GLAECONOMICS

Identifying Green Occupations in London

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MAYOR OF LONDON

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Contents

Executive summary

In this paper we use an O*NET-based[1] classification of green jobs to identify occupations that are likely to be affected by the transition to a low-carbon circular ('greener') economy. This approach provides a broad and inclusive framework for exploring the impacts of green activities and technologies on jobs and skills in London. It allows us to identify occupations where a process of greening will result in:

- an increase in demand for existing jobs and skills, without significant changes in work or worker requirements (e.g. construction operatives for insulation work or bus and coach drivers);

- significant changes in tasks and skills for existing job roles (e.g. vehicle technicians for work on electrical vehicles or construction managers to apply new green building strategies); or

- new and emerging job roles with unique green skill areas (e.g. management consultants focused on sustainability issues or marketing professionals focused on green marketing).

This paper adds to previous GLA Economics research on the impacts of the transition to a greener economy based on analysis of greenhouse gas emissions by industry group.[2] Our findings have also been used to inform GLA-commissioned research which aims to identify Adult Education Budget (AEB) courses related to green jobs and explore ways for the AEB to meet green skills needs in future.

Background

Delivering a green economic recovery and reducing greenhouse gas emissions in pursuit of net zero could have a significant impact on London's labour market. A variety of jobs are likely to change as the result of the transition to a low-carbon circular economy, in both the short term and the longer term.

Identifying which jobs and skills will be affected by these changes, and integrating this information into education and training provision, is a priority for mayoral and national climate policy. This is important for both meeting green skills needs and preparing people for work in a greener economy.

Key findings

- **There were 1.5m jobs in occupations affected by greening in London in 2019**, which equates to over a quarter of all jobs (28%) in London. This figure is higher than estimates derived from other approaches. Our approach is relatively broad and includes all of the jobs in a 'green' occupation, whereas other green definitions tend to focus on jobs or businesses directly involved in low-carbon or environmental activities.

- **The rate of jobs growth in occupations affected by greening has been higher than for non-green occupations in recent years**. The number of jobs in green occupations increased by 4.1% per year from 2015 to 2019 against an average of 0.6% in non-green occupations. This suggests that the impact of greening could, to some extent, already be taking place within these occupations.

- **The number of London-based jobs in green occupations is highest in the managerial, professional, and associate professional and technical groups**.[3] Some 72% of jobs in occupations affected by greening were in these groups in 2017-19 and a further 14% were in skilled trades roles. While most green occupations will face changes as a result of the transition to a greener economy, this

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[1] Occupational Information Network (O*NET), an occupational database produced by the United States Department of Labor.
[2] GLA Economics (2021): Just transition: initial analysis by industry group in London.
[3] Major groups 1-3 of the UK SOC2010 classification.

profile suggests that the need to upskill or reskill could be especially relevant to higher-skilled occupations.

- **The sectors with the highest shares of jobs in green occupations also tend to be relatively high emitting.** This includes electricity and gas (70% of jobs), construction (65%), manufacturing (42%) and transport & storage (36%). At the same time, greening in London will also have a major impact on activities that indirectly support the pursuit of net zero, such as finance and professional services.

- **The transition to a greener economy will have wide-ranging and variable impacts on skills and training requirements.** We identify a range of occupations where workers will need to carry out new or enhanced green tasks, with implications for education provision and workforce training. But our findings also indicate the need to address existing skills shortages to support the transition to a greener economy in London, even where there is less of a need for new or enhanced green skills.

- **The quality of jobs is likely to vary between different green occupational categories.** Overall, employee jobs in green occupations are more likely to be permanent and command higher pay than jobs in non-green occupations. This is particularly true for those in green enhanced skills and green new and emerging occupations, but not for employee jobs in green increased demand occupations.

- **The proportion of workers who participate in job-related training in green occupations is lower than for non-green occupations**. Only a fifth (20%) of individuals surveyed in 2017-19 who worked in a green occupation in their main job reported receiving training in the past three months, compared to a quarter (25%) of workers in non-green occupations. Receipt of job-related training is, however, far higher in green new and emerging occupations than in green increased demand occupations.

- **There is scope to increase the diversity of employment in occupations affected by greening.** Jobs in green occupations are more likely to be held by men than women (73% of jobs in green occupations were held by men in 2017-19) and a relatively high proportion of job holders are from a White ethnic background (74% compared to 67% for non-green occupations) with fewer from ethnic minorities.

