degree in physical or environmental science, compared with 5% of all graduate workers. Business and financial studies is the most common degree subject among workers in green jobs, as it is among the graduate workforce generally, although this subject is over-represented among green graduates (22% compared with 16%), and business and financial studies graduates are found across all green sub-sectors, reflecting the high proportions of managerial roles in green sectors in London. Social studies was the third most common (after engineering), although the proportion of green graduates with degrees in social studies was lower than the proportion of all graduates (12% and 13% respectively). Biological studies, and architecture, are also over-represented among green graduates.

Figure 8: First degree subject of graduates, London, 2020



Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

The LFS also contains data on subject of vocational qualifications. Table 10 shows the largest vocational subject areas among workers in green jobs with vocational qualifications. Just over one in five (22%) had qualifications in building and civil engineering, compared with 5% of all workers with vocational qualifications, and in the homes, buildings and landscape sector, this subject area accounted for 43% of all workers with vocational qualifications. Electricity and energy is also heavily over-represented in green jobs (14% compared with 2% of all workers with vocational qualifications, and 22% of workers in homes, buildings and landscape). There are relatively large proportions with vocational qualifications in finance, banking and insurance, and in business and administration, being most prevalent in the consultancy and finance sector, while there are also large numbers with management and administration qualifications, but this is below the proportion across all sectors.

Table 10: Proportion of workers in green jobs and in all sectors with vocational qualifications by subject area

	Green jobs	All sectors
Building and civil engineering	21.6%	5.4%
Electricity and energy	13.7%	2.2%
Finance, banking and insurance	7.3%	4.1%
Management and administration	6.0%	6.7%
Electronics and automation	4.6%	2.3%
Engineering and manufacturing trades	4.6%	1.0%
Business and admin	4.1%	3.6%
Proportion of all workers with one of the above	61.9%	25.3%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Demographics

Results suggest that green jobs are male-dominated, and have a higher proportion of white workers than across all sectors. Table 11 shows that 66% of workers in green jobs are male, compared with 54% of all jobs in London. Only one in five workers in homes, buildings and landscape (20%), and just under one in four workers in power, and reduce, reuse, recycle (23%) are female, although there is a much higher proportion in green consultancy and finance sectors (41%).

Across all green sectors, 30% of workers are from Black, Asian and Minority Ethnic backgrounds, compared with 36 per cent of all workers. The power sector has the lowest representation of workers from Black, Asian and Minority Ethnic backgrounds (6%), followed by homes, buildings and landscape (28%) and consultancy and finance (30%), while in reduce, reuse, recycle, the proportion of workers from Black, Asian and Minority Ethnic backgrounds is the same as the proportion across all sectors (36%).

Table 11: Demographic breakdown of green jobs within our definition

	All green jobs	All sectors	Power	Homes	Reduce, re-use and recycle	Consultancy / finance
Male	66%	54%	77%	80%	77%	59%
Female	34%	46%	23%	20%	23%	41%
White	70%	64%	94%	72%	64%	70%
Black, Asian and Minority Ethnic	30%	36%	6%	28%	36%	30%
Mixed/multiple	3%	3%	-	1%	4%	3%
Asian	18%	18%	-	16%	19%	18%
Black	6%	10%	-	8%	8%	5%
Other	4%	5%	-	2%	5%	4%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Skills supply

We can also look beyond the likely skills of those already in green jobs, to where the future flow of skills into the green sectors could come from. In broad terms, this could come from the same route as those already working in green jobs, those already qualified in other (non-green) sectors and / or from people developing the requisite skills. To understand the scale of each of these areas, we have assessed:

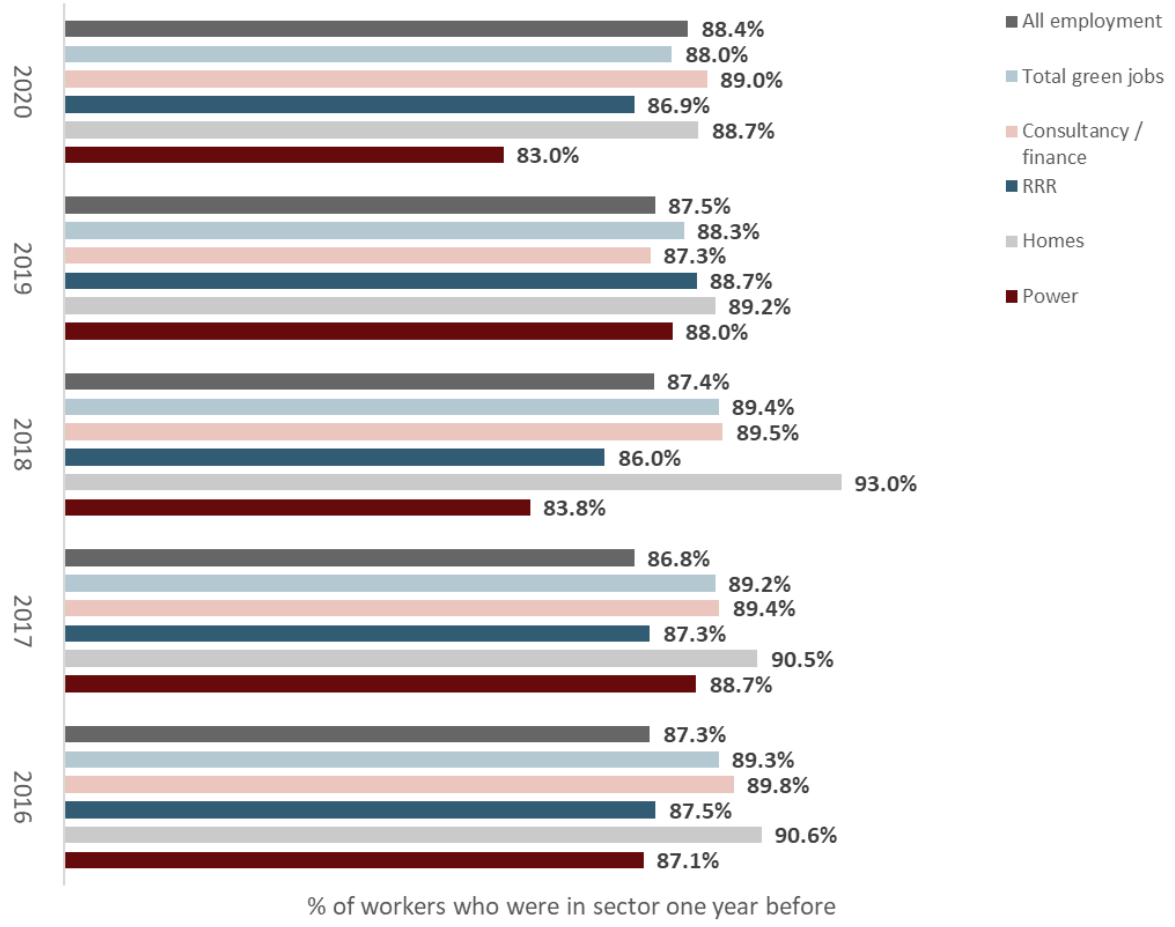
- The current flow of people into green jobs, allowing us to understand where these individuals have come from and the likely scale of future supply from these sources.
- The number of people in other sectors that have the requisite skills and could be attracted to green jobs in the future.
- Current provision of courses in further and higher education, which could provide individuals with the requisite skills.

Flows of labour/skills into green sectors

The first approach has been to investigate the size of flows into green sectors from one year to the next, and where new entrants have come from. This has used data from the LFS, which asks individuals what they were doing one year ago in the April-June quarter each year, and comparing this data with their current employment status. This analysis has been done at the national level as the sample size in the data are too small to analyse at the London level, from 2016 to 2020.

Figure 9 shows the proportion of workers in green jobs each year who had been working in green jobs in the previous year, for the four broad sectors (individuals moving from one green sector to another are counted as staying within green jobs). Overall, just under nine out of ten green workers had been in green sectors one year previously, although the proportion is slightly lower in 2019 and 2020 than in earlier years, possibly reflecting the growth in the sector pulling in more workers from outside. The homes, buildings and landscape, and consultancy and finance sectors, had the highest proportion of existing workers each year, while the power sector was the most fluid, with around one in seven workers being new entrants to the sector.

Figure 9: Proportion of workers who were in each green jobs sector one year before

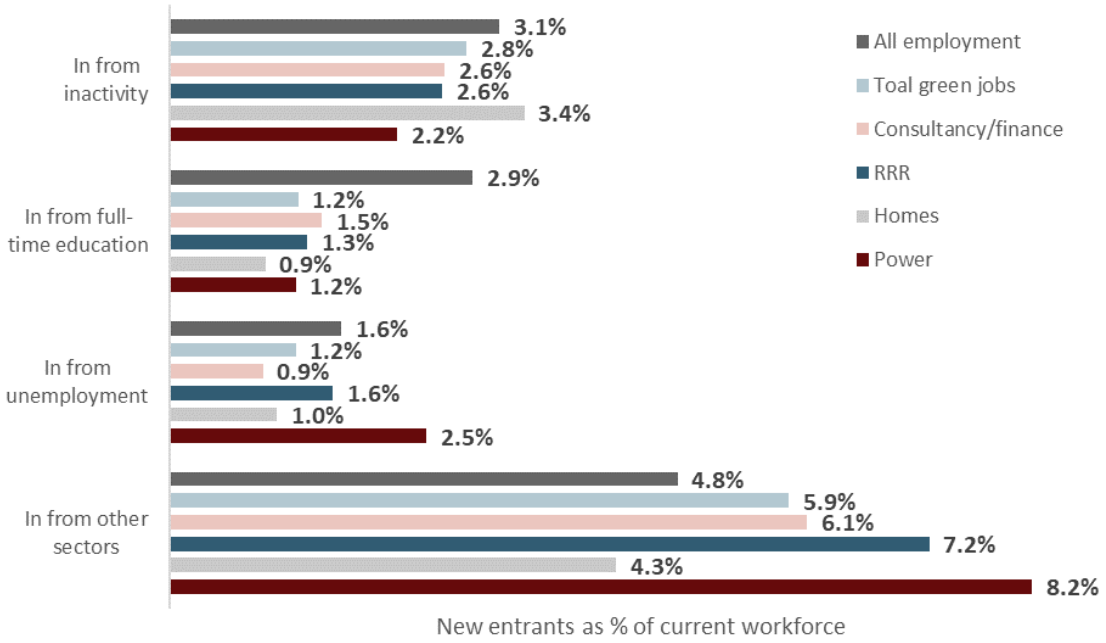


Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Figure 10 looks at the size of inflows by the source of the new entrants, either from other sectors, from unemployment, from full-time education, or from economic inactivity (illness, looking after family/home etc.) – these results have pooled the data across the five years from 2016 to 2020. The bulk of new entrants came from those working in other sectors, who accounted for around half of

new entrants to green jobs overall, and nearly 60% of entrants to jobs in the power sector. Entrants from full-time education accounted for around 1% of the green-jobs workforce each year, whereas across all sectors, 3% of workers had been in full-time education one year previously. This suggests that green sectors tend to draw from those already in employment, who may have developed appropriate skills through their initial employment, rather than directly recruiting those straight from education.

Figure 10: New entrants as a proportion of current workforce: green economy areas



Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Table 12 shows the main sources of new entrants from other sectors, for each of the four broad green sectors. Entrants from manufacturing are a major source for all four sectors, while the retail trade is a major source of labour for power, and homes, buildings and landscape, but likely to be supplying lower-skilled/ elementary staff or those in office functions, e.g. admin/secretarial. Other sources reflect the sector specialisms, with construction sectors feeding the homes, buildings and landscape sector, and IT consultancy, market research and financial support services supplying labour to the consultancy/finance sector.

Table 12: Main sources of new entrants for each sector

Power	Homes	RRR	Consultancy/ finance
Retail trade, except vehicles	Specialised construction activities	Wholesale retail trade repair vehicles	Computer programming and consultancy
Manufacturing	Retail trade, except vehicles	Manufacturing	Manufacturing
Computer programming and consultancy	Construction of buildings	Land transport incl. via pipelines	Advertising and market research
Financial ex insurance and pension	Manufacturing	Retail trade, except vehicles	Public admin, defence, social security
Food and beverage service activities	Services to buildings and landscape	Food and beverage service activities	Auxiliary to financial and insurance

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

Workers with potential green skills outside of green sectors

The second skills supply issue is an investigation of the potential supply of skills that is currently in the labour market but working in non-green sectors. This analysis has used LFS data for London pooled across the four quarters in 2020, and identifies the number of workers in the key occupations for each of the four broad green sectors who are working in non-green sectors; thus for homes, buildings and landscape we estimate the size of workers in electrical and plumbing trades, and production managers in construction etc., working outside of the sectors that make up homes, buildings and landscape.

Table 13 presents the estimate of the size of the four broad sectors, along with the estimate of the number of workers in key occupations for each sector who are currently working in non-green sectors. Overall, the size of this potential supply is more than twice the number of green jobs, although there is substantial variation between the four sectors. The potential supply for consultancy and finance is nearly five times as large as the current size of the sector, while the potential supply for homes, buildings and landscape is only three quarters the size of the current workforce. This suggests that skills shortages are much more likely to emerge within homes, buildings and landscape than in the other three broad sectors.

Table 13: Number of green jobs and workers in key occupations for each sector that are currently working in other sectors

	Power	Homes	RRR	Consultancy / finance	Total green
Green jobs estimate	82,900	76,100	14,500	60,900	234,400
Workers in key occupations in other sectors	131,400	55,600	46,100	290,800	523,900
Potential supply / current jobs	159%	73%	318%	478%	224%

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

- In the power sector, the bulk of the potential supply is among associate professional occupations (which make up 73% of the total workforce in the sector), and these are spread across a wide range of sectors, including financial services, IT, health and social care, professional services, manufacturing and retail, while there is some potential supply at professional level in the public administration sector.
- Just over half of the potential supply for the home, buildings and landscape sector is at managerial level, largely in the real estate and administration/support services sectors, while there is some potential supply of skills at the skilled craft level in manufacturing and elsewhere within the construction sector.
- The main areas of potential supply for the reduce, reuse, recycle sector are managers in manufacturing, and skilled craft and semi-skilled workers in the transport and distribution sector.
- The financial services sector is a major source of potential skills at managerial, professional and associate professional level for the consultancy/finance sector, accounting for one third of the total potential supply, and three quarters of the potential supply of associate professional skills. Professional workers with relevant skills can also be found in the public administration sector, while managers can be found across most service sectors, particularly professional services, wholesale and retail, and administrative and support services.

Current provision in Further Education (FE) in London

The third aspect of skills supply investigated is the education and training provision in FE and HE in relevant curriculum areas. Data for this have come from the DfE (FE data) and HESA (HE data). Table 14 shows trends in numbers of learners studying for qualifications at Level 2 and above in curriculum areas associated with green skills in London from 2014/15 to 2018/19 (the most recent full academic year for which data are available). Total provision has averaged around 22,000; representing almost 10% of the current employment level in green jobs.

During this period there has been a shift from Level 2 provision (falling by 11%) towards Level 3 provision (increasing by 26%), and growth in numbers studying courses in building and construction at all levels, although there have been falls in numbers studying other areas apart from business management (increase at Level 3 although decrease at Level 2) and environmental conservation (large increase in Level 2 provision between 2017/18 and 2018/19).

The flows analysis of new entrants to the sector found that nationally, only one per cent of workers in green sectors had entered from full-time education in the previous year into the sector. Applying that proportion to the London workforce suggests that the sector recruits around 2,300 workers from full-time education, which is equivalent to one tenth of the relevant provision in FE each year. It should be remembered that new entrants to green sectors from full-time education will include some people who studied subjects outside of these core areas in the definition of relevant provision.

Table 14: Numbers of Further Education learners in qualifications associated with green skills

	2014/15	2015/16	2016/17	2017/18	2018/19	% change 2014/15-2018/19
Level 2						
Accounting and Finance	2,500	2,346	1,850	1,921	1,840	**-26%**
Building and Construction	3,357	2,305	3,762	3,868	3,939	**17%**
Business Management	5,509	5,473	5,792	4,839	4,836	**-12%**
Engineering	1,370	879	820	862	703	**-49%**
Environmental Conservation	107	49	16	12	909	**750%**
Manufacturing Technologies	1,305	463	355	463	508	**-61%**
Transportation Operations and Maintenance	2,181	1,303	1,683	2,111	1,747	**-20%**
Level 3						
Accounting and Finance	1,117	1,145	911	697	528	**-53%**
Building and Construction	1,457	2,024	2,539	2,600	2,691	**85%**
Business Management	2,359	3,539	3,881	2,485	3,295	**40%**
Engineering	590	704	759	534	430	**--27%**
Environmental Conservation	0	0	0	0	0	-
Manufacturing Technologies	1	15	102	324	216	**N/A**
Transportation Operations and Maintenance	288	195	139	130	149	**-48%**
Above Level 3						
Accounting and Finance	657	426	406	351	205	**-69%**
Building and Construction	23	73	70	33	60	**161%**
Business Management	145	64	130	118	226	**56%**
Engineering	71	47	68	55	49	**-31%**
Environmental Conservation	0	0	0	0	0	-
Manufacturing Technologies	0	0	13	17	5	-
Transportation Operations and Maintenance	13	2	7	2	0	**N/A**
Total	**23,050**	**21,052**	**23,303**	**21,422**	**22,336**	**-3%**

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

In addition to the potential supply of new labour market entrants from the FE sector, there is the pool of apprenticeship learners combining on-the-job training with study at college. Table 15 shows the latest apprenticeship starts and achievements in sector subject areas that are relevant for green jobs. Apprenticeship starts in construction, planning and the built environment accounted for four per cent of the total, although a slightly higher proportion of intermediate apprenticeships (i.e. at Level 2). The

number of starts at intermediate and advanced level are lower than the number of learners studying in FE at those levels (Level 2 and 3), while the number of higher apprenticeship starts is substantially higher than the number of FE learners above Level 3. Starts in engineering and manufacturing technologies are higher than in construction, accounting for around one in ten of all apprenticeship starts, although there are relatively few starts for higher apprenticeships in this sector subject area. By contrast, business, administration and law accounts for more than half of all higher apprenticeship starts, and over one in three starts overall. The patterns of apprenticeship achievements by subject sector area and level are broadly in line with the patterns of starts. Overall, there were around 2,500 achievements in the skilled craft subject areas of construction and engineering, and 4,300 achievements in business subjects, in the 2018/19 academic year

Table 15: Numbers of Apprenticeship starts and achievements in qualifications associated with green skills, 2018/19

	Starts		Achievements	
	Number	% of total in that level	Number	% of total in that level
Construction, Planning and the Built Environment				
Intermediate Apprenticeship	720	6.1	420	6.8
Advanced Apprenticeship	450	2.4	190	2.3
Higher Apprenticeship	390	3.8	20	1.4
Total	**1,560**	**3.8**	**630**	**4.0**
Engineering and Manufacturing Technologies				
Intermediate Apprenticeship	1,560	13.1	1,000	16.2
Advanced Apprenticeship	2,030	11.0	920	11.3
Higher Apprenticeship	120	1.2	10	0.7
Total	**3,710**	**9.1**	**1,930**	**12.3**
Business, Administration and Law				
Intermediate Apprenticeship	2,480	20.8	1,560	25.3
Advanced Apprenticeship	6,260	33.9	2,010	24.7
Higher Apprenticeship	5,980	57.7	690	47.9
Total	**14,720**	**36.1**	**4,260**	**27.0**

Source: Department for Education

Current provision in Higher Education (HE) in London

Turning to ***HE provision***, London has a large student population, and there are 253,000 first degree students at London HE providers.

Table 16 presents data on the estimated numbers of graduate workers with degrees in the main subject areas in green jobs, along with data on HE provision in those same broad areas. Nearly one in four green workers (22%) have degrees in business and finance, and 14% have degrees in engineering, while these subject areas account for lower proportions of undergraduate provision, of 18% and 6% respectively. The only subject area which accounts for a higher proportion of HE provision than graduates in green jobs is maths and computing (7.7% of undergraduate provision and 6.3% of employed graduates in green jobs).

The table also presents the size of the annual cohort in each subject area (assuming three years of first degree undergraduate study) in relation to the size of the graduate workforce with degrees in that subject area. This gives an indication of how easy or difficult it is likely to be for employers to meet their future demand for graduate workers within each subject area. The annual cohort studying engineering courses is around a quarter of the size of the green workforce with engineering degrees, while in business and finance, and social studies/sciences, the student population is relatively larger, at almost half the employed graduate population, and in maths and computing it is larger still, at around two thirds of the employed graduate population. The relative size of the student population is smallest in physics and environmental sciences, where the number of undergraduate students in each year equals around one sixth of the graduate workforce in green sectors. Therefore, it is likely to be easier for employers to meet their increased needs for business, maths and computing graduates, then for engineering and physical/environmental sciences graduates. Across these subject areas, there are around 42,000 students in each year's cohort, which equals just under one fifth of the total green-jobs population.

Table 16: First degree student enrolments in London Higher Education providers in relation to workforce size for selected broad subject areas

	Green jobs		HE provision			
	% of graduate workers	Estimated number	Total first degree enrolments	Estimated annual cohort	% of total	HE Cohort as % of employment
Business/finance	22.3	33,400	44,300	14,800	17.5	44.2
Engineering	13.5	20,300	16,100	5,400	6.4	26.5
Social Studies	12.1	18,100	25,100	8,400	9.9	46.2
Physical/Env. Sciences	9.6	14,300	6,800	2,300	2.7	15.8
Biological Sciences	7.2	10,800	9,000	3,000	3.5	27.6
Maths and Computing	6.3	9,500	19,500	6,500	7.7	68.5
Architecture	3.4	5,100	6,200	2,100	2.4	40.3

Source: Quarterly Labour Force Survey, Jan-Mar 2020 to Oct-Dec 2020 combined

The analysis of green skills is based on the occupations within the sectors that fall into the definitions used by the green jobs analysis, and the courses and subjects that are relevant for these jobs. The primary source of information on skills issues within the green workforce is the Labour Force Survey data for 2020 (all four quarterly datasets combined) while information on education and training provision comes from the Department for Education and the Higher Education Statistics Agency. The skills analysis uses four broad sectors, which combine some of the 11 detailed sectors together where their sector definitions overlap.

Most jobs within green sectors in London are either high level managerial, professional or technical jobs, or skilled craft jobs. In comparison with all employment in London, skilled craft roles are heavily over-represented (19% of green jobs, compared with 6% of all jobs), and managerial and associate professional/technical jobs are also over-represented, while jobs in professional occupations are under-represented in the green sector (24%, compared with 30% across all sectors). Employment in the consultancy/finance and power sectors is predominantly managerial, professional and technical occupations, while skilled craft occupations are the largest group in the homes, buildings and landscape sector, and the reduce, reuse, recycle sector.

There is a high proportion of graduates in green sectors, reflecting the concentration of employment in managerial, professional and technical occupations. Engineering graduates are heavily over-represented in comparison with the labour market as a whole, as are graduates in physical and environmental sciences, and in business and finance, reflecting the green consultancy and finance sectors. Among green workers with vocational qualifications, one in three have qualifications in building and civil engineering, or in electricity and energy.

The green workforce as a whole has a lower proportion of female workers and is less ethnically diverse than the overall London labour market; only one in three green workers are female, compared with 46% of all workers in London, and only 30% are from Black, Asian and Minority Ethnic backgrounds, compared with 36% of all workers. The consultancy/finance sector has the highest proportion of female workers (41%), while the reduce, reuse, recycle sector has the highest proportion of workers from non-white ethnic backgrounds (36%). Widening access to green jobs will be important to ensure that the growth of the sector does not reinforce existing labour market inequalities.

The analysis of skills supply has focused on three areas – the current flow of people into green jobs, the size of the workforce with relevant skills working in other sectors, and current education and training provision in further and higher education.

A national-level analysis of flows into green jobs shows that green sectors draw in a relatively high proportion of workers from other sectors each year, and very few entrants from full-time education (only 1% of green workers were in full-time education the previous year, compared with an average of 3% across all sectors), which suggests that attracting people already in work, and re-skilling them where necessary, will be a more important source of new skills for the sector than attracting FE/HE leavers. The manufacturing sector is a key source to all green sectors. It is estimated that the number of workers in key green occupations but in sectors outside of green sectors is more than twice the size of the green workforce, with this potential supply greatest for consultancy and finance (five times the current workforce) and lowest for homes, buildings and landscape sector (73% of current workforce).

There were around 22,000 learners in FE in 2018/19 (the most recent full year for which data are available) studying courses that are related to green sectors, at Level 2 or above, and numbers had

been stable over the previous few years. There have been expansions in building and construction at all levels, and in business management at Level 3 and above. The number of apprenticeship starts in relevant sector subject areas was slightly lower, at 20,000, with most in business, administration and law rather than construction or engineering, while there were just under 7,000 achievements in these subjects in 2018/19.

Turning to HE provision, the concentration of universities in London means there is a large number of graduates in relation to the size of the green workforce with degrees in relevant subjects – each year the number of graduates in business and finance and social studies courses is just under half the number of graduates in green sectors with these qualifications. However, the supply in relation to the existing workforce is lower for engineering and physical/environmental sciences, where new graduates each year account for 27% and 16% respectively of the number of green workers with degrees in these subjects.

4. Projecting green jobs and skills in London in the future

In this chapter we project the potential **gross number of green jobs** across each sector that there will be in the coming decades. This allows us to understand the potential demand for workers with the requisite skills. This can inform approaches to skills provision, however it does not take into account the number of jobs that will be destroyed .

Chapter 5 explores the impact of the transition on **net jobs** which takes into account the number created, minus those that are lost.

Our approach to estimating the growth of green jobs is set out below:

1. **Estimating the jobs growth rate for each sector –** this was done based on a range of sources including Ricardo energy and environment for the CCC (2017) 'UK business opportunities of moving to a low-carbon economy'[68] and Ecuity for LGA (2021) 'Local green jobs - accelerating a sustainable economic recovery'[69] as well as a number of other sources which support separate sector specific assumptions.[70]
2. **Created a time series** – based on these sources, we mapped growth between 2020-2050, with growth rates tending to be fastest in the next decade and somewhat slower to 2050 as many net zero targets are delivered and the green sector matures.
3. **Creating three scenarios –** these provide us with our central scenario. We then created a low scenario to reflect the potential for a slower roll-out of green infrastructure and services, and a high scenario to reflect the potential for London to capture more of the UK and global markets, particularly in the case of services such as green finance, consultancy and research. We have constructed these using evidence on potentially slower or faster growth rates where available. Where direct evidence to inform these assumptions was not available, we have projected a low growth rate of half the central rate, with the high growth rate then at 150% of the central rate . This provides an indication of the potential variation in outcomes.

The results based on this approach can be found below. Table 17 provides a summary of the year-on-year growth rates for each sector derived from the approach above. Key features include that many of the sectors are expected to grow significantly in the period to 2030. For example, industrial decarbonisation, hydrogen and carbon capture (22%), low carbon transport (18%), green finance (11%), climate change strategy, monitoring and planning (11%), climate change research and development (11%) all have double-digit annual growth rates in the period to 2030. This reflects the need to move quickly in the next decade to face the climate emergency. Following this period of very fast growth, yearly growth rates tend to reduce over the years to 2050, but remain significantly above that expected across the economy generally.

Table 17: *Projections of yearly growth rates of green jobs by sector*

	2021-2030	2031-2040	2042-2050
Green finance	11%	5%	5%
Power	4%	4%	2%
Homes and Buildings	7%	1%	1%
Low Carbon Transport	18%	4%	4%
Climate change strategy, policy, monitoring and planning	11%	5%	5%
Climate change Research and Development	11%	5%	5%
Reduce, reuse, recycle	2%	1%	1%
Industrial decarbonisation, hydrogen and carbon capture	22%	6%	6%
Climate adaptation	5%	5%	5%
Reducing localised pollution	5%	5%	5%
Green and Blue infrastructure	4%	2%	2%
Total	8%	4%	4%

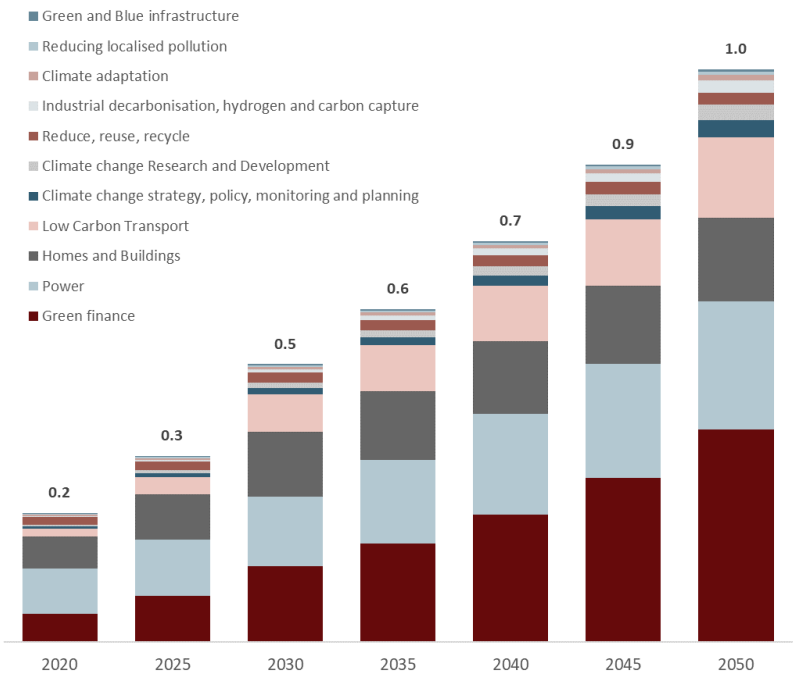
Figure 11 shows the central scenario for the overall total of green jobs in London projected out to 2050, as well as the breakdown of these jobs by the different sectors. It shows that the total number of green jobs projected under the central scenario rises from 234,000 in 2020, to 505,000 in 2030 and then a little over 1 million in 2050. This represents a 4.5-fold increase in green jobs in London over three decades.

The chart shows that, by 2050, there are four sectors which provide nearly 9 in 10 (88%) of the total number of jobs. These are:

- Green finance (387,000), representing 37% of total green jobs in London.
- Power (232,500), representing 22% of total green jobs in London.
- Homes and Buildings (151,700), representing 15% of total green jobs in London.
- Low Carbon Transport (147,200), representing 14% of total green jobs in London.

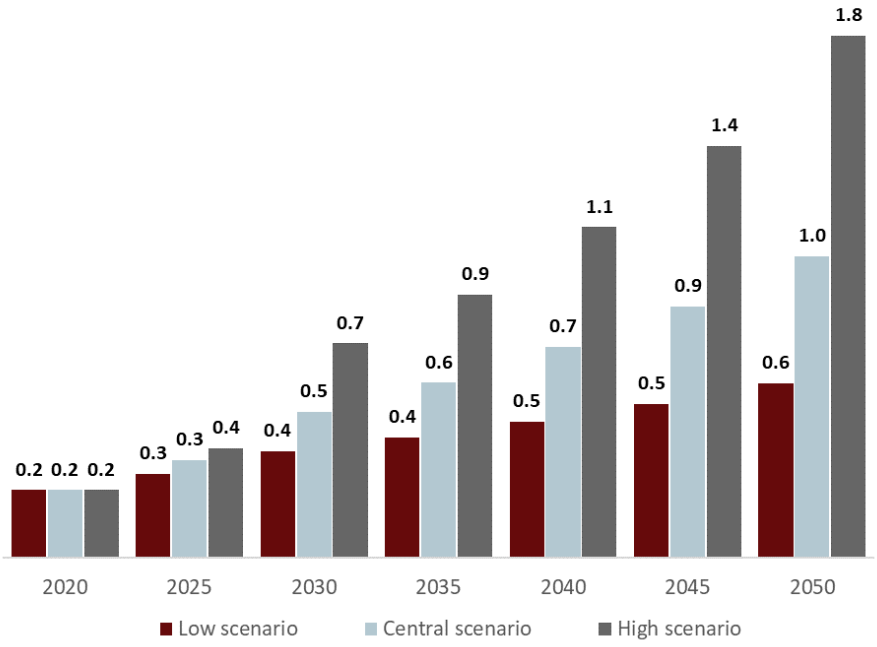
Figure 12 shows the difference in total green jobs in London for each of the three scenarios. Under the high scenario, there are an additional 764,000 green jobs in London compared to the central scenario. However, for the low scenario, total green jobs in London are projected to be 438,000 lower than under the central scenario.

Figure 11: Projections of green jobs in London – central scenario (millions)



Source: WPI calculations

Figure 12: Scenarios for projections of total green jobs in London (millions)



Source: WPI calculations

Table 18: Low, central and high projections of green jobs in London in 2030 and 2050

Sector	2020	2030			2050	
		Low	Central	High	Low	Central	High
Climate adaptation	**2,400**	3,100	**3,900**	4,500	5,000	**10,000**	15,000
Climate change Research and Development	**3,700**	7,900	**9,900**	12,400	18,300	**28,000**	42,400
Climate change strategy, policy, monitoring and planning	**4,100**	8,800	**11,100**	13,800	20,400	**31,100**	47,100
Green and Blue infrastructure	**1,600**	2,000	**2,400**	2,800	2,400	**3,600**	5,100
Green finance	**50,700**	109,400	**137,600**	172,100	253,500	**387,000**	586,600
Homes and Buildings	**58,200**	83,300	**117,600**	196,400	94,600	**151,700**	151,700
Industrial decarbonisation, hydrogen and carbon capture	**900**	2,500	**6,400**	15,000	4,700	**21,600**	90,300
Low Carbon Transport	**13,700**	31,900	**69,200**	142,100	46,600	**147,200**	436,600
Power	**82,900**	102,700	**126,600**	155,500	139,400	**232,500**	384,100
Reduce, reuse, recycle	**14,500**	15,000	**18,100**	23,000	15,600	**22,600**	36,700
Reducing localised pollution	**1,600**	2,100	**2,600**	3,000	3,300	**6,700**	10,000
Total	**234,000**	369,000	**505,000**	741,000	604,000	**1,042,000**	1,806,000

Source: WPI calculations

How the scenarios relate to policy

Whether a low, central or high scenario is met in each sector will clearly be dependent on a number of complex and interrelated factors. One of these key factors is policy action from national and local governments. In many sectors (for example, green finance and climate change research and development), achieving a high scenario is likely to require London tapping into globally significant markets, and this will depend on a range of policy actions from skills and innovation policy to developments around trade and regulation.

Of course, there are also much broader considerations than government policy. In order to understand how green sectors could evolve, it is instructive to consider how the CCC models different

pathways to reaching net zero in its Sixth Carbon Budget. According to the CCC, who in turn drew on a broad range of analyses, two key determinants of pathway to net zero are as follows:

- **Engagement and behaviour change** – the extent to which members of the public/businesses actually adopt low carbon options and behaviours, e.g. to install energy efficiency measures in their homes; and
- **Innovation** – how does technology which helps to replace fossil fuels to reduce energy assumption evolve over the coming decades. For example, what cost reductions are possible as we scale heat pumps, hydrogen or CCUS.

Clearly, these two effects are in turn impacted by Government policy. A good example of a single Government policy which could affect both is the £5,000 grant announced by Government as part of the new Heat and Buildings Strategy.[71] By reducing costs associated with moving to low carbon heating, Government is encouraging behaviour change in this direction. Furthermore, stimulating the market through demand will help to scale these technologies and potentially create the space for companies to innovate.

To give an example of how these two different factors play out to affect decarbonisation pathways, consider the CCC's exploratory scenarios in the Heat and Buildings sector below:

Table 19: Sixth Carbon Budget exploratory scenarios for buildings

	Low behaviour change/engagement	High household behaviour change/engagement
Low innovation	Headwinds scenario – 71% of homes using hydrogen for heat (still 13 million heat pumps)	Widespread engagement – fully electrified scenario (including heat networks)
High Innovation	Innovation – 10% use of hydrogen, widespread use of heat pumps	Tailwinds scenario – 11% using hydrogen for heat, particularly homes around industrial clusters. Otherwise – fully electrified and no biomass

Source: CCC Sixth Carbon Budget[72]

However, while different in various ways, the CCC exploratory pathways all result in the UK meeting net zero in 2050. This means that, even if net zero was achieved, the scale and nature of the different green sectors (both in London and nationally) could be quite different under different scenarios.

There is also a clear risk of insufficient policy and investment to meet net zero, and low scenarios occurring as a result of this. For example, through its net zero policy tracker, Green Alliance has suggested that there is currently a £64 billion shortfall nationally in the spending on net zero required over the course of this parliament.[73]

Together, this means that our projections provide an indication of the scale of green jobs that could be feasible in London and how this might vary based on a range of different factors, including the success or failure of government policy. If London is to take the opportunity provided by the transition, achieving the high scenarios should be the aim. This will clearly require the right choices from policymakers, underpinned by ambitious goals such as London's 2030 net zero target.[74]

Implications of the scenario results for skills provision

In the context of the focus of this report, skills provision and associated policy responses are a vital part of getting that policy landscape right.