Limitations and caveats

There are limitations to our approach to be aware of. Our analysis of green occupations relies on a novel application of research originally carried out in the United States and any mapping between occupational taxonomies is likely to be imperfect. Green occupational requirements will also vary between regions and evolve over time as the transition to a greener economy takes place.[4]

For these and other reasons, our findings should be interpreted with caution. This research is not definitive and there are, for example, likely to be occupations affected by greening we do not identify. It's also worth noting that the occupation-based classification we adopt here should only be considered complementary to other definitional approaches. The Low Carbon and Environmental Goods and Services (LCEGS) data produced for the Greater London Authority (GLA) remains vital for quantifying and monitoring the impact of key sectors supporting the transition to a low-carbon circular economy.[5]

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[4] Ultimately, most jobs and skills will need to become 'greener' to achieve net zero emissions targets.
[5] See: kMatrix (2020) London's Low Carbon and Environmental Goods and Services Sector: Interim Report - November 2020

Illustrative examples of green occupations and related jobs

Green category	Examples of SOC2010* occupations	Examples of green-related jobs
Green increased demand	Construction operatives n.e.c.** Carpenters and joiners Bus and coach drivers	Insulation installers Construction carpenters Bus drivers
Green enhanced skills	Plumbers and heating and ventilating engineers Vehicle technicians, mechanics and electricians Finance and investment analysts and advisers	Renewable energy engineers Electric vehicle mechanics Directors of sustainability
Green new and emerging	Management consultants and analysts Actuaries, economists and statisticians Marketing associate professionals	Sustainability consultants Environmental economists Green marketers

*Source: GLA Economics analysis of O*NET and Emsi.*
*UK Standard Occupational Classification 2010. ** Not elsewhere classified.

1   Introduction

Delivering a green economic recovery and reducing greenhouse gas emissions in pursuit of net zero could have a significant impact on London's labour market. A variety of jobs are likely to change as the result of the transition to a low-carbon circular economy ('greening').[6] These changes will have important implications for education and training in London, in both the short term and the longer term.

For analysis to inform skills and other policy interventions, it is necessary to adopt criteria to classify jobs as 'green'. There are already several different approaches to defining and measuring green jobs in the UK. These work well for quantifying and monitoring the impact of key sectors, but face limitations when it comes to understanding how different jobs and skills will be affected by greening. As the Green Jobs Taskforce (2021) puts it, 'The UK's climate ambition will entail an economy-wide transformation.'

Every job has the potential to become green or be affected by greening, but not all jobs or sectors will be impacted in the same way or at the same time. Research shows that future demand for green skills is likely to sit on a spectrum – ranging from specific technical requirements in activities directly supporting the transition to a greener economy (e.g. renewable energy), to more general skills needed across sectors. In this context, it makes sense to adopt a more scaled approach, rather than a binary classification of jobs as 'green' or 'not green'.

In this paper we explore an alternative US O*NET-based classification of green jobs.[7] We use this classification to identify which UK occupations (SOC2010) are likely to be affected by the transition to a greener economy. This approach, although not perfect, provides a broad and inclusive framework for exploring the potential impacts of green activities and technologies on jobs and skills in London.

Here we apply this framework to consider the following:

- What kinds of occupations will be affected by the transition to a low-carbon circular or 'greener' economy in London?
- What are the likely implications of this transition in terms of skills, qualifications and workforce requirements?
- What do we know about the types of jobs and characteristics of workers in occupations affected by the 'greening' of the economy?

The rest of the paper is organised as follows:

- Section 2 sets out some of the challenges of defining green jobs and describes the O*NET-based classification we adopt to identify occupations affected by the transition to a low-carbon circular economy or 'greening' of the economy.
- Section 3 summarises our data sources and draws attention to some key data-related limitations.
- Section 4 explores our findings. We discuss the number and types of jobs in occupations affected by greening in London and how this has changed in recent years. We also provide initial evidence on job type, workforce characteristics and location of jobs in occupations affected by greening.

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[6] In this paper: the 'green economy' or 'low-carbon circular economy' refers to economic activity related to reducing fossil fuel usage, decreasing pollution and greenhouse gas emissions, recycling materials, increasing energy efficiency, and developing/adopting renewable energy sources; 'greening' is the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements; and 'green skills' are skills needed by the workforce, across all sectors and levels, to help the adaptation of products, services and processes to changes due to climate change and to environmental requirements and regulations. See the glossary of key terms for more details.

[7] Occupational Information Network (O*NET), an occupational database produced by the United States Department of Labor.

2   Methodology

2.1   Defining green jobs

This section outlines some of the challenges of defining green jobs and skills from a labour market perspective. It then describes the alternative US O*NET-based classification of green jobs we have used to identify occupations that are likely to be affected by the transition to a low-carbon circular or 'greener' economy in London.

Background

Delivering a green economic recovery and reducing greenhouse gas emissions in pursuit of net zero could have a significant impact on the labour market in London. While the exact impacts will be shaped by a range of factors,[8] there are three main ways that jobs could be affected by 'green-biased' change:

- Structural changes could lead to increased demand for some jobs and decreased demand for others.[9]

- Existing jobs could experience changes in tasks or duties to be carried out, which may require adjustments to training and qualification frameworks.

- Green economic activities and technologies could create demand for new or renewed job roles and related qualifications and skills profiles.

Identifying which jobs and skills are likely to be affected by these changes, and integrating this information into education and training provision, is a priority for mayoral and national climate policy (Committee on Climate Change, 2020; Green Jobs Taskforce, 2021). This is important for both meeting green skills needs (i.e. avoiding skills bottlenecks) and preparing people for work in a greener economy.[10]

Challenges of defining green jobs

For analysis to inform skills and other policy interventions it is necessary to adopt working criteria to classify jobs as 'green'. There are, however, several different approaches to measuring green jobs in the UK with no universally agreed definition. As the ONS (2021a) puts it:

> 'The term "green job" has no one particular meaning, so this is a complex area. Often, more than one definition is cited, and different definitions can suit different uses.'