The central employment projections suggest an increase in the green-jobs workforce of around 27,000 per year to 2030. Overall, this represents an increase in the total green workforce of 116% from its current level. The numerical scale of the increase in green jobs is similar for the 20 years following that. The key issue is how this increase compares with the current level of skills provision, and how easy it will be for green businesses to meet their future skills needs.

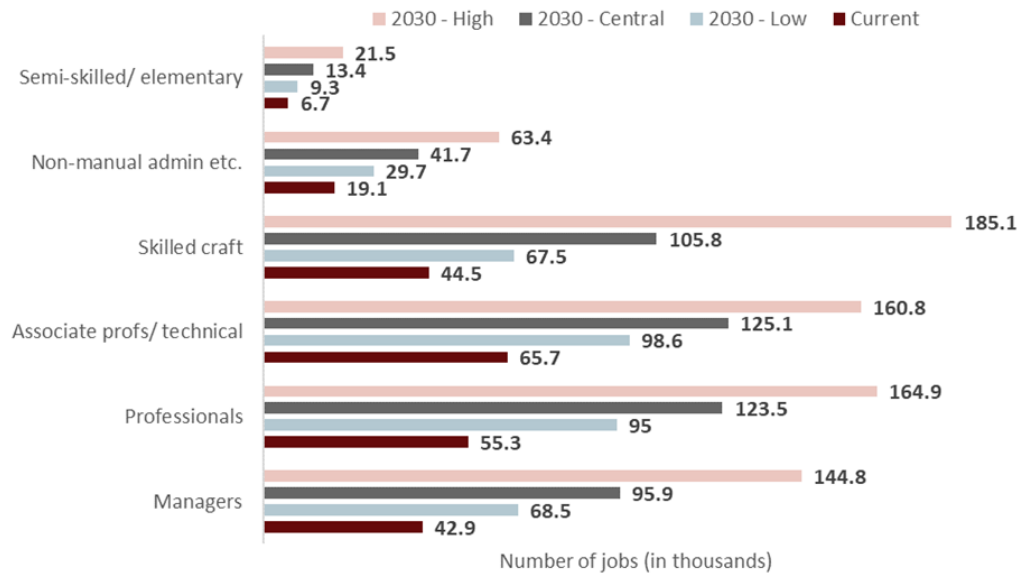
The first thing to note is that there are markedly different rates of increase across the different sub-sectors. Using the four broader sub-sectors in the skills analysis, the size of the reduce, reuse, recycle sector could increase by around 25% over the coming decade, while the projection for the power sector shows that the implications of National Grid's net zero work planning are an increase in the London workforce of just over 50%. the homes, buildings and landscape sector (including low carbon transport) will increase by about 160%, and the consultancy and finance sector will increase by around 170%.

The key questions from a skills point of view are:

- What are the likely occupational changes over this period; and
- How this increase compares with the current level of skills provision, and how easy it will be for green businesses to meet their future skills needs.

Figure 13 shows the projected changes by occupational group to 2030, while Table 20 shows the detail behind the figure. The projections are calculated by applying the growth rate in each of the four broad sectors to the estimated number of current workers in each occupation in that sector, to forecast the number of workers in that sub-sector and occupation in 2030 under the different scenarios. These are then summed to give total for green jobs in the different occupational groups. This method assumes that the skills mix within each of the four broad sub-sectors will be the same in 2030 as it is now, but the mix across all green jobs will change as some sectors are forecast to grow much faster than others.

Figure 13: Change in occupational group to 2030



Source: IES calculations

Considering the central forecast first, the largest increase, in numeric terms, is among professional workers, whose numbers are projected to increase by 68,000 to reach 124,000 in 2030, an increase of 123%. By 2030, the number of professional workers is projected to have risen above the number of associate professional workers, as the latter have a relatively low projected increase in employment, of 90%. Skilled craft workers are projected to experience the fastest growth, of 138%, with numbers rising by 61,000, while the growth rate in the number of managers is similar to that for professional workers, at 124%.

Under the low jobs forecast, to total number of jobs is projected to rise by 13,000 per year to 2030. Professional workers are projected to experience the largest increase in percentage terms as well as numeric terms, with numbers rising by 70 per cent, followed by managers (60% increase), skilled craft workers (52%) and associate professional workers (50%).

The high jobs forecast projects that there will be an average increase of 50,000 workers per year across all green sectors to 2030, with a fourfold increase in the number of skilled craft workers, from 45,000 currently to 185,000 in 2030 (316% increase), and this will be the largest occupational group in 2030 under this scenario.

Table 20: Change in employment by occupational major group (central scenario)

	Current	2030	Change	% change
Central forecast				
Managers	42,900	95,900	53,000	124
Professionals	55,300	123,500	68,200	123
Associate profs/ technical	65,700	125,100	59,400	90
Skilled craft	44,500	105,800	61,300	138
Non-manual admin etc.	19,100	41,700	22,600	118
Semi-skilled/ elementary	6,700	13,400	6,700	99
Low forecast				
Managers	42,900	68,500	25,600	60
Professionals	55,300	95,000	39,700	72
Associate profs/ technical	65,700	98,600	32,900	50
Skilled craft	44,500	67,500	23,000	52
Non-manual admin etc.	19,100	29,700	10,600	55
Semi-skilled/ elementary	6,700	9,300	2,600	37
High forecast				
Managers	42,900	144,800	101,900	238
Professionals	55,300	164,900	109,600	198
Associate profs/ technical	65,700	160,800	95,100	145
Skilled craft	44,500	185,100	140,600	316
Non-manual admin etc.	19,100	63,400	44,300	232
Semi-skilled/ elementary	6,700	21,500	14,800	219

Source: IES, WPI Economics

Table 21 shows the detailed occupational unit groups with the largest projected increase in numbers to 2030. The number of business and related associate professionals not elsewhere classified (business systems analysts, data analysts, project coordinators etc.) is projected to increase by 25,000, accounting for nearly one tenth of the total increase, although this is the lowest growth rate among the occupations

with the largest increases in numbers, at 61%. The number of management consultants and business analysts is projected to increase by 15,200, representing an increase of 167% on current numbers,. Among the craft occupations, there are large projected increases for electricians (17,500, increase of 140%), gardeners and landscape gardeners (12,600, 161%) and plumbers (9,900, 161%), while the other occupations with large projected increases in numbers are production managers in construction, and marketing and financial managers and directors.

Table 21: Occupations with the largest projected increases in employment to 2030

	Current	2030	Change	% change	% of total increase
3539 'Business and related associate professionals n.e.c.'	40,800	65,700	24,900	61	9.2
5241 'Electricians and electrical fitters'	12,400	29,900	17,500	140	6.4
2423 'Management consultants and business analysts'	9,100	24,400	15,200	167	5.6
5113 'Gardeners and landscape gardeners'	7,900	20,500	12,600	161	4.7
5314 'Plumbers and heating and ventilating engineers'	6,200	16,100	9,900	161	3.7
1122 'Production mngrs and directors in construction'	6,100	15,900	9,800	161	3.6
1132 'Marketing and sales directors'	9,000	17,100	8,100	89	3.0
5319 'Construction and building trades n.e.c.'	5,200	13,100	7,900	150	2.9
1131 'Financial mngrs and directors'	4,700	12,400	7,700	163	2.8
2136 'Programmers and software development professionals'	11,000	18,500	7,500	69	2.8

Source: IES, WPI Economics

There are some differences in the rank order of occupations by size of increase under the alternative low and high jobs scenarios. Under the low jobs scenario, management consultants and business analysts are projected to experience the second largest increase after business and related associate professionals not elsewhere classified, with increases of 110% and 29% respectively, while there are also relatively large increases for sales associate professionals, and business and financial project management professionals. Under the high jobs scenario, the increase in electricians and electrical fitters is projected to be nearly as large as the increase in business and related associate professionals not elsewhere classified (increases of 40,300 and 41,500 respectively, with percentage increases of 324% and 102% respectively), and the number of gardeners, plumbers and production managers in construction is projected to increase by around 370%.

The Friends of the Earth Green Jobs report looked into the skills situation at a national level for the occupations it identified as being within green jobs. It is worth noting that that occupations related to the homes, building and landscape sector – electricians, plumbers, production managers in

construction – had current skills shortages, that is employers already struggled to fill vacancies, as well as significant retraining being needed for the current workforces to meet decarbonisation needs.

Having looked at the likely occupational changes over the coming decade, we turn to comparing with future increases in demand with the size of the output from education and training provision to provide insights into how easy it may be for employers to meet their future skill needs. It should be remembered that green sectors currently draw very few workers directly from full-time education, with most new entrants coming in from other sectors, although with the rapid projected growth over the coming decade, employers may need to draw more new workers straight from education.

The current data on skills provision show that across London there are around 22,000 learners per year in FE in relevant subject areas, and around 42,000 HE students each year in relevant subjects, giving an annual output from FE and HE of around 65,000 students. Thus, if the projected expansion of the sector were to be met solely from new entrants from full-time education (and given the current in-flows from education this is a rather unlikely assumption), green employers would need to attract half of all education leavers with potentially relevant skills, and an even higher proportion if FE leavers progress to HE rather than entering the labour market. The current analysis of flows suggests that the sector recruits around 2,500 education leavers per year, so this suggests a more than ten-fold increase in business' recruitment from education over current levels, if the growth in demand was met solely from education leavers and not from those switching sectors/occupations.

The relationships between subject areas and broad sector are such that it is only advisable to look at the balance between future labour demand and current skills provision at a broad level of consultancy-based jobs and skills, and craft-based jobs and skills. The former covers the consultancy and finance sector, and the majority of the power sector, while the latter cover the homes, buildings and landscape, reduce, reuse, recycle, and the rest of the power sector. The balance of future demand and current supply in these are as follows:

- The number of consultancy-based jobs is projected to increase by around 13,400 per year over the coming decade, while current FE and HE provision is around 41,500 students per year, so future demand equals 32% of the annual output from education.
- The increase in craft-based jobs is projected to be similar, at around 13,600 per year, and provision is smaller, at around 23,000, so future demand is a higher proportion of current education provision than in the consultancy-based side, at 59%.

These analyses show that to meet the rapid expansion of the sector over the coming decade there is an urgent need to

- increase education provision in subjects and courses that are relevant for green jobs;
- increase the proportion of those taking relevant courses who progress to employment within green sectors; and
- increase the flows from other, non-green, sectors into green sectors, including through re-skilling training.

Given the size of the projected increases in the number of green jobs, and the current low rate of in-flow from education into the sector, it is likely that the flows from other sectors will be the main source of new entrants, at least in the short term while green education and training provision increases to meet the needs of the sector.

The green sector currently recruits a far higher proportion of new entrants from other sectors than directly from education, but the skills pipeline also needs to supply replacements for these workers, as well as expand to increase supply directly to the green sector.

In summary, the green sector in London will experience large increases in employment, even under the low jobs scenario, and employers will face challenges recruiting the skills to meet future needs. They currently source a far higher proportion of new entrants from other sectors than straight from education, and this is unlikely to change in the short term. However, over the medium term, employers and education providers will need to work together to increase provision in current and emerging green areas, and a growing awareness of and interest in sustainability among young people should support this expansion of provision, with a clear steer from government and the funding systems. Consultancy and finance based green sectors may find it easier to meet future needs from the large professional services sector in the capital, and the large output from education providers in these subject areas; however, employers of skilled craft labour may find it much harder to recruit the skills they need, given a much smaller supply in other sectors, much smaller numbers of students taking these courses, and current skills shortages in these occupations. Across all green sub-sectors there is a need to widen access to groups that are currently under-represented, to maximise the potential skills supply and to reduce existing labour market inequalities.

5. Impact on the total number of jobs

How will the transition to a net zero economy affect the overall number of jobs in the London economy? In Chapter 4 we projected the estimated number of green jobs across London in each of our eleven sectors. However, these are not all additional jobs to the London economy because:

i. A non-green job may have become a green job; for example, a fossil-fuel based energy job becoming a renewable energy job; and

ii. Some jobs may cease to exist.

The Committee on Climate Change (CCC) commissioned modelling to look at the impact on the UK economy of the sixth carbon budget,[75] which included the policy changes necessary to reach net zero. This analysis modelled the impact on net jobs – i.e. how will overall employment levels be affected by the transition to net zero.

This modelling found that **there will be an increase in the net number of jobs over the next three decades in the UK due to the change to a net-zero carbon economy by 2050, alongside increases in both GDP and incomes.** This is because:

i. The transition to a low carbon economy requires that investment is brought forward into capital-intensive technologies, stimulating economic demand;

ii. The decarbonisation of power reduces the imports of oil and gas, which in turn increases domestic production, leading to increases in GDP and employment; and

iii. Electricity prices are expected to fall, as economies of scale for low carbon energy technologies are substantial. Low electricity prices boost GDP and employment and also reduces consumer prices across the economy.

Employment is projected to be around 1% higher by 2035, equivalent to 300,000 net jobs across the whole of the UK economy. There will however be some sectors declining, in particular a reduction in demand for refined oil means a large fall in the mining and refinery sector nationally. However, all other sectors of the economy see increases in output and employment, both directly due to capital investment and indirectly due to higher output across the economy.

Table 22: Estimated impact of net zero policies on net employment in the UK, by sector

Sector	Employment, UK (% change from baseline of current policies rolled forward)	
	2030	2050
Agriculture	4.2%	2.9%
Mining and refinery	-7.8%	-11.0%
Utilities	4.5%	35.5%
Manufacturing and construction	1.1%	0.5%
Distribution, retail, hotel and catering	1.8%	0.9%
Transport and communications	2.0%	0.1%
Services	0.2%	0.0%

Source: Climate Change Committee (2020)[76]

We have estimated the impact on the London economy of the move to net zero policies by overlaying these sectoral changes on London's pattern of sectoral employment. Table 23 shows the current number of jobs, the number projected to exist if current policies are continued, and the number projected to exist if policies that will reach net zero are introduced.

This suggests that there will be a small positive impact of a change to net zero policies on London, increasing net employment by around 50,000 jobs in 2030 and around 20,000 jobs in 2050. It is possible this is an underestimate as this analysis does not take account of the occupational mix, and London may benefit from a greater proportion of professional and higher qualification level jobs in green professions. However, the increase in jobs is likely to be broadly spread across occupation types because much of the growth arises from increased demand across the economy stimulated by the green economy.

Table 23: Estimated impact of net zero policies on net employment in London

Sector	Jobs in London, 2019	Estimated jobs in London, 2030			Estimated jobs in London, 2050		
	Latest data	Based on current policies	With net zero policies	Change due to net zero policies	Based on current policies	With net zero policies	Change due to net zero policies
Agriculture	1,800	1,600	1,600	0	1,200	1,300	100
Mining and refinery	2,500	2,300	2,100	-200	1,700	1,600	-100
Utilities	28,000	25,300	26,500	1,200	19,600	26,500	6,900
Manufacturing and construction	328,000	325,900	329,500	3,600	311,400	312,900	1,500
Distribution, retail, hotel and catering	1,054,000	1,106,800	1,126,800	20,000	1,134,900	1,145,100	10,200
Transport and communications	708,000	766,900	782,200	15,300	838,000	838,800	800
Services	3,246,000	3,624,200	3,631,500	7,300	4,136,000	4,136,000	0
Total	5,368,000	5,853,000	5,900,000	47,200	6,443,000	6,462,000	19,400

Source: WPI calculations based on Climate Change Committee (2020)[77] and ONS Business Register and Employment Survey

6. Jobs at risk from decarbonisation and equalities impacts

The disproportionate impacts of climate change and its effects on vulnerable groups, ethnic minorities and poorer countries and communities is recognised across both local, national and international literature and narratives.[78] There is also recognition of the need for a transition to net zero which does not leave certain groups and communities behind, both internationally and in the UK, with a particular focus on sectors and industries with the greatest need for change, such as those in transport, manufacturing and extractive industry jobs.[79] However, there is little literature quantifying the potential impacts of the UK transition to net zero on groups such as BAME populations, women, disabled people and older adults. One of the reasons cited has been the lack of adequate data on minority groups to make robust predictions.[80]

Analysis of selected existing data by the Green Jobs Taskforce presented the current state of play of certain sectors and occupations relevant to the net zero transition in terms of gender and ethnicity representation. The analysis found that only around one fifth or less of employees in the offshore wind, nuclear, green finance and rail sectors identify as female, and only a quarter in oil and gas.[81] Turning to the LCREE survey to consider representation of different ethnicities in the low carbon economy, the research finds that over 90% of employees in manufacturing, electricity, gas, steam and air conditioning supply and construction are White, with this group making up 89% of the professional, scientific and technical activities sector. This is slightly greater than the average across all industries of 87%.[82] Policy Exchange published findings from analysis of the Labour Force Survey which found that 'environment professionals' was one of the least ethnically diverse occupations in the UK, second only to farmers in this respect.[83]

Another estimate by the Grantham Institute and UK100 has found that 3.1 million jobs will need access to skills and training due to the move to a green economy – over half a million of these are in London.[84] Research by the Grantham Institute suggests that construction, transport and manufacturing are the sectors which face the greatest level of reskilling, sectors identified by GLA Economics as having a higher than London average proportion of BME workers.[85] Other analysis by GLA Economics has considered the potential impacts of a just transition on different high-emitting industries and the ethnic make-up of the workforces in these, or in boroughs with a high number of employees in these sectors. For example, changes to the transport and storage sector will disproportionately impact those from minority ethnic groups; 50% of employees in the transport and storage industry are from an ethnic minority background compared with 35% across all industries in London.[86]

To build on this existing evidence, and to understand the potential implications of the findings in this report, we have assessed the set of eleven carbon intensive industrial activities as a proxy for those areas likely to undergo the most substantial change in the coming decades. The eleven sectors we look at follow the report *Greening the Giants* (Onward, 2021)[87] which identifies sectors that either have emissions above 100tCO_2e per job or which contribute more than 2% of annual total UK emissions. We identify 390,000 of London's 5.3 million jobs in these sectors, shown in table 24 below.

Although it is not possible to get demographic data at a detailed industrial breakdown, we can establish the likely picture by using the broad section level SIC codes for each of the eleven areas. If we assume that the carbon intensive activity will be approximately in line with the broad SIC section it sits within then the following picture emerges:

- London has relatively fewer jobs highly exposed to transition than the rest of the economy, where 11% of jobs are in the sectors identified;

- 38% of people in employment in London in the sectors highly exposed to transition are non-White versus 11% nationally. However, this is in line with London employment as a whole where 36% of people in employment identify as non-White;
- The national data suggests that the carbon intensive industries have relatively more male employees, with female workers accounting for only 18% of the employees. London data is not available for many of the SIC codes from the ONS unfortunately; and
- There is no strong pattern in the age of works in the eleven carbon intensive sectors.

Overall, it is clear that, wherever the impacts of the transition fall, there are potentially significant changes to many people's jobs. As London's population is more diverse than that of the country as a whole (in terms of ethnicity and a range of other characteristics),[88] changes in London will also be likely to overlay on existing inequalities felt by these diverse groups and communities.

However, the green transition also represents a significant opportunity. London is one of the most inequitable places in the UK, with huge inequalities in pay, qualifications, health and outcomes such as poverty and deprivation. The changes that we are about to see through the shift to green sectors provides an opportunity to turn those around. With the right skills provision, and support both for those needing to transition from non-green jobs and those not currently in work, the green sectors identified in this report could provide the higher-skilled, more productive, stable and better-paid work that many families in London need to be able to make ends meet. By doing so, as well as driving a just transition, these green jobs could also drive inclusive growth and tackle the underlying inequalities that have existed in London for decades. We hope that this report provides at least part of the evidence base that is needed to build an understanding of how this might happen.

Table 24: Jobs in carbon intensive sectors

	SIC code section	Employment, 2019	Proportion of employees that identify as an ethnicity other than "White"		Proportion of people in employment that identify as female		Proportion of people in employment aged 16-64 that are under 25		Proportion of people in employment aged 16-64 that are over 50	
		London	*London*	*Great Britain*	*London*	*Great Britain*	*London*	*Great Britain*	*London*	*Great Britain*
					NB/ This data is at the SIC code section level only					
Construction	F	205,000	24%	7%	-	14%	4%	10%	35%	38%
Land Transport	H	112,700	55%	18%	39%	22%	4%	7%	22%	31%
Aviation	H	37,000	55%	18%	39%	22%	4%	7%	22%	31%
Waste and sewerage	E	12,750	56%	7%	-	23%	8%	8%	19%	31%
Electricity, gas, steam and air conditioning supply	D	12,000	44%	10%	-	23%	8%	8%	19%	31%
Carbon intensive manufacturing	C	6,260	38%	9%	-	27%	10%	9%	35%	36%
Shipping and fishing	Mostly H	3,050	55%	18%	39%	22%	4%	7%	22%	31%
Oil and gas	B	1,750	44%	7%	-	23%	8%	8%	19%	31%
Agriculture	A	1,000	4%	1%	-	26%	N/A	14%	30%	62%
Steel	C	185	38%	9%	-	27%	10%	9%	35%	36%
Coal and lignite mining	B	0	Not applicable as zero jobs in London							
Total in carbon intensive sectors		**390,000**	**38%**	**11%**	**-**	**18%**	**5%**	**9%**	**29%**	**35%**
All industries		**5,252,000**	**36%**	**13%**	**-**	**48%**	**7%**	**11%**	**27%**	**34%**

Source: ONS Business Register and Employment Survey (BRES) and Annual Population Survey (APS). Notes: The data on gender breakdown of industries in London for SIC codes A-F is not available; the ONS say the figures are suppressed as they are statistically unreliable. The Onward Greening the Giants report included the Retail sector as it accounts for over 2% of UK emissions, even though it has a relatively low amount of emissions per job. However, they excluded the sector from their cross-sectional analysis as they noted a recent LSE study that shows the sector is 91% non-exposed to the transition. We therefore also exclude the retail sector. We use total Employments from the BRES survey, including self-employed workers.

Annex A: Interim Report

Executive Summary

Introduction

To shape the green economic recovery local authorities across London need a firm understanding of the jobs that make up the green economy now, how the labour market might change in the future and what skills people will be required to contribute effectively to the changing economy. To help in this process we have been commissioned by the four sub-regional partnerships in London to form a shared understanding and establish a definition of 'green jobs' and 'green skills' based on best practice that works in a London context.

Given the range of existing definitions and approaches in place, this first stage report considers the definition of 'green jobs' and 'green skills' and provides an overview of current Higher Education / Further Education skills provision in London.

Approaches to defining a "green job"

We have identified six definitions / approaches that are potential routes to defining a green job in a London context:

i. Environmental Goods and Services Sector (EGSS).

ii. Low Carbon and Renewable Energy Economy estimates (LCREE).

iii. Low Carbon and Environmental Goods and Services Sector (LCEGS).

iv. Task-based approaches.

v. International Labor Organization definition.

vi. "Mission-based" definition following Green Jobs Taskforce

The table at the end of this section summarises the pros and cons of these six approaches for use in a London context. The majority of the feedback from our stakeholder sessions was that the need for a common definition of green jobs for London boroughs arises from the practical questions that arise for policy makers – for example how will the labour market change during the net zero transition, what do skills providers need to plan for and what support do they need, and what programmes and policies are required to support citizens and make a strong green economy? Therefore, we recommend the use of a mission-based definition that prioritises practicality and a strong link to both net zero and broader environmental goals.

We have built on the recent approach by the Green Jobs Taskforce that identified seven sectors to produce a version tailored for the London context, shown in the box below.

Phase 2 of this project will operationalise this definition to understand the situation in London now, and to forecast the potential implications of future changes in the green economy. We explore three approaches for mapping the green economy against the mission-based definition:

- Mapping standard industrial and occupational classifications data to proposed sectors

- Mapping Low Carbon and Environmental Goods and Services Sector (LCEGS) data to proposed sectors
- Using Real-Time Industrial Classifications to develop detailed company level understanding of the green economy in London.

Mission-based definition: proposed sectors for a London based definition

Net zero focus

1. **Homes and buildings:** Including retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen & electric boilers
2. **Low carbon transport:** Including low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling;
3. **Power:** Including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology;
4. **Business and industry**: including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation
5. **Green Finance:** The concentration of financial activity in Central London means that in our context Green Finance could be a key area to separately identify
6. **Climate change research & development:** Including private sector, academic and public research.
7. **Climate change strategy, policy, monitoring and planning:** Including public, private and NGO sector strategy and policy, outreach to citizens, environmental monitoring and use of planning system to achieve net zero
8. **Climate adaptation:** Including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation.

Broader environmental goals (may have some impact on climate change goals)

9. **Reducing localised pollution:** Including air pollution, water pollution and noise; London has ambitious goals across all three of these areas
10. **Reduce, reuse, recycle:** Including waste management and circular economy
11. **Green and blue infrastructure:** Within a London context this will focus on urban green and blue infrastructure, and include activity aimed at increasing biodiversity directly or through offsetting

Source: WPI Economics

London's economy and the distributional impact of decarbonisation

Phase 2 of this project will also look at the equalities implications of jobs that will be significantly affected by the greening of the economy – either reducing in number or requiring substantial reskilling. Key aspects that the literature review in this report finds include that high-emitting industry groups, such as transport, tend to account for a relatively small share of employment among London residents but there is likely to be a disproportionately large impact for those from a non-white ethnic group.

Looking at the sectoral employment breakdown we find that the Central London Forward sub-region has the highest proportion of overall employment but also the highest proportion of jobs in sectors such as finance that account for very low proportions of London's emissions. There are concentrations of industrial activity in other areas of London of importance to the distributional consequences – for example 12% of jobs in the West London Alliance sub-region are in transportation and storage.

Summary prioritisation table for definitional approaches

Name	Definition	Government recognised definition?		Comprehensibility & strength of relationship to political narrative	Feasibility		Sector coverage			
							Broader than net zero?	Up to date with modern economy		In London context?
Environmental Goods and Services Sector (EGSS)	*Areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources*	✓✓✓	National statistic	✓	✓✓	Would require ONS to provide data	✓✓✓	✓	Based on SIC codes	✓
Low Carbon and Renewable Energy Economy estimates (LCREE)	*Economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide*	✓✓✓	National statistic	✓✓	✓✓	Would require ONS to provide data	X	✓✓	Survey updated annually but still misses areas due to SIC code limitations	✓
Low Carbon and Environmental Goods and Services Sector (LCEGS)	*EGSS sectors expanded to include activities that contribute and enable growth in the sector, including value and supply chains*	✓✓	GLA commissioned report	✓✓	✓✓✓	Requires data purchase	✓✓✓	✓✓✓	Approach updated regularly	✓✓✓
Task-based approaches	*Approaches typically from the United States that identify green tasks, and then the proportion of each job type that is spent on green tasks*	X	Current applications US based	✓✓✓	X	Timescale too short	✓✓✓	✓✓✓	Depending on approach	✓✓✓
International Labor Organization	*Jobs which reduce the consumption of energy and raw materials, limit greenhouse gas emissions, minimize waste and pollution, protect and restore ecosystems and enable enterprises and communities to adapt to climate change. In addition, green jobs have to be decent.*	✓	Internationally recognised	✓✓	X	Not operationalised	N/A	N/A		N/A
Mission-based definition following Green Jobs Taskforce	*Employment in an activity that directly contributes to - or indirectly supports - the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks. 7 specific policy areas identified*	✓✓	National Government commissioned report	✓✓✓	✓✓✓ ✓✓	With modern methods With publicly available data	✓✓✓	✓✓✓	Can use modern methods	✓✓
Mission-based definition: tailored to London context	*Same as above but tailored to London context - suggested 11 areas including Green Finance, Environmental R&D and Reducing Localised Pollution (air, water and noise)*	✓	Adapting a government recognised approach	✓✓✓	✓✓✓ ✓✓	With modern methods With publicly available data	✓✓✓	✓✓✓	Can use modern methods	✓✓✓

Approaches to defining 'green skills'

Feedback was obtained from a number of Further and Higher education providers regarding definitions of green skills and issues in green skills provision. Providers were aware of the range of definitions of green jobs used but felt that it was not an easy task to clearly define green skills that supported those jobs. Often green provision was a top-up for traditional trade skills (e.g. retrofitting heat pumps for trained heating engineers), or green skills were a smaller element of a larger course or qualification. Furthermore, the definition of green skills would depend upon the definition of green jobs, as the nature of jobs would determine the nature of skills. We have developed a definition of green skills that reflects the policy areas of the mission-based definition, and could link to the classifications of courses and qualifications used in Further and Higher Education:

- Green social sciences
- Environmental Protection/ Conservation
- Energy Economics / Management / Conservation
- Pollution / Pollution Control
- Recycling Collection / Treatment
- Building / Construction Operations
- Building Maintenance / Services
- Mechanical engineering
- Power/Energy engineering

It was recognised that the independent training sector played a large role in providing green skills, and their views would be collected in the later stage of the research. Major issues for Further and Higher Education providers in terms of green skills provision were the lack of clarity over what is funded and current green provision being a small part of broader courses or qualifications rather than something that can be taken in its own right. There was a low level of demand from learners currently, although this is anticipated to rise over time with the increase in policy importance and a rising interest in sustainability among young people.

1. Introduction – the purpose of defining green jobs and green skills

The UK's Net Zero agenda includes a wide range of targets, programmes and initiatives including a legal commitment made in 2019 to decarbonise the economy by 2050 and the launch of the Ten Point Plan in 2020. The Climate Change Committee's 6th Carbon Budget has suggested that over half of climate change action will need to occur at the local and individual level, with local authorities spearheading a considerable part of these efforts.

Local authorities in London are committed to acting quickly to tackle the significant threat that climate change presents, with many declaring more ambitious timelines than those of central Government. For most London councils, this will require moving from a carbon-based economy to a net zero carbon economy within a generation,[89] and many of the capital's boroughs have published Climate Action Plans to outline how they seek to do this (see annex B). There is a collective commitment to develop a greener economy that can address the combined challenge of the climate emergency and the substantial economic challenges raised by the pandemic. By one definition, the green economy is worth £48 billion to the London economy each year, rising from £30 billion in 2014/15.[90]

However, London has been hit hard by the pandemic. Economic activity fell by 7.2% in 2020.[91] Despite the recent recovery in the labour market the number of payrolled employees living in London is still down by 129,400 people or 3.1%, compared to a 0.6% decline across the UK over this time.[92] Growth on this measure is also slower in all parts of London than the rest of the UK, especially in West and North-West London.[93] Central London also faces unprecedented challenges due to the impact of the restrictions on events, entertainment and hospitality through the pandemic and an £11 billion decline in spend from tourism compared to 2019.[94] However, London is also crucial to the country's economic recovery; it accounts for 24% of the UK's GDP[95], despite only accounting for 13% of the UK's population.[96]

To shape this green economic recovery local authorities across London need a firm understanding of the jobs that make up the green economy now, how the labour market might change in the future and what skills people will be required to contribute effectively to the changing economy. This will enable the four sub-regional partnerships, London's boroughs and other public authorities to:

- Develop skills and employment policy to drive inclusive growth in the green sector, and make sure all London's residents have access to the skills and support they need to enter and sustain good work.
- Develop a shared public narrative on green jobs and skills to emphasise and explain London's collective commitment to de-carbonisation
- Provide an evidence base for communication with residents, careers advisers and community groups on what the green transition means for jobs and skills

To help in this process we have been commissioned by the four sub-regional partnerships in London[97] to form a shared understanding and establish a definition of 'green jobs' and 'green skills' based on best practice that works in a London context. Using this definition, we will go on to produce quantitative scenario analysis that will provide a practical tool to shape green skills and employment provision to match the needs of each sub-region within London.

Given the range of existing definitions and approaches in place, this first stage report considers the definition of 'green jobs' and 'green skills' and provides an overview of current Higher Education /

Further Education skills provision in London. This has been informed by desk-based research, along with extensive consultation with Skills & Employment Officers and Recovery Leads from across London boroughs, representatives of Central London Forward's Employment and Skills Board, Further and Higher Education institutions, London Councils, Greater London Authority economics and green skills leads and others including representatives of the Office for National Statistics, Green Alliance, and ReLondon.

To provide background to the approach recommended here, the annex gives an overview of the green recovery in a London context.

2. Approaches to defining a "green job"

Despite an established and growing interest in the green economy across a broad range of organisations there is no single or standard definition of a 'Green Job' at the national or international level. The criteria for existing definitions differ on what industries or activities should be included, how to account for indirect jobs and supply chains, and whether certain industries (and jobs themselves) fall neatly under a 'green'/'non-green' split, or if the reality is more nuanced.

We have identified six definitions / approaches that are potential routes to defining a green job in a London context:

vii. Environmental Goods and Services Sector (EGSS).

viii. Low Carbon and Renewable Energy Economy estimates (LCREE).

ix. Low Carbon and Environmental Goods and Services Sector (LCEGS).

x. Task-based approaches.

xi. International Labor Organization definition.

xii. "Mission-based" definition following Green Jobs Taskforce.

Table A1 summarises the pros and cons of these definitions which the remainder of the chapter explains.

Table A1: Summary prioritisation table for definitional approaches

Name	Definition	Government recognised definition?		Comprehensibility & strength of relationship to political narrative	Feasibility		Sector coverage		
							Broader than net zero?	Up to date with modern economy	In London context?
Environmental Goods and Services Sector (EGSS)	*Areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources*	✓✓✓	National statistic	✓	✓✓	Would require ONS to provide data	✓✓✓	✓ Based on SIC codes	✓
Low Carbon and Renewable Energy Economy estimates (LCREE)	*Economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide*	✓✓✓	National statistic	✓✓	✓✓	Would require ONS to provide data	X	✓✓ Survey updated annually but still misses areas due to SIC code limitations	✓
Low Carbon and Environmental Goods and Services Sector (LCEGS)	*EGSS sectors expanded to include activities that contribute and enable growth in the sector, including value and supply chains*	✓✓	GLA commissioned report	✓✓	✓✓✓	Requires data purchase	✓✓✓	✓✓✓ Approach updated regularly	✓✓✓
Task-based approaches	*Approaches typically from the United States that identify green tasks, and then the proportion of each job type that is spent on green tasks*	X	Current applications US based	✓✓✓	X	Timescale too short	✓✓✓	✓✓✓ Depending on approach	✓✓✓
International Labor Organization	*Jobs which reduce the consumption of energy and raw materials, limit greenhouse gas emissions, minimize waste and pollution, protect and restore ecosystems and enable enterprises and communities to adapt to climate change. In addition, green jobs have to be decent.*	✓	Internationally recognised	✓✓	X	Not operationalised	N/A	N/A	N/A
Mission-based definition following Green Jobs Taskforce	*Employment in an activity that directly contributes to - or indirectly supports - the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks. 7 specific policy areas identified*	✓✓	National Government commissioned report	✓✓✓	✓✓✓ ✓✓	With modern methods With publicly available data	✓✓✓	✓✓✓ Can use modern methods	✓✓
Mission-based definition: tailored to London context	*Same as above but tailored to London context - suggested 11 areas including Green Finance, Environmental R&D and Reducing Localised Pollution (air, water and noise)*	✓	Adapting a government recognised approach	✓✓✓	✓✓✓ ✓✓	With modern methods With publicly available data	✓✓✓	✓✓✓ Can use modern methods	✓✓✓

Environmental Goods and Services Sector (EGSS) (UK)

ONS produces National statistics for the Environmental Goods and Services Sector, including an estimate of employment, with data recorded annually since 2010. The environmental sector is defined as: ***"areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources."*** [98] This definition follows an internationally comparable framework set out by the UN System of Environmental Economic Accounting. 17 activities are included in the EGSS estimates, shown below.

Environmental Goods and Services Sector activities	
Energy saving and sustainable energy systems	Management of forest ecosystems
Environmental charities	Managerial activities
Environmental consultancy and engineering	Organic agriculture
Environmental low emission vehicles, carbon capture and inspection and control	Production of industrial environmental equipment
Environmental related construction	Production of renewable energy
Environmental related education	Recycling
In-house environmental activities	Waste
Insulation activities	Wastewater
Water quantity management	

The EGSS approaches most important strength is that it is developed directly from the National Accounts process, and therefore is highly credible and robust. In addition, it is internationally comparable, particularly across European countries where many EGSS estimates are produced.[99]

However, we have identified four significant limitations of the EGSS approach:

i. EGSS depends on the how companies define themselves using Standard Industrial Classification (SIC) codes. These codes were last updated in 2007 and the Independent Review of UK Economics Statistics commissioned by the Chancellor of the Exchequer in 2015 found that "the changing structure of the economy means that SIC will constantly lag reality, under-representing newer industries and over-representing ones that are declining in importance",[100]
ii. Approaches based on environmental goods and services do not capture all types of green jobs, for example failing to count jobs that improve the environmental impact of production processes in enterprises in any industry,[101]
iii. The dichotomous green / non-green classification approach does not account for the potentially substantial variation between goods and services included in the approach. For example, there is a significant difference between the environmental impact of a zero-emission car and of a hybrid SUV but both would be included in the same way,[102]
iv. The large and growing area of green finance is not included.