Different statistical frameworks are available to quantify and monitor the impact of key sectors supporting the transition to a low-carbon circular economy (Table 1). These approaches provide valuable insights but also face limitations when it comes to understanding how different jobs and skills will be affected by green-biased change. For example:

- They tend to focus on a somewhat narrow range of green activities or sectors, based on their final outputs or 'green credentials' (Sofroniou and Anderson, 2021). For example, data on the environmental goods and services sector (EGSS) produced by the ONS focuses exclusively on jobs engaged in 'producing goods and services for environmental protection purposes' and 'conserving and maintaining natural resources' (ONS, 2021a). While clearly important, this kind of approach does not cover the *full* range of jobs that could be affected by the move to a greener economy.

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[8] According to the ILO (2019) '[t]he changing environment, policies and regulations, green technology and innovation, green productivity and green markets are all stimulating demand for skills for green jobs, both directly and indirectly through supply chains.'

[9] In this paper we mainly focus on increases in demand. However, for initial analysis on high greenhouse gas emitting sectors, see GLA Economics (2021).

[10] For example, '[a] major role going forward for public actors will be to provide direction and co-ordination for skills development and training activities to occur' (OECD/Cedefop, 2014).

- They typically do not map directly on to other standard job classifications. For example, the LCEGS data produced for the GLA by kMatrix operates on a 'bottom up' basis with unique sectoral categories. The process helps to classify and quantify otherwise difficult-to-measure green activities and their supply chains. But it also means the data cannot be easily translated into other relevant datasets, thereby limiting the range of further (e.g. labour market-related) analysis that can be carried out.

Looking ahead, the demand for green skills is also likely to sit on a spectrum with varying requirements across different areas of the economy. This will include significant changes in terms of the technical skills and knowledge required in activities directly supporting the transition to a greener economy (e.g. renewable energy) as well as changes in general or core skills requirements across a range of other sectors (International Labour Organization (ILO), 2019).[11] In this context, it makes sense to adopt a more disaggregated approach rather than adopting a binary classification of jobs as 'green' or 'not green' (Auktor, 2020).

Table 1: Examples of existing approaches to defining green jobs in the UK

Definitional approach	Criteria
EGSS – ONS	Economic activities that produce goods and services for environmental protection, as well as those engaged in conserving and maintaining natural resources. Excludes goods and services produced for purposes that, while beneficial to the environment, primarily satisfy technical, human and economic needs or are requirements for health and safety.
Low-carbon and renewable energy economy – ONS	Economic activities that deliver goods and services that are likely to help the UK generate lower emissions of greenhouse gases, predominantly carbon dioxide. Activities such as recycling and the protection of biodiversity are not among the sectors included in this definition.
LCEGS – kMatrix	The LCEGS sector has been defined using 24 sub-sectors which are grouped into three broad categories: environmental; renewable energy; and low carbon. This bottom-up and inclusive approach measures the core activities within each sector along with those in the supply chain.

O*NET classification of green occupations

In the rest of this paper we explore an alternative way of identifying green jobs and skills. The approach we adopt is based on research originally carried out in the United States by Erich Dierdorff and colleagues (Dierdorff et al., 2009; 2011) and their resulting O*NET-based classification of green jobs.

This O*NET-based classification, which should be considered complementary to other definitional approaches, is unique in several respects.

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[11] Ultimately, most jobs and skills will need to become 'greener' to achieve net zero emissions targets (Skills Development Scotland, 2020). However, recent analysis also suggests that relatively few skills are specific to green jobs (Bowen et al., 2018).

First, it takes a scaled approach to identifying green jobs, highlighting the differential impacts of the transition to a greener economy through a process of 'greening'. That is:

> '… the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements' (Dierdorff et al., 2009; 2011).

Second, it distinguishes between three categories of green jobs. This step – which is based on a judgement about the impact of green economy activities and technologies on occupational demand and worker requirements – is considered essential for 'locating, describing, and forecasting potential workforce consequences of the green economy' (Dierdorff et al., 2011). The resulting categories are:

- **Green 'increased demand' occupations** – these green occupations are not subject to any significant change in work and worker requirements, but are in increased demand due to greening. The context of work might change but the competencies and tasks remain the same.

- **Green 'enhanced skills' occupations** – these green occupations are not new but are subject to significant changes in work and worker requirements, which may or may not be associated with a change in demand. The essential purposes of the role remain the same, but tasks, skills, knowledge and external elements, such as credentials, are altered.

- **Green 'new and emerging' occupations** – the impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements, resulting in the generation of new or renewed roles. These new roles could be entirely new or 'born' from existing occupations.

Third, the O*NET classification is also more occupation-centric than other approaches. It focuses on the impact that greening has on occupations rather than on the outputs from a given occupation on the environment or green economy (Dierdorff et al., 2011). In short, it identifies