Low Carbon and Renewable Economy survey (LCREE)

The Low Carbon and Renewable Economy (LCREE) survey is carried out by the ONS and began in 2015. The definition of the "low carbon and renewable energy economy" is ***"economic activities that***

deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide".[103] 17 sectors, different to the sectors in the EGSS definition above, are included under the LCREE definition.

Low Carbon and Renewable Economy survey sectors	
Alternative fuels	Low emission vehicles and infrastructure
Bioenergy	Nuclear power
Carbon capture and storage	Offshore wind
Energy efficient products	Onshore wind
Energy monitoring, saving or control systems	Other renewable electricity
Fuel cells and energy storage systems	Renewable combined heat and power
Hydropower	Renewable heat
Low carbon financial and advisory services	Solar photovoltaic
Energy efficient lighting	

Like the EGSS approach, this measure is a National Statistic and hence highly credible. It accounts for the low carbon and renewable energy activities of businesses across all sectors (except the financial sector). Other measures focus on sectors defined as "green" whereas this approach, by surveying business across virtually all sectors, includes businesses who undertake some green activities even if they do not operate in a "green" sector.[104]

However, the LCREE approach focuses on low carbon activities which excludes many broader environmental activites; for example, protection of biodiversity and recycling.[105] Green finance is also not covered, which has implications for measuring London's economy (it was most recently ranked third in the Z/Yen Global Green Finance Index, and central Government has recently pledged £10 million to London and Leeds to drive forward green finance and investment).[106] Also, a study carried out by Ecuity for the Local Government Associations finds that the sectors do not map very accurately to SIC codes.[107]

Low Carbon and Environmental Goods and Services Sector (LCEGS)

The LCEGS dataset captures environmental, renewable energy and low carbon activities in the UK. Annual LCEGS figures were previously reported by the Department for Business, Innovation and Skills (BIS), although it is now published by kMatrix when commissioned by local authorities including in particular the Greater London Authority. The LCEGS measure expands on the EGGS approach to capture ***"all activities that contribute and enable growth in the sector"*** – including value and supply chains:[108]

"Those elements which are excluded from EGSS which are produced for purposes that, while beneficial to the environment, primarily satisfy technical, human and economic needs or that are requirements for health and safety are included in LCEGS if they contribute to the sector"[109]

The LCEGS sector is divided into three broad categories – Environmental, Renewable Energy and Low Carbon – followed by the Level 2 sub-sectors shown below, and then further categorisations within each sub-sector.

Low Carbon and Environmental Goods and Services Sector		
Level 1 sub-sectors		
Environmental	Renewable	Low Carbon
Level 2 sub-sectors		
Air Pollution Control	Biomass	Additional Energy Sources
Contaminated Land Reclamation and Remediation	Geothermal	Alternative Fuels and Vehicles
Environmental Consultancy	Hydro	Alternative Fuels
Environmental Monitoring	Photovoltaic	Building Technologies
Marine Pollution Control	Renewable Energy Consultancy	Carbon Capture and Storage
Noise and Vibration Control	Wave and Tidal	Carbon Finance
Recovery and Recycling	Wind	Energy Management
Waste Management		Nuclear Power
Water Supply and Waste Water Treatment		

The number of jobs captured by LCEGS is significantly larger than for the EGSS measure. In 2017/18 the LCEGS approach estimates 1.25m green jobs across the UK,[110] compared to 0.4m under the EGSS approach.[111] Table A2 and Figure A1 compare LCEGS to the two ONS measures of environmental activity in the UK.

The methodology is designed to capture a much more complete measure of the green economy's characteristics, and specifically aims to address the limitations of measures based on outdated industrial classifications. It also aims to account for the green economy's whole value chain. It explicitly includes green finance, and therefore reflects important changes in the London economy well.

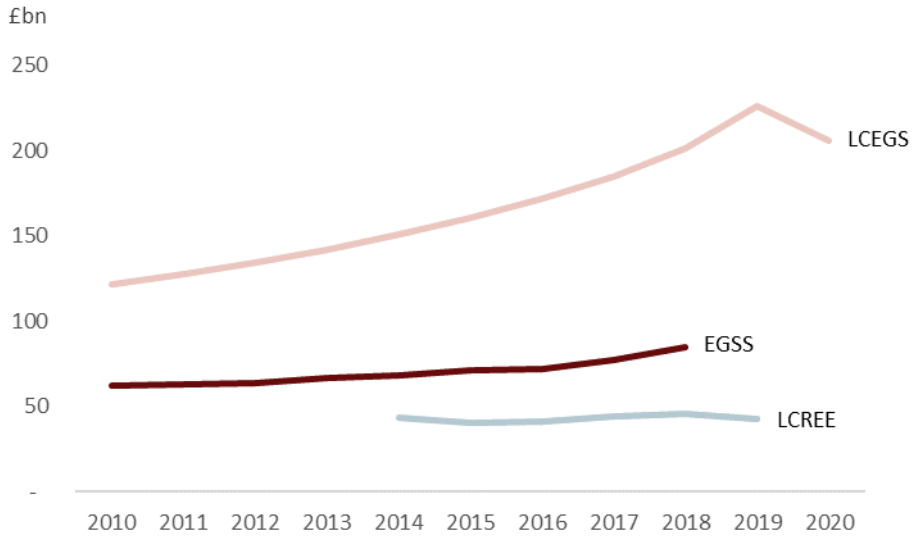
However, the data used in this approach is proprietary and therefore incur a cost to use and keep up to date.

Table A2: Summary table comparing size of estimates of environmental activity in the UK

Name	Definition	Date	Total output	Total jobs
Environmental Goods and Services Sector (EGSS)	*Areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources*	2018	£84bn	0.4m
		Latest available (2018)	£84bn	0.4m
Low Carbon and Renewable Energy Economy estimates (LCREE)	*Economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide*	2018	£46bn	0.2m
		Latest available (2019)	£43bn	0.2m
Low Carbon and Environmental Goods and Services Sector (LCEGS)	*EGSS sectors expanded to include activities that contribute and enable growth in the sector, including value and supply chains*	2017/18	£185bn	1.3m
		Latest available (2020/21)	£206bn	1.3m

Sources: ONS[112] and kMatrix[113]

Figure A1: Comparison of change over time of estimates of environmental activity in the UK; turnover / sales estimates



Sources: ONS[114] and kMatrix[115]

Task-based definitions

A recent research angle has been to try to identify the tasks within jobs that can be classified as green. A key example of this is Vona et al. (2018).[116] The method breaks away from a definition that defines a job as either green or non-green, instead considering all jobs to be on a continuous spectrum of 'greenness'. This is determined by a job's time dedicated to green activities relative to time devoted to non-green activities.[117] The ranking is as follows:[118]

I. "Jobs that carry out primarily green tasks (e.g., environmental engineers, solar photovoltaic installers or biomass plant technicians).

II. Occupations wherein environmental work tasks are part of a broader set of activities (e.g., electrical engineers, metal sheet workers or roofers).

III. Jobs that engage environmental tasks only occasionally (e.g., traditional engineering occupations, marketing managers and construction workers)."

Vona et al (2018) applied this approach to the US job market, using job task data from O*NET, a national source of occupational information.

This approach allows a nuanced understanding of how the labour market is greening over time, including where portions of jobs are becoming more (or less) green. Also it is well-suited to identifying implications for skills policy as it focuses on how activities undertaken in jobs are changing.

However, application of this approach in a UK context is difficult because the job task data that is available in America is not available at a high degree of granularity. Within the scope of this project this makes this approach not feasible. However, we note that the GLA are currently undertaking a project to explore this approach in the UK context that may be a useful companion to our work in this project.

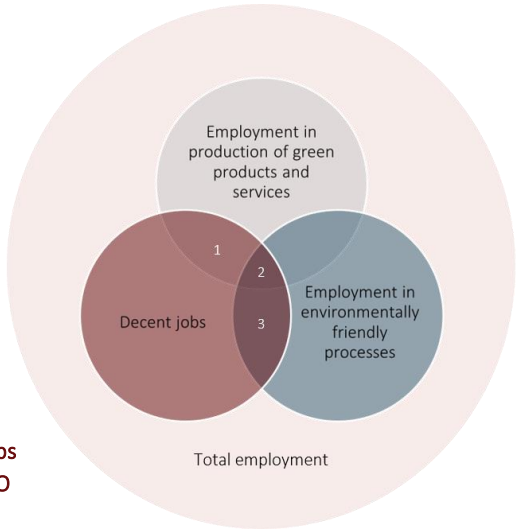
International Labor Organization and decent jobs

The International Labour Organization (ILO) defines green jobs as jobs in any sector or business which ***"…reduce the consumption of energy and raw materials, limit greenhouse gas emissions, minimize waste and pollution, protect and restore ecosystems and enable enterprises and communities to adapt to climate change. In addition, green jobs have to be decent."***[119] This requirement stems from the ILO's recognition of the importance of a just transition (see Box A1) in efforts to decarbonise the economy.

By including "decent jobs" as a requirement, this definition integrates desirable outcomes beyond just environmental goals, highlighting the dual opportunity presented in greening the economy. This also aligns with the inclusion of a Just Transition in the UK's green policy agenda, as well as London's agenda itself; the Mayor of London recently published research to develop an understanding of the impacts and opportunities of a just transition on London's economy.[120]

In terms of capturing green jobs, a potential drawback of integrating a decent work requirement into a definition is that it adds complexity – we are not aware of a quantitative application of the ILO definition beyond international figures quoted in the report where the definition was proposed. In addition, decision-makers may wish to monitor and understand poorer green jobs in order to target employment policy at these areas. Integrating quality criteria within a green jobs definition may hide important information.

Figure A2: The International Labor Organization's approach to defining green jobs



Sections 1, 2 and 3 represent green jobs according to the ILO criteria.

Source: Adapted from ILO

Box A1: Just Transition

Though the linking of environmental protection with creating employment and good working conditions has been stated by trade union movements for over 20 years, the concept of a Just Transition has become an integral part of the environmental agenda more widely in recent years, notably included in the Paris Agreement (2015).

Though the concept is used in a range of frameworks and agendas, the general principle centres around moving towards a more sustainable economy while creating decent work and ensuring that a transition to a more sustainable economy does not leave communities behind.

Recognition of a Just Transition is increasingly prevalent in the UK green policy landscape, where the concept is being related to upskilling the workforce to meet the needs of Net Zero, good quality jobs, and equipping people to benefit from the transition and climate action.

Sources: UN Framework Convention on Climate Change (UNFCC)[121], UNFCC[122], Green Jobs Taskforce[123], GOV.UK[124], Just Transition Commission[125]

"Mission-based" definition following Green Jobs Taskforce

The recently published report from the independent Green Jobs Taskforce established by the UK Government reviews definitions of green jobs and finds that setting a single definition of a 'green job' that can be applied to the whole economy is a complex task. The Taskforce decided to take a broad approach, which goes beyond simply looking at low carbon sectors, and to focus on a sectoral approach linked to the policies and activities required to meet the country's environmental goals.

They therefore use the following definition of a green job: ***"employment in an activity that directly contributes to - or indirectly supports - the achievement of the UK's net zero emissions target and other environmental goals, such as nature restoration and mitigation against climate risks."*** We refer to this approach as a "mission-based" definition as it defines green jobs with respects to achieving environmental policy goals.

The Green Jobs Taskforce identify seven sectors / policy areas, prioritising those that are crucial to meeting net zero and where the evidence is clearest; see box A2.

Box A2: Green Jobs Taskforce seven green sectors

1. Power – including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology;
2. Business and industry – including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation;
3. Homes and buildings – including retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen boilers;
4. Transport – including low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling;
5. Natural resources – including nature restoration, tree planting and decarbonising agriculture, waste management and recycling;
6. Enabling decarbonisation – including science and innovation for climate change, green finance, circular economy and energy networks;
7. Climate adaptation – including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation.

Source: Green Jobs Taskforce[126]

The substantial advantage of this approach is that allows analysis based on the definition to account for the full range of economic transformation needed to deliver the UK's environmental goals, and the evolving nature of the transition to net zero. Skills policy developed from this definition can therefore be directly linked to the achievement of environmental policy goals. On the other hand, a mission-based approach could result in an evolving definition over time as policy changes. From a statistical point of view this is a significant disadvantage, but from a practical point of view this would reflect evolving policy.

A challenge of this approach is how to define indirect support of policy goals. If this is defined too broadly then the definition becomes diluted as a practical tool. However, drawn too narrowly the

definition would miss important supporting activity. This issue needs to be tackled alongside the quantitative analysis that we will undertake for phase 2 of this project.

Conclusion

The official ONS definitions of the Environmental Goods and Services Sector and the Low Carbon and Renewable Energy Estimates are highly credible and consistent measurements of aspects of the green economy, and have high trust with central government. However, they are relatively hard to explain and use for practical policy, and key areas of London's green economy are missed. The alternative approach commissioned by the GLA or LCEGS includes a wider definition of the green economy and is a trusted, if not official, source. However, it is still somewhat opaque to policy makers. Both task-based approaches and the ILO approach including an analysis of decent jobs could not be operationalised in the context of this project.

This takes us to "mission-based" definitions. The majority of the feedback from our stakeholder sessions was that the need for a common definition of green jobs for London boroughs arises from the practical questions that arise for policy makers – how will the labour market change during the net zero transition, what do skills providers need to plan for and what support do they need, and what programmes and policies are required to support citizens and make a strong green economy?

We did also hear alternative views from our stakeholder engagement. For some local authority officers it is important to stick closely to official definitions in order to easily allow follow up analysis without further consultancy spend and to be directly applicable for us in funding bids from central Government. We will advise on the ongoing cost of approaches that improve on the use of official definitions before making decisions on our data analysis approach. Funding bid rules will often specify particular approaches or definitions themselves, so whilst this is important we think that it would not be proportionate to shape the definition around this consideration.

Hence for the purpose of this work we recommend that the definition prioritises practicality and a strong link to both net zero and broader environmental goals. For this reason, we recommend that a "mission-based" definition is most appropriate. These definitions are easier to understand for individual policy makers and directly applicable to the policy questions at hand. We could also use modern methods described below to identify the specific London companies that fall within such a definition to produce something that really speaks to the work of boroughs across London.

It would be feasible to follow directly in the Green Jobs Taskforce definition – this would increase recognition in central Government of the approach taken. However, there are some specific areas that we may want to adapt to better reflect the London context. Using our literature review and stakeholder engagement we have produced an adapted list of sectors / policy areas – see box A3 below. This uses many of the Green Jobs Taskforce sectors but specifically splits areas with a net zero focus from a broader environmental focus and separately identifies Green Finance and the areas of climate change research & development, strategy, policy, monitoring & planning, and climate adaptation.

Table A1 summarises the definitional approaches and how they rank across a range of considerations. The choice between using the Green Jobs Taskforce definition directly or our adapted definition is a nuanced one. This will be dependent on the relative importance of choosing a definition that has been developed in a Central Government commissioned report (and hence may have greater credibility in a funding bid for example) versus reflecting the London context more closely.

Box A3: Mission-based definition: proposed sectors for a London based definition

Net zero focus

12. **Homes and buildings:** Including retrofit, building new energy-efficient homes, heat pumps, smart devices and controls, heat networks and hydrogen & electric boilers
13. **Low carbon transport:** Including low or zero emission vehicles, aviation and maritime, rail, public transport and walking or cycling;
14. **Power:** Including renewables (such as wind, solar and hydropower), nuclear power, grid infrastructure, energy storage and smart systems technology;
15. **Business and industry**: including hydrogen production and industrial use, carbon capture, utilisation & storage (CCUS) and industrial decarbonisation
16. **Green Finance:** The concentration of financial activity in Central London means that in our context Green Finance could be a key area to separately identify
17. **Climate change research & development:** Including private sector, academic and public research. London has several clusters of environmental research, including the Grantham Research Institutes at the London School of Economics and Imperial College and the Climate KIC initiative linked to Imperial College's White City campus.
18. **Climate change strategy, policy, monitoring and planning:** Including public, private and NGO sector strategy and policy, outreach to citizens, environmental monitoring and use of planning system to achieve net zero
19. **Climate adaptation:** Including flood defences, retrofitting of buildings to be resilient to extreme weather/climate events, nature-based solutions to reduce climate impacts and civil and mechanical engineering for infrastructure adaptation.

Broader environmental goals (may have some impact on climate change goals)

20. **Reducing localised pollution:** Including air pollution, water pollution and noise; London has ambitious goals across all three of these areas
21. **Reduce, reuse, recycle:** Including waste management and circular economy
22. **Green and blue infrastructure:** Within a London context this will focus on urban green and blue infrastructure, and include activity aimed at increasing biodiversity directly or through offsetting

Source: WPI Economics

3. Approach to categorising and quantifying green jobs

Using a mission-based definition there are a number of approaches that can be taken to categorising and quantifying the jobs that fall within the policy areas identified. These include:

a. Direct use of industrial and occupational classifications: One approach would be to map data from the Business Register and Employment Survey and Annual Population Survey on to the categories above. Standard Industrial Classification (SIC) and Standard Occupational Classification (SOC) codes could be mapped across to our categories. However, given the granular nature of some parts of the definition and associated mapping it is likely that a number of assumptions would need to be made to avoid capturing too broad a category of jobs within the current workforce. As noted in the discussion of definitions, use of data based on the official codes will constantly lag the emerging economy and would struggle to meet London borough's needs for effective policy based on the actual skills that are needed for the jobs that are coming into existence or growing in number. This approach would not, for example, allow us to identify green finance jobs.

b. Mapping Low Carbon and Environmental Goods and Services Sector (LCEGS) data to policy areas: It would be feasible to purchase LCEGS data at an appropriate level of granularity and map the categories in this dataset to the policy areas identified. As a dataset is published regularly by the Greater London Authority, this would bring consistency. However, it would also add a layer of complexity, using data produced for one definition of green jobs to populate another definition. For local authority officers this may not assist in understanding the green economy. This option would attract an upfront cost and ongoing cost to keep the data up to date.

c. Using Real-Time Industrial Classifications: New approaches have been developed to tackle the shortcomings of SIC codes, recognising that many companies arbitrarily select a code and never revisit it. About one third of companies are registered under categories that start with "Other", meaning they have not found an SIC code that accurately reflects their business activities.

   A leading example of an alternative approach is from The Data City.[127] The company have developed "Real-Time Industrial Classifications" that use machine learning and artificial intelligence to find companies working within specific fields, based on the way companies actually describe themselves on their websites. The tools that The Data City have developed allow a classification to be developed using an initial "training set" of companies in each area and then allow direct identification of all companies and the number of jobs that fall within this definition for every London borough. The approach also identifies actual operating addresses rather than simply registered addresses that is often not where jobs are located. Updating the classification and associated data takes minutes and will update in line with how companies update their websites, so constantly moves with the sector.

   However, this approach would mean that all jobs within any company included would be counted, even if some of the jobs were not actively contributing to the achievement of environmental goals. This is an important drawback and the approach may be best used alongside one of the other approaches in order to understand both the nature of green companies and how existing businesses are greening their operations.

Using machine learning also means that it is not possible to answer exactly why some companies have been included and others not included. The machine learning tool will likely deliver insights and identify innovative companies that other approaches would have missed, but it must be recognised that to gain this advantage there needs to be comfort with an approach that cannot be fully interrogated in the way a traditional approach could be. However, a set of benchmarking tests carried out against expertly curated lists for known sectors has shown a high level of matching with the algorithm alone, and that it can outperform expertly curated list with a small amount of manual intervention from sector experts.

This data would require an up-front purchase and ongoing cost.

There are also a number of other useful sources of data we have identified:

- The Place-Based Climate Action Network Just Transition Jobs Tracker:[128] Based on analysis by the Grantham Research Institute on Climate Change and the Environment and the Sustainability Research Institute at the University of Leeds, this dataset estimates at a local geography level the number of jobs that will require upskilling due to the transition to a green economy and the number of existing jobs that are expected to be in high demand due to their important role in the net-zero economy. The data is not in a format that can be mapped across to our policy sectors but it does provide material for forecasting the potential impact of future trends on job numbers.
- Emsi Burning Glass: Analysis carried out by Emsi Burning Glass on job postings data identified 366 "green job" titles and an associated 111 "green skills".[129] This data can be used to identify the numbers of job postings for different types of jobs and the most in demand skills split between common skills such as communications and management and unique / technical skills that are likely to need formal training or experience such as Environmental Health and Built Environment. The data is well-suited to analysing changes in the economy based on trends in job postings, but would not be sufficient on its own to identify the number of green jobs in a policy area. This data would require an up-front purchase and ongoing cost.

4. Which types of jobs are likely to be at risk from the greening of the economy?

An important aspect of analysing green jobs is to understand the profile of London citizens that will be affected by the transition to a green economy. In a recent listening campaign run by the Institute of Public Policy Research, participants highlighted the interconnected nature of economic, social, and environmental issues. People from marginalised communities in particular were unsure that they could benefit from green jobs – there was a view that climate change and its solutions mostly concerned the 'elite'.[130]

Phase 2 of this project will look at the equalities implications of jobs that will be significantly affected by the greening of the economy – either reducing in number or requiring substantial reskilling. Here we identify likely key aspects highlighted by a recent GLA Economics research project, and through analysis of employment data at a sub-regional level.

In February 2021 GLA Economics published initial research on the impact that the transition to a net-zero carbon and circular economy will have on London's labour market.[131] By analysing the industries which account for the largest share of greenhouse gas emissions, the research can identify the profile of workers who are working in sections of the economy that are likely to be most substantially affected by decarbonisation.

The analysis uses resident employment data to apportion UK level GHG emissions to London by industry group. The research found that the industries responsible for the most greenhouse gas emissions in London are:

- Transport and storage (35% of London's emissions)
- Electricity and Gas (15%)
- Manufacturing (12%)

Transport and Storage is responsible for a much higher proportion of emissions in London compared to the rest of the UK, where the sector account for 20% of overall emissions. Just over half of transport and storage emissions in London are due to air transport, with just under half land transport.

Conversely, many major economic activities in London are responsible for very low proportions of emissions; for example finance & insurance, real estate activities, arts & entertainment and information & communications each account for less than 1% of London's total emissions.

A similar story emerges from analysis of energy consumption, with transport accounting for the largest share and many major economic activities accounting for low levels of total energy consumption.

Turning to the labour market, the research finds that high-emitting industry groups tend to account for a relatively small share of employment among London residents:

- Transport & Storage accounted for 35% of London's GHG emissions but only 4.7% of London's employment, with air transport accounting for only 0.2% of resident employment in London (although it might support more jobs through its supply chain)
- Similarly, Electricity & Gas accounted for 15% of GHG emissions apportioned to London but only 0.2% of resident employment.

The impact on London's overall labour market will therefore be substantially lower than places where high emitting industries account for significant proportions of employment.

London's economy and the distributional impact of decarbonisation

Transport and storage may account for only 4.7% of total employment in London, but the impact of decarbonisation on the sector will disproportionately impact those from a non-white ethnic group. Across industries in London, an average of 35% of employees are non-white but for the transport & storage industry this rises to 50%. The research does not provide data on age and gender, but this is something we hope to look at in the next phase of this project.

Furthermore, four of the five highest-emitting industry groups have lower average wages than the London average – hence lower income people are more likely to be affected by decarbonisation in London.

The impact is likely to be focused on particular areas of London because the highest emitting industries tend to be spatially concentrated:

- Hounslow is the most reliant on jobs in high-emitting industries (34% of all jobs in Hounslow are in these industries). Other boroughs with high concentration include Newham (27%), Croydon (27%) and Barking and Dagenham (26%).
- Transport and Storage accounts for 25% of all jobs in Hounslow and 17% of all jobs in Hillingdon.
- Ealing is the borough with the highest proportion of manufacturing jobs, accounting for 9% of employment (with over half of these in food manufacturing). Barking and Dagenham also has a high proportion of manufacturing jobs, accounting for 8% of jobs in the borough (67% of which were manufacturing of vehicles).

To understand the impact across the different sub-regions of London, Phase 2 of our project will look at employment data across the capital. We have carried out an initial assessment of employment by sub-region which illustrates important patterns; see table A3. This illustrates that:

- The Central London Forward area has the highest proportion of overall employment, accounting for 60% of the total,
- Transportation and storage is over-represented in the West London Alliance area, due to a concentration of jobs around Heathrow Airport and along the M4 corridor in Hillingdon and neighbouring settlements in Hounslow; the area accounts for two in five London transport and storage jobs.[132] This area of London also has a relatively high number of jobs in Information and communication, and Professional, scientific and technical activities,[133]
- The Local London area has the highest proportion of manufacturing and construction jobs, together accounting for 12% of jobs in this area,
- Central London has a much higher proportion of employment in information & communication, financial & insurance activities and professional, scientific and technical activities,
- Education, health and social work account for a quarter of jobs in the South London Partnership area. Wholesale and retail trade accounts for 16% of jobs in this area.

Table A3: Proportion of employment by sector by sub-regions of London, 2019

	Central London Forward	Local London	West London Alliance	South London Partnership
Total employment (2019) *Of which:*	**3.2m**	**0.7m**	**1.0m**	**0.4m**
Manufacturing	1%	5%	4%	2%
Construction	2%	7%	5%	6%
Wholesale and retail trade	8%	17%	16%	16%
Transportation and storage	2%	7%	12%	5%
Information and communication	10%	3%	7%	5%
Financial and insurance activities	11%	1%	1%	2%
Professional, scientific and technical activities	18%	5%	8%	9%
Hospitality and arts & recreation	12%	9%	10%	10%
Education / health / social work	14%	24%	18%	22%
Other	21%	21%	19%	23%

Source: ONS Business Register and Employment Survey

This can hide important borough level differences that we will need to account for. As an example, consider two boroughs within the Central London Forward area – the City of London and Lewisham. Table A4 below shows how these areas of course differ substantially, with almost half of employment in the City of London account for by just two sectors – finance and professional activities.

Table A4: Proportion of employment in the City of London and Lewisham, 2019

	City of London	Lewisham
Total employment (2019) *Of which:*	**0.54m**	**0.07m**
Manufacturing	0%	2%
Construction	2%	6%
Wholesale and retail trade	2%	13%
Transportation and storage	1%	4%
Information and communication	11%	3%
Financial and insurance activities	35%	1%
Professional, scientific and technical activities	24%	5%
Hospitality and arts & recreation	5%	12%
Education / health / social work	3%	31%
Other	17%	21%

Source: ONS Business Register and Employment Survey

Across London we will look to identify the concentrations of particular types of economic activity, and account for the importance of major employers.

Looking at reskilling, the Grantham Research Institute found that 10% of London workers – over 500,000 people – would need reskilling to participate in the green economy (the same proportion as the UK as a whole).[134] However, the research anticipates a disproportionate impact on construction, transport and manufacturing (with the proportion of workers needing to reskill in these respective industries being 30%, 26% and 17%).[135]

The same research looks at the existing jobs that are expected to be in high demand due to their important role in the net-zero economy. These include both newer specialised positions such as wind turbine installers but also the skills and expertise of welders, builders and engineers already working to build the infrastructure of a green economy.

We have aggregated borough-level data to understand the pattern at a sub-regional level in London. The proportions of each sector are broadly similar across sub-regions, so we have presented the total number of jobs in table A5.

Table A5: Jobs requiring upskilling and jobs in demand due to the transition to a net-zero economy – Place-Based Climate Action Network

	Central London Forward		Local London		West London Alliance		South London Partnership	
	Number of jobs requiring upskilling	Number of new and in-demand jobs	Number of jobs requiring upskilling	Number of new and in-demand jobs	Number of jobs requiring upskilling	Number of new and in-demand jobs	Number of jobs requiring upskilling	Number of new and in-demand jobs
Total	**297,000**	**254,000**	**74,000**	**68,000**	**113,000**	**102,000**	**45,000**	**40,000**
(Proportion of total jobs)	9%	8%	11%	10%	12%	11%	10%	9%
of which:								
Manufacturing	6,100	11,600	5,300	10,300	7,100	13,600	1,800	3,400
Construction	22,900	23,300	13,900	14,100	13,300	13,500	7,300	7,400
Wholesale and retail trade	22,200	20,200	12,200	10,600	18,000	15,800	7,000	6,100
Transportation and storage	19,700	14,700	12,800	9,600	29,400	22,000	5,300	3,900
Information and communication	25,500	29,600	1,900	2,200	5,600	6,600	1,900	2,200
Financial and insurance activities	29,800	23,800	700	600	1,100	900	800	700
Professional, scientific and technical activities	71,400	55,100	4,300	3,300	10,200	7,900	5,400	4,200
Hospitality and arts & recreation	12,100	6,700	2,200	1,200	3,000	1,600	1,800	1,100
Business administration & support services	45,500	38,100	10,500	8,800	14,500	12,100	7,800	6,500
Education / health / social work	8,300	6,100	3,000	2,300	3,200	2,400	1,800	1,400
Other	33,600	24,600	6,700	5,300	8,000	5,500	3,900	3,100

Source: Place-Based Climate Action Network Just Transition Jobs Tracker[136]

5. A London definition of 'green skills'

This section discusses the issues around a definition of 'green skills' that are required for 'green jobs', reporting findings from initial stakeholder engagement with Further Education (FE) and Higher Education (HE) providers based in central London, plus insights from employment and skills officers across London. The independent training provider sector, which plays a significant role in the delivery of certain green skills, has not yet been consulted in the work, but will be included in Stage 2 work, as will awarding bodies such as City and Guilds. This section first discusses FE and HE providers' thoughts on defining green jobs and skills, before presenting a definition of green skills based on the classifications of qualifications in FE and HE.

Skills providers' thoughts on defining 'green jobs and skills'

The discussions with colleges and universities as part of the initial stakeholder engagement started by asking respondents about any definitions of green jobs and skills that they used, and for their thoughts on the existing definitions produced by the Office for National Statistics and others. It is acknowledged that the initial engagement has not included the independent training sector, nor awarding bodies, and the Stage 2 work will involve discussions with representatives of these to gain insights from the wider skills provision sector.

Some **Further Education (FE) college** interviewees spontaneously mentioned the 'green jobs' categories published by the GLA in the recently published Good Work for All prospectus, and in particular the four categories of:

- Low carbon.
- Renewable energy.
- Transport infrastructure.
- Retrofit.

They found this a good starting point and were proceeding on the basis that a lot of 'green jobs/skills' were construction related – for example, photovoltaics, and internal/external insulation activities. One participant mentioned that in a mature city like London about 70% of CO^2 comes from built environment (data from the GLA on London Energy and Greenhouse Gas Inventory (LEGGI) https://data.london.gov.uk/dataset/leggi on CO^2 sources for 2018 show that 68% of emissions are from domestic, industrial and commercial energy use, while 20% are from road transport fossil fuel emissions, 5% are from other transport emissions, and 7% are from other sources such as industrial processes and agriculture). Due to this focus on the built environment, a substantial proportion of green jobs/skills seem to fit within the areas of construction and engineering, although there are overlaps with other subject/programme areas too, such as motor vehicle production and science.

One interviewee sought to make a distinction between 'dark green' and 'light green' jobs. Dark green jobs are what the above categories focus on – buildings and retrofit, reducing carbon footprints etc. Light green covers every other job with has a carbon footprint, i.e. almost everything else, and the key issue is how to build the sustainability agenda into these light green jobs. Including light green jobs broadens the definition, but in their view it is important to distinguish between dark and light green jobs and the issues related to them.

Another college felt that 'grey' skills might be a better term for skills related to technologies such as electric vehicles, low-flush toilets or retro-fitting, and that 'green' should be used when referring to the natural environment – plants, animals, water etc.

Respondents were asked about the specific definitions derived by other organisations:

- EGSS Definition – some felt that this was more of a 'country/rural' definition, and that to operationalise it for a city like London you would need to rejig it. For example: the transport area seemed very road-based, whereas in London there is a lot of transportation using the river, for passenger and goods transport, and it was felt that marine engineering is relatively unadvanced in terms of carbon footprint. It was also difficult to immediately see where retrofit was identified in the definition beyond potentially under insulation activities. Logistics needed to be included in the definition somewhere; electric vehicle charging points will be much more of a challenge in a high-density city like London than in other areas, with planning issues and the likelihood of objections from local residents. A specific issue was raised around the the conversion of gas to hydrogen boilers. Although hydrogen maybe less polluting it is not necessarily renewable if fossil fuels are used to produce hydrogen.
- LCREE Definition – comments here related to a need to include ground source heat pumps, and that current technologies such as lagging and insulation are more important and immediately effective than exciting new technologies.
- LCEGS Definition – this had largely been discussed under the GLA categories, for example including retrofit as a fourth subsector. There were additional comments in relation to building management – smart buildings, and being able to turn things off when not in the building etc. – as a potential driver of low carbon activity.

Some colleges brought hospitality into the discussion, as it is a large sector in London, and has green considerations in terms of reducing/recycling food waste and food packaging, and the rise in food deliveries.

There was a general feeling that it is not easy to map all of the 'green skills' across all these industries/businesses, as the green jobs will have a lot of generic skills involved in them, and green businesses will have a lot of essential roles that are not specifically related to the 'green' aspect of them, but without which they would not be able to function effectively. In relation to the former, tradesmen working in green jobs will need the full trade training behind them, and then may gain the specific 'green' training on top of that, for example to allow gas engineers to work on air source heat pumps. And in relation to the latter, administrators, finance and contracts staff are important roles in the construction sector, but would those roles also be counted in deriving totals of green jobs?

Finally, there were comments that the definition of 'green jobs' did not include traditional agriculture, horticulture and other land-based jobs and skills. Capel Manor College, located in Enfield borough in the Local London Sub-Regional Partnership but likely to be providing skills to residents across Greater London, is a specialist environmental and land-based college, but the definitions seem to focus on low carbon and net zero, rather than on jobs/skills working with plants and animals that Capel Manor provides. One particular London factor combining both types of roles/skills was living roofs on office tower blocks – these required horticulture skills but also specific plumbing skills around sustainable drainage.

Feedback was obtained from two Higher Education (HE) respondents, who brought a slightly different perspective to the discussion of definitions of green jobs and skills. There was a more holistic

approach to defining green skills, and more emphasis on embedding sustainability. One interviewee said:

> *"For each industry you need the same skills whether they're within the green economy or not." and*
>
> *"Green skills are the knowledge of sustainability and sustainable practice in your industry and what that means in your industry."*

Another felt that the university sector needs to be doing much more to embed sustainability across the whole curriculum (via Education for Sustainable Development) so that all students leave university with an understanding of the issues facing society – not necessarily about specific knowledge per se but rather about transferable skills and approaches to tackling the interconnected challenges facing society. They were encouraging more systems-thinking and less siloed thinking. For example, green skills for fashion and green skills for finance are going to be different but the knowledge of sustainable practice (sustainable development, and net zero) helps to give students the green skills for their industry.

Within some industries 'green' skills are more 'hard' and 'technical' e.g. skills within green engineering and construction etc., while in other industries, they will be more related to environmental sustainability. A helpful distinction could be between jobs where the main purpose is 'green' (so those related to net zero and renewable energy), and other jobs which would need an awareness of sustainability but whose main focus is not 'green'. So green skills provision involves both supporting people to develop new skills and capabilities for existing job roles such as fashion, and education, as well as training for completely new roles that will be created to support the transition to net zero goals. Also, green specialties develop within non-green industries, for example environmental law and green finance, but the question was raised over to what extent the definition of 'green' extends into the broad job category – is law 'green' because it involves environmental law? But environmental law is definitely 'green'; and similarly with green finance.

One interviewee suggested it could be viewed through the lens of process change – ensuring processes are in place to meet ecological goals, including jobs that are created solely to meet net zero goals.

There was a general feeling that broader definitions would work better, as sustainability touches every bit of society, and it is a rapidly changing area so narrower definitions might not include new and emerging areas. One suggestion was defining green jobs and skills as those which "*make a gentler impact on people, place and planet*", which could then be sub-divided into areas such as environmental, renewable energy, low carbon etc.

A definition of 'green skills' for London

The definition of 'green skills' for London serves dual purposes for the research – as a guide for policy makers and employers in understanding the skills that are needed by green jobs, and as a framework for understanding the size and nature of green skills provision by colleges, universities and the wider training sector.

The FE sector classifies courses/qualifications using the LearnDirect Classification System (LDCS). The HE sector used the Joint Academic Coding System (JACS) as a way of classifying academic subjects. The Office for Students has produced a mapping between the LDCS codes and the JACS classification to aid the linking of the two systems.

The definition of 'green skills' is based on the skills needed for the jobs identified within the various policy areas of the "mission-based" definition that are felt to be appropriate for central London. The table below summarises the broad subject areas that comprise the definition. Detailed lists of the LDCS and JACS codes and descriptions within each broad area are presented in the Appendix. While the independent training sector does not use the classifications that are used in FE/HE, their work in green skills provision would sit within the broad green skills areas identified in the definition.

Table A6: Broad subject areas that fall within the definition of green skills

Broad green skills area	FE broad headings	HE broad headings
Green social sciences	Environmental (Green) Studies Natural Resource Economics Environmental Economics Environmental Law	Politics not elsewhere classified Applied economics Law by topic
Environmental Protection/ Conservation	Environmental Studies Environmental Conservation / Policies Environmental Science Landscape Conservation Conservation / Protection Of Specific Environments	Applied environmental sciences Landscape studies Environmental conservation Environmental sciences Environmental biology Environmental chemistry
Energy Economics / Management / Conservation	Energy Economics (Applied) Alternative Energy Research Electric Power Economics Vegetable Crop Fuel Economics Waste Materials Fuel Economics Renewable Energy Resources	Applied economics Energy resources
Pollution / Pollution Control	Environmental Pollution Environmental Pollution Control Air Pollution / Pollution Control Soil Pollution / Pollution Control Water Pollution / Pollution Control Control Of Specific Pollutants	Pollution control
Recycling Collection / Treatment	Recycling Collection / Treatment	Technologies not elsewhere classified
Building / Construction Operations	Glazing (Buildings) Building Insulation	Combined/general subject unspecified
Building Maintenance / Services	Building Services Building Electrical Work Plumbing (Building Work) Heating Installation (Building Work) Ventilation (Building Work) Air Conditioning (Building Work) Building Maintenance	Building technology Building not elsewhere classified Engineering design Combined/general subject unspecified
Mechanical engineering	Mechanical engineering Hydraulic Engineering Fluid Engineering Pneumatic Engineering Thermal Engineering Heating / Ventilation Engineering	Mechanical engineering Thermodynamics Turbine technology
Power/Energy engineering	Energy Engineering Electric Power Engineering Nuclear Power Engineering Electric Power Storage / Transmission Electromagnetic Engineering	Electrical power Electrical power generation Electrical power distribution Electronic & electrical engineering not elsewhere classified Combined/general subject unspecified

6. An overview of the current Higher Education/Further Education green skills provision in London.

Discussions were undertaken with, or feedback was obtained from, the following London-based skills providers:

- United College Group
- Newham College
- West London College
- Capital City College Group
- New City College
- Capel Manor College
- University of East London
- Imperial College London

The stakeholder engagement with education providers has focused on those serving central London, although contextual information from discussions with skills advisers from the other sub-regional partnerships (SRPs) has been included. Stage 2 work will cover all four SRPs equally, and will involve in-depth discussions with all types of training providers regarding future issues in green skills provision, including barriers and challenges to offering green qualifications, and the green skills that need to be prioritised in London in the future.

Issues in green skills provision in FE in London

There was a general feeling that skills and course provision did not map across well to definitions of 'green skills', for two main reasons.

The first was the lag between what is approved for funding, and what is provided. To date, there had been little green skills provision that was 'fundable' – there were some bits and pieces funded through the Adult Education Budget that mapped across well to green jobs, but a lot of it would be commercial provision and there was currently little demand from employers. One college reported that an external wall insulation course came directly from employers in the sector as a specific request from a group of employers off the back of green homes grant. They had a contract with Boroughs and housing associations to install the insulation, and they needed to recruit significant numbers of workers who had a fairly good level of training and for them to then continue the specific training on the job. That was driven through the employers themselves.

The second was that green skills provision was often 'top up' training once individuals were trained in their traditional trade. One college said they were trying to make sure their students were skilled in particular traditional skills, and then if any 'green' elements linked to that traditional skill they would have the opportunity to upskill in that course – e.g. an electrician would learn traditional electrical skills, but then could do a solar panels 4 day course, which is a Level 3 course so they need to be a qualified electrician before they could move on to it. Similarly, gas engineers would need a FGas qualification before being able to move onto ground-source heat pumps course. There was very little where you could start doing green skills from scratch. Some apprenticeship standards may involve

green topics/units, but it is delivered as part of the whole apprenticeship and not as a standalone unit – examples that sprang to respondents' minds were plumbing may include solar heating panels, and brickwork may include insulation techniques. However, one college said that they were looking at embedding green skills within all courses, using information from Carbon Literacy Trust.

Colleges' short to medium term priorities are therefore more around re-skilling those with a grounding in their particular trade to get the 'green' add-on to their trade, although in the longer term they will need to start thinking about embedding green skills into these traditional trade courses.

Learner demand is a key driver of provision; as one college put it, provision is largely determined by the labour market, and what jobs learners think they can get with their qualifications – if they can see a job at the end of it. And as one respondent said, you can't go straight into a green job. So, colleges' provision responds to this, and if there is increased demand from learners for green-related courses they would respond by increasing provision. Another key driver was historic provision – for example one college said that they offer Mastic Asphalt Roofing training, the only college in UK to offer this. It is a very traditional method of waterproofing roofs, with an entirely green material, and they have offered this for many years as they had a lecturer who was very interested in this and developed the course for them.

One college noted that there have been specific qualifications in the past e.g. BTEC in sustainability, but they tended to fail as not enough students took them up as they could not see a clear pathway to a job at the end of it. Hence instead the college introduced some sustainability units within subjects, including science, which have been a more successful at delivering some sustainability skills to learners.

Another college reported that discussions with curriculum leads had shown they did not have any single courses that were solely around green skills. Instead they were looking at environmental sustainability embedded in curriculum, e.g in bricklaying. However, these modules are often voluntary, so not many learners take it, and then they end up with staff lacking the skills/confidence to teach it. The felt that units about green skills are there, but are quite "tokenistic" at the moment.

There was a feeling that in trying to measure current green skills provision, colleges might 'over-egg' the activity they are currently undertaking, and try to paint things as 'green' rather than their true colour – '*no-one wants to say the cupboard is bare*'. There was also a danger that all jobs/skills in certain sectors may be classed as 'green' when only some of them involve green activities – e. g. accountants at Thames Water might be classed as in 'green' jobs.

It was felt that all colleges are currently at a very low baseline of green skills provision, although all participating colleges were looking to develop opportunities for increased green skills provision as circumstances (funding, regulation, demand) allowed. But they reported that they did not want to plough into a market that does not exist yet, as there is the risk of developing courses for which the demand is not yet there. They feel that demand will rise over time, as climate change is a huge concern of young people – it matters to them and they want to do jobs that are important and have meaning – so colleges feel that they do need to grow the numbers of 16-18 year old students in these areas.

Colleges felt that the funders (mainly the Adult Education Budget via the Education and Skills Funding Agency and the GLA, but also the National Skills Fund) have a major role to play in influencing behaviour, and so far colleges feel that the funders have not yet been clear and direct about what they want colleges to do – if there is a qualification that is funded then colleges will provide it. But it is

a struggle for colleges to know what green jobs there will be, and the level of demand for them, in the future, and it was a risk for them to put on courses if there were no jobs at the end – one college mentioned setting up retrofitting workshops for Jobcentre Plus but the number of learners expected did not come through, and also the jobs were not there for them at the end, so it had been a negative experience for the college and the learners.

Issues in green skills provision in HE in London

The HE providers also raised some of the issues that the colleges had raised, around a lack of clarity over what is funded, and 'green' provision being part of broader courses/qualifications rather than stand-alone courses in their own right.

One started off by mentioning the significant need for training in the retrofit sector and heat pump installation given the 600,000 homes per year that will need to be fitted with a heat pump across the UK by the end of the decade, but there was a lack of clarity over how this workforce would be trained/skilled and how the training would be funded. In their view it would need to be a combination of retraining existing gas fitters and training up new workers via vocational courses (with FE providers having a particularly important role to play here).

Moving onto HE qualifications, the respondents said that there were no formal degrees in sustainability in their institutions, but there are some specific sustainability modules and general "infusions" of sustainability in some degrees. For example, architecture has a module on sustainability, and sustainability teaching is infused throughout the course e.g. how to design in a sustainable way. They thought however that architecture was unlikely to be seen as a current green job, but it is a job that needs to get greener, and the university aimed to produce architects that have an awareness of sustainability ('know about green things'), not 'green architects'.

One university described plans to introduce sustainability provision more explicitly within certain degree programmes – one plan is to develop a psychology and sustainability degree, although this has not received the go-ahead yet, and another is to include a 'sustainable pathway' (e.g. pathway to sustainable jobs) for business and law MBA students, recognizing that there is not yet demand for a pure Masters degree in sustainable finance.

This university also had a plan to incorporate, within the next year or two, a specific sustainability module into the employability module that has been embedded into courses across the whole curriculum. The sustainability module would cover the concept of climate change and net zero and what this looks like in the industries/sectors relevant to the courses, with activities for students to calculate their carbon footprints. It was noted that GCSEs are already covering this as schools are already introducing these concepts, so while it is not new for young students, it may be new for mature students. However, the school-based knowledge could be broad-brush and not provide enough information about the reality of the problems society is facing. Therefore the plan is to focus students on their own industry, with clearer explanations of the extent of the problem which will be new for all students, and to emphasise that the students themselves are very much part of the solution. The aim is for this to lead to greater engagement in issues of sustainability,. It is also hoped that this will also assist the university in meeting its own target to become net zero.

Future issues in green skills provision

The view from colleges was that the key to getting the green skills agenda right in the future was to focus on employers' demand for skills, and the funding availability for them. If the organisations who commission building work could make commitments and create a reliable pipeline, then employers will organise around that and providers will address their needs. On the finance side, a degree of pump priming from the public sector will be needed but then it would be sustainable through a combination of private and public funding. One college said they would like to see the GLA and London Assembly promote the natural environment to the same extent as carbon reduction within the 'green' agenda, and also more promotion of green skills by careers advisers at school – corporate environmental responsibility was expanding and demonstrated why green skills should be a higher priority than they were.

Colleges had seen employers get burned by changes in the agenda. For example, they had seen employers engage with green skills grants and recruit and train staff, but then when the funding dries up they have to lay staff off. There is a need for reliable investment in green skills to generate demand that the skills supply sector will match, rather than schemes which could collapse due to changes in focus by ministers.

It will also be more effective to get the 'low hanging fruit' first – tried and tested technologies. So in London, just start focusing on retrofit, which is well established technology with good payback on the investment, and then over time move into the more complex technologies with longer periods for returns. Colleges could develop specialisms in a planned and co-ordinated way rather than all crowding into the same segments – the Mayor's construction academies demonstrated how that can be achieved.

But overall, colleges expressed the view that there is not much more they can do until job market shows demand. If demand arises, they feel they can have courses ready in a matter of weeks. But it comes down to timing, and they do not want to invest too early, before the jobs are there.

ANNEX B: The green recovery in a London context

This annex reviews national policy on climate change and on broader environmental goals, and then looks at the London context specifically.

National climate change policy

In 2019, the UK Government introduced a legal target to reduce greenhouse gas emissions by 100%, known as the Net Zero target (remaining emissions can be offset) by 2050. As part of this commitment, the Climate Change Committee (CCC) was set up as an independent statutory body to advise Government and report on its progress in meeting its targets.[137] The CCC's *Net Zero* 2019 report urged Government to ramp up policy, speed up delivery and strengthen ambitions to credibly meet the net-zero greenhouse gas emission target by 2050, while voicing concerns that the current policy foundations in place would not deliver on this critical goal. The Committee's subsequent 2020 progress report stated that the 12 months since the passing of Net Zero targets into law had not delivered adequate climate policy progress.[138]

In 2020 the Government released its Ten Point Plan for a Green Industrial Revolution, comprising a series of ambitions to make the UK carbon-neutral by 2050 and policies and investment to this end, while driving a green recovery from the Covid-19 pandemic.[139]

The Sixth Carbon Budget, also developed by the CCC, advises the Government of the near-term (2033-37) path to Net Zero, effectively bringing forward Government's previous territorial emissions reduction target of 80% by 15 years and requiring a significant investment scale-up to meet these new ambitions, while stressing the importance of a Just Transition.[140] The Government has since passed legislation in line with this recommendation, which should take the UK over three-quarters of the way to reaching net zero emissions by 2050.[141]

Key policy initiatives include:

- Wind energy policy: The Government aims to quadruple the UK's offshore wind capacity by 2030.[142] This will be done through investment into modern ports and manufacturing infrastructure, and incentivising investment through Contracts for Difference auctions.[143]
- Hydrogen policy: The Government has announced a target of 5GW of low carbon hydrogen production capacity by 2030, supported by the Net Zero Hydrogen Fund and pilot schemes for Hydrogen Neighbourhoods, alongside encouraging private sector investment. [144] A Hydrogen

up London's waterways.[145] London Councils' CAP database identifies 237 actions under the theme of *Creating a resilient and green London* (which also includes activities related to biodiversity, food growing and green/blue infrastructure and maintenance); our analysis has identified that 36 of these relate specifically to climate resilience and adaptation.

Natural environment

- The LES' approach to the natural environment places a focus on improving, protecting and Strategy is expected soon.
- Transport policy: The Government has made a range of commitments covering private vehicles, public transport and freight and logistics in the Department for Transport's Decarbonising Transport Strategy, aligning with travel and transport elements of the

Government's Ten Point Plan. They outline plans for the phasing in of zero emissions vehicles, including a ban on the sale of most new petrol and diesel cars and vans from 2030, supported by a £28 billion support package for the UK car manufacturing industry, and further funding to support electrification of vehicles and their supply chains and trials for zero emissions freight transport.[146] This will be supplemented by efforts to increase the role of public transport through expansion of routes and increased frequency of services, while greening the UK's bus fleets through zero emissions buses and decarbonising the rail network by 2050;[147] the Ten Point Plan outlines a goal of at least 4,000 more zero emissions buses.[148]

- Greener buildings: The Ten Point Plan highlights the need to decarbonise buildings, recognising that buildings standards, regulations and funding will be necessary to support this ambition.[149] Specific points are made regarding the need to replace fossil fuel boilers with low carbon alternatives and plans for implementing standards for new buildings' energy efficiency and heating.[150] Targets include 600,000 heat pump installations annually by 2028 and supporting 50,000 new jobs by 2030. [151] Home energy efficiency measures are to be announced in the upcoming Heat and Buildings Strategy, though this has been delayed a number of times and is anticipated in the Autumn.[152]
- Carbon Capture, Usage and Storage (CCUS): To meet ambitions to capture 10MT of CO_2 a year by 2030, the Ten Point Plan announces £1 billion of funding to create 'SuperPlaces' through four industrial clusters by 2030 to deliver CCUS swiftly and at the required scale, and a revenue mechanism to support this through private investment. [153]
- Green Finance and Innovation: To support the development of future technologies necessary for Net Zero, the Government's Ten-point Plan announces an increase of total R&D investment to 2.4% of GDP by 2027, and a £1 billion Net Zero Innovation Portfolio to invest in named priority areas such as bioenergy, disruptive technologies and energy storage and flexibility.[154] The recently launched UK Infrastructure Bank will increase infrastructure investment across different regions with the dual purpose of levelling up the UK and tackling climate change.[155]

National broader environmental policy

Natural Environment

Broader environmental policies have also been introduced in recognition of the extremely detrimental impacts of unabated use and damage of the natural environment. The recently published Dasgupta Review finds that this damage threatens not only natural ecosystems, but our existence itself, given human reliance on the natural environment for everything we need to live, from oxygen to food.[156] Policies and targets with the aim of preserving and enhancing the natural environment include the Nature Strategy, Green Recovery Challenge funding for nature conservation and restoration projects, and environmental land management schemes, such as the landscape Recovery scheme and Local Nature recovery projects. [157] [158] The Government aims to protect and improve 30% of UK land by 2030 and establish 10 long-term Landscape Recovery projects over four years. [159]

Air quality

A study from the Royal College of Physicians estimated that 40,000 deaths a year in the UK are attributable to exposure to outdoor air pollution;[160] and Defra estimated that just one pollutant, PM2.5 (fine particulate matter – thought to have the greatest impact on human health)[161], caused just over 14,000 premature deaths of people aged 25 or older in 2017.[162] Air quality is tackled in a

range of legislation and policies such as the Environment Bill, the Air Quality Strategy and the Clean Air Strategy. The Environment Bill covers a range of measures to reduce air pollution, including setting national targets, simplifying the framework for local authorities to tackle smoke emissions and new Government powers to enforce environmental standards for vehicles.[163] Targets across governmental air quality policy include meeting the WHO guideline limits of PM2.5 concentrations and ensuring the sale of only the cleanest available stoves by 2022.[164] The Government's Ten Point Plan also mentions the air quality benefits from policies increasing electric vehicle uptake and cycle infrastructure.

London regional policy

The London Environment Strategy (LES), published in 2018, outlines policy across a range of environmental themes to meet the Mayor's ambition for London to be a zero-carbon city by 2050, and maps these ambitions alongside national targets and policy. Specific milestones within this overarching ambition include:

- a 50% reduction in the Capital's CO_2 emissions by 2023-27;
- 15% of energy demand being met by renewable and district energy by 2030; and,
- the installation of 2GW of solar photovoltaic capacity by 2050.[165]

Local authorities in London also set borough-specific climate and broader environmental policy. In fact, the CCC has highlighted that over half of the necessary emissions cuts rely on local solutions, and a third of emissions are under the purview of local authorities, in areas such as buildings and transport planning, waste and risk management.[166] Almost all London boroughs have declared a climate emergency and 22[iii] have published Climate Action Plans (CAPs) which set out the policy measures they will follow to help meet net zero targets, ranging from retrofit programmes to promoting the circular economy.

London climate policy, like UK climate policy, has a strong focus on decarbonisation and a switch to renewable energy sources, as well as specific focus on surface transport. Both incorporate to some degree a mix of standards setting and funding programmes to help meet goals. Significant policy initiatives at a cross-London level include (this list is adapted from a recent summary by the Institute of Public Policy Research[167]):

- Housing:
    - Warmer Homes programme: £10m over four years to upgrade efficiency of up to 1,000 fuel poor homes[168] as well as a Warmer Homes Advice Service to provide support for applications and other bills.[169]
    - Retrofit Accelerator - homes: Delivering whole-house retrofits to 1,678 homes in Greater London over the next three years.[170]
    - Social Housing Retrofit Accelerator: Supporting social housing providers to bid successfully for funding from BEIS' £160 million Social Housing Decarbonisation Fund to upgrade social housing stock to EPC C.[171]
- Non-domestic buildings:

[iii] 22 London boroughs and the City of London Corporation

- **Mayor of London Energy Efficiency Fund:** £500m for energy efficiency upgrades in partnership with Amber Infrastructure Group and the European Regional Development Fund.[172]
- **Retrofit Accelerator - workplaces:** Free support to public sector organisations to help them deploy energy efficiency retrofit projects.[173]

- **Transport:**
  - **Ultra-low emission zone (ULEZ):** Zone around central London that charges vehicles which do not meet ULEZ emissions standards, with plans to expand to the North and South Circular from 25th October 2021.[174]
  - **Electric vehicle charging points:** £4.5m funding allocated to work with councils to deploy rapid charge and slower charging points.[175]
  - **Cleaner buses:** £300m committed as part of an ambition to convert all buses to be zero carbon by 2037 and 12 low emission bus zones.[176]
- **Nature:**
  - **Greener City Fund:** A £12m fund to drive the commitment to make a national park city with over half the city's area being green by 2050.[177]
  - **Air Quality Fund:** £22m over 10 years to support projects to improve air quality.[178]

London differs from policy at the national level in a range of ways. In some cases, these differences clearly relate to the different remits between the two (London has more powers over local transport, waste and planning systems than it can influence regulatory systems for example), as well as applicability; delivering offshore wind farms is less relevant to the local London picture than to the UK as a whole. Specific aspects of these differences are outlined below:

- **Timescale ambitions**: In 2020, the Mayor announced London's net zero target deadline as 2030, 20 years earlier than the UK's legally binding target. London Councils' Climate Programmes are scheduled within the 2020-2030 timescale, as are the majority of London borough targets for reaching net zero.[179]
- **Level of specificity regarding deliverables**: Much of London's climate action is being set out and delivered through councils, with CAPs outlining many policies to meet decarbonisation in detail, including the actions and timescales within broader climate policy aims.
- **Relative focus on topics**: Compared with the UK's environmental policy headlines, London's regional environmental policy and strategy comprises a greater narrative focus on aspects such as ambient noise and air quality than UK policy does. There is also a greater narrative focus on the circular economy and waste, though some policy areas are yet to be extensively developed.
- **Explicit focus on social impacts**: Though the notion of a Just Transition is recently being included in the national policy narrative, London's policy has tended to express a greater focus on the social impacts of tackling the climate crisis, such as the disproportionate impacts of air quality on disadvantaged communities and the health impacts of climate change in the 2018 LES as well as the more recent London Recovery Board missions. Tied into this is community engagement, expressed both in the London Environment Strategy and the London Councils' Joint Statement on Climate Change.[180]

In a Joint Statement in November 2019, London Councils committed to prioritising delivery of climate programmes under seven key themes:

- Retrofit London
- Low carbon development
- Low carbon transport
- Renewable power for London
- Reduce consumption emissions
- Build the green economy
- Creating a resilient and green London

To understand climate policy across London boroughs, London Councils have carried out an analysis of Climate Actions Plans. See box A1 for further details.

Box B1: London Councils analysis of borough Climate Action Plans

London Councils have carried out analysis of London borough's climate action plans (CAPs) to understand the mix of actions across London under each of the TEC-LEDNet themesseven climate programme themes, and also analysing topic areas and the kinds of activity involved. This analysis suggests that of the seven TEC-LEDNet themesprogrammes, Low carbon transport has the most 'total actions' in place (404) across the boroughs' published CAPs, followed by Retrofit London (295), Consumption emissions (268), Creating a resilient and green London (237), and then Renewable power, Low carbon development and Build the green economy (each comprising 154, 143, and 76 total actions respectively).

Between boroughs, there is significant variation in the proportion of focus on a given theme within their climate action plans; retrofit actions take up anywhere from 6% to 30% of a borough's CAP actions, with similar variation in low carbon transport, consumption emissions and resilient and green economy. CAPs generally contain proportionately fewer actions towards a green economy, with seven boroughs plans not containing any actions on this theme.

The categorisation also shows the commonality of actions between boroughs. Tree planting for example is the most common 'Resilient and Green London' action, featuring in over 80% of published CAPs, with all other actions within the theme appearing in between 17%-35% of published CAPs. Close to three-quarters of CAPs incorporate switching to sustainable procurement. Less frequent policies include encouraging residents and businesses to switch to renewable energy (13% of CAPs) and skills and training opportunities on sustainable procurement and reducing consumption emissions (17% of CAPs contain actions towards this).

The analysis was completed using 25 CAPs completed or in draft as of April 2021; since this period more borough CAPs have been published.

Source: London Councils Borough CAP Database[181]

Climate policies

Seven programmes developed by London Councils and London boroughs include retrofitting all domestic and non-domestic buildings to an average level of EPC B by 2030, using borough planning systems to deliver low carbon infrastructure, and securing 100% renewable power for London's public sector.[182] The analysis by London Councils of boroughs climate actions plans show that over half of the published borough CAPs contain actions to switch all council-purchased electricity to low-carbon

sources. Under the *Retrofit London* theme, London Councils has also identified 295 actions stated across published borough CAPs. Key retrofit activities include supporting private landlords to improve their property's energy efficiency and compliance with standards, as well as decarbonising heating systems in council housing and buildings.

The Energy for Londoners programme aims to support Londoners to cut their energy use by improving the energy efficiency of homes and public buildings, for example through a smart meter rollout, replacing polluting boilers with cleaner boilers, and installing more solar panels to contribute to reaching 1GW of capacity by 2030.[183]

The London Councils analysis has identified 404 actions across published borough CAPs under the theme of *Low-carbon transport*. The most common action across CAPs are building electric vehicle charging points and greening borough fleets towards electric vehicles, hydrogen- or biofuel-powered vehicles, among measures to encourage and facilitate more travel by bike. The London Environment Strategy (LES) outlines a roadmap to zero emission road transport for 2020-2050, with London-specific measures underpinned by (i) demonstration of technologies (e.g., zero emission capable taxis, and electric buses and charging infrastructure), (ii) changing purchasing patterns (through delivery of a vast expansion in electric vehicle charging points and all new taxis being zero-emissions capable, among others), and (iii) fleetwide adoption and managing congestion (for example, the capital's bus fleet becoming either zero emission or hybrid 2030-2035, then phasing to all zero emission by 2037, and a move from ultra-low emissions zones towards zero emission zones).[184]

Boroughs across London are taking action to increase and enhance green spaces to support decarbonisation as well as adaptation. London Councils identified 42 actions related to tree planting across published CAPs (within the *Creating a resilient and green London* theme), as well as creating new open green spaces and enhancing biodiversity in the public realm. Another key action across several CAPs is the building (or supporting the delivery of) sustainable drainage systems. Adaptation to climate change is also a theme in the LES, with the Strategy including measures such as using the city's planning system to combat flood risk and inter-agency working to clean increasing the city's green spaces through a range of measures, including funding and a Green Spaces Commission to support better management of local parks and the planting of more trees, increasing green space in areas it is lacking, and protecting the city's Green Belt.[185] The Strategy outlines an ambition for the city to become the world's first National Park City, meaning more than half of the area would be green.[186]

Air quality

Air quality is one of the topics London Councils explores in its analysis of CAPs, alongside the seven aforementioned themes. Policies included in CAPs are implementation of anti-idling policies, creating clean air neighbourhoods and communities, and strategic action plans on air quality. The LES sets an ambition for London to have the best air quality of all major world cities by 2050 and outlines policies which target the city's current poor air quality.[187] As well as Ultra-Low Emission Zones, the strategy introduces a new Air Quality Positive standard so that new buildings contribute positively to the city's air quality, setting stringent long-term air quality standards and seek further powers with a view to enforce controls on a range of sources of air pollution.[188]

Waste

Policies and targets relating to waste are woven through various themes in borough CAPs, including specific policies on reducing food waste, expanding street waste measures and reviewing/creating waste collection systems. Regional London policy includes a target of no biodegradable or recyclable

waste to sent to landfill by 2026, and by 2030 65% of London's municipal waste to be recycled.[189] Measures to support this include awareness campaigns about reducing food waste, minimum recycling standards for London's waste authorities and ensuring sufficient waste management sites to meet these goals.[190]

Linked to the topic of waste is that of the circular economy, which is a specific sub-topic in the London Councils analysis. The analysis identifies 34 total actions on the circular economy, including embedding circular economy principles into council strategy, operations and procurement and creating apprenticeship and training pathways into the green circular economy. At a regional London level, the GLA intends to enhance the circular economy through its procurement decisions and the establishment of the Centre for CleanTech Innovation.[191]

ReLondon, a partnership of the Mayor of London and the London boroughs is one key initiative at both a regional and borough level. Its aim is to improve waste and resource management and transform the city into a leading low carbon circular economy. The partnership informs and collaborates with London's government, businesses and citizens to reduce volumes of waste, shift to circular economy business models and improve recycling.[192]

Annex C: Lists of all LDCS and JACS codes included in green skills provision

LDCS code	LDCS code description	JACS code	JACS code description
QA.	Environmental Protection/Conservation	F751	Applied environmental sciences
QA.1	Environmental Studies	F751	Applied environmental sciences
QA.11	Landscape Studies	K320	Landscape studies
QA.2	Environmental Conservation/Policies	D447	Environmental conservation
QA.21	Environmental Management	F751	Applied environmental sciences
QA.22	Environmental Policy	F751	Applied environmental sciences
QA.23	Environmental Analysis	F751	Applied environmental sciences
QA.24	Environmental Planning	F751	Applied environmental sciences
QA.25	Environmental Regeneration Planning	F751	Applied environmental sciences
QA.26	Renewable Resources Planning	F751	Applied environmental sciences
QA.3	Environmental Science	F750	Environmental sciences
QA.31	Environmental Monitoring	F751	Applied environmental sciences
QA.32	Environmental Biology	C150	Environmental biology
QA.33	Environmental Chemistry	F140	Environmental chemistry
QA.35	Global Warming	Z990	Combined/general subject unspecified
QA.4	Landscape Conservation	D447	Environmental conservation

QA.41	Soil Conservation	D447	Environmental conservation
QA.9*	Conservation/Protection of Specific Environments	D447	Environmental conservation
QA.91	Nature Conservation/Protection (Land)	D447	Environmental conservation
QA.911	Wildlife Conservation/Protection	D447	Environmental conservation
QA.912	Wild Plant Conservation/Protection	D447	Environmental conservation
QA.913	Habitat Management	D447	Environmental conservation
QA.914	Nature Reserve Management	D447	Environmental conservation
QA.92	Wetland/River Conservation/Protection	D447	Environmental conservation
QA.93	Marine/Coastal Conservation/Protection	D447	Environmental conservation
QA.931	Coastal Conservation/Protection	D447	Environmental conservation
QA.934	Marine Wildlife Conservation/Protection	D447	Environmental conservation

* Note: QA.94 Tropical Rain Forests Conservation / Protection and QA.96 Polar Areas Conservation / Protection are excluded as not relevant to green jobs in London

LDCS code	LDCS code description	JACS code	JACS code description
QB.*	Energy Economics/Management/Conservation	Z990	Combined/general subject unspecified
QB.1	Energy Economics (Applied)	L110	Applied economics
QB.12	Energy Resources	H221	Energy resources
QB.13	Energy Conservation	H221	Energy resources
QB.14	Energy Management	H221	Energy resources
QB.2	Alternative Energy Research	H221	Energy resources
QB.3	Electric Power Economics	L110	Applied economics
QB.7	Vegetable Crop Fuel Economics	L110	Applied economics
QB.8	Waste Materials Fuel Economics	L110	Applied economics
QB.9	Renewable Energy Resources	H221	Energy resources

* Note: QB.4 Gas Fuel Economics, QB.5 Oil Based Fuel Economics and QB.6 Solid Fuel Economics are excluded as they are not green technologies

LDCS code	LDCS code description	JACS code	JACS code description
QC.	Pollution / Pollution Control	F753	Pollution control
QC.1	Environmental Pollution	F753	Pollution control
QC.2	Environmental Pollution Control	F753	Pollution control

QC.3	Air Pollution / Pollution Control	F753	Pollution control
QC.4	Soil Pollution / Pollution Control	F753	Pollution control
QC.5	Water Pollution / Pollution Control	F753	Pollution control
QC.51	Water Supply Pollution / Pollution Control	F753	Pollution control
QC.6*	Control Of Specific Pollutants	F753	Pollution control
QC.62	Industrial Effluent Control	F753	Pollution control
QC.621	Smoke Pollution Control	F753	Pollution control
QC.66	Oil Pollution Control	F753	Pollution control

* Note: QC.64 Noise Pollution Control is excluded because it is not related to green jobs

LDCS code	LDCS code description	JACS code	JACS code description
QE.43	Recycling Collection / Treatment	J990	Technologies not elsewhere classified

LDCS code	LDCS code description	JACS code	JACS code description
TG.3	Glazing (Buildings)	Z990	Combined/general subject unspecified
TG.31	Double Glazing	Z990	Combined/general subject unspecified
TG.32	Leaded Lights Glazing	Z990	Combined/general subject unspecified
TG.33	Replacement Window Fixing	Z990	Combined/general subject unspecified
TG.34	Plastic / Polycarbonate Glazing Work	Z990	Combined/general subject unspecified
TG.5	Building Insulation	Z990	Combined/general subject unspecified

LDCS code	LDCS code description	JACS code	JACS code description
TH.	Building Maintenance / Services	K290	Building not elsewhere classified
TH.1	Building Services	K290	Building not elsewhere classified
TH.11	Energy Efficiency (Buildings)	K210	Building technology
TH.12	Building Services Engineering	K290	Building not elsewhere classified
TH.2	Building Electrical Work	K290	Building not elsewhere classified
TH.21	Building Electrical Work (DIY)	Z990	Combined/general subject unspecified

TH.22	Electrical Installation (Buildings/Construction)	K290	Building not elsewhere classified
TH.23	Electrical Maintenance (Buildings)	Z990	Combined/general subject unspecified
TH.24	Emergency Lighting / Power Supply	Z990	Combined/general subject unspecified
TH.25	Lighting (Building Work)	Z990	Combined/general subject unspecified
TH.3	Plumbing (Building Work)	Z990	Combined/general subject unspecified
TH.31	Plumbing (Professional)	Z990	Combined/general subject unspecified
TH.32	Plumbing (DIY)	Z990	Combined/general subject unspecified
TH.33	Plumbing Installation Work	Z990	Combined/general subject unspecified
TH.34	Drainage (Building Work)	Z990	Combined/general subject unspecified
TH.35	Water Supply (Building Work)	Z990	Combined/general subject unspecified
TH.37	Lead Work (Plumbing)	Z990	Combined/general subject unspecified
TH.4	Heating Installation (Building Work)	Z990	Combined/general subject unspecified
TH.41	Heating Appliance Installation / Servicing	Z990	Combined/general subject unspecified
TH.42	Boiler Installation / Servicing	Z990	Combined/general subject unspecified
TH.43	Central Heating Installation / Servicing	Z990	Combined/general subject unspecified
TH.6	Ventilation (Building Work)	Z990	Combined/general subject unspecified
TH.7	Air Conditioning (Building Work)	H150	Engineering design
TH.91	Building Maintenance	K290	Building not elsewhere classified

LDCS code	LDCS code description	JACS code	JACS code description
XH.	Mechanical Engineering	H300	Mechanical engineering
XH.1	Mechanical Engineering (General)	H300	Mechanical engineering
XH.13	Mechanical Production Engineering	H300	Mechanical engineering
XH.2	Hydraulic Engineering	H300	Mechanical engineering
XH.21	Hydraulic Power Systems	H300	Mechanical engineering
XH.3	Fluid Engineering	H300	Mechanical engineering
XH.31	Flow Systems	H300	Mechanical engineering
XH.312	Pipework Engineering	H300	Mechanical engineering
XH.32	Steam Engineering	H311	Thermodynamics
XH.321	Boiler Engineering	H311	Thermodynamics

XH.33	Blowers / Fans	H321	Turbine technology
XH.34	Mixing Machines	H300	Mechanical engineering
XH.35	Turbine Engineering	H321	Turbine technology
XH.36	Pneumatic Equipment / Processes	H300	Mechanical engineering
XH.361	Compressors	H300	Mechanical engineering
XH.362	Pumps	H300	Mechanical engineering
XH.363	Valves	H300	Mechanical engineering
XH.4	Pneumatic Engineering	H300	Mechanical engineering
XH.41	Pressure Vessels	H300	Mechanical engineering
XH.43	Refrigeration Engineering	H311	Thermodynamics
XH.44	Heat Pumps	H311	Thermodynamics
XH.45	Heat Exchanger Technology	H311	Thermodynamics
XH.6	Thermal Engineering	H311	Thermodynamics
XH.62	Gas Turbines	H321	Turbine technology
XH.9	Heating / Ventilation Engineering	H300	Mechanical engineering
XH.91	Air Conditioning Engineering	H300	Mechanical engineering
XH.92	Heating Engineering	H300	Mechanical engineering
XH.93	Ventilation Engineering	H300	Mechanical engineering

LDCS code	LDCS code description	JACS code	JACS code description
XK.	Power / Energy Engineering	H630	Electrical power
XK.1	Energy Engineering	H630	Electrical power
XK.2	Electric Power Engineering	H631	Electrical power generation
XK.21	Electric Power	H631	Electrical power generation
XK.211	Power Plants	H631	Electrical power generation
XK.213	Electric Generators	H631	Electrical power generation
XK.22	Hydroelectric Power	H631	Electrical power generation
XK.23	Wind Powered Generators	H631	Electrical power generation
XK.26	Solid Fuelled Power Generators	H631	Electrical power generation
XK.3	Nuclear Power Engineering	H631	Electrical power generation
XK.4	Electric Power Storage / Transmission	H632	Electrical power distribution

XK.41	Power Supply (General)	H632	Electrical power distribution
XK.42	Power Transformers	Z990	Combined/general subject unspecified
XK.43	Switchgear	Z990	Combined/general subject unspecified
XK.44	Power Transmission	Z990	Combined/general subject unspecified
XK.45	Electric Power Storage	Z990	Combined/general subject unspecified
XK.5	Electromagnetic Engineering	H690	Electronic & electrical engineering not elsewhere classified

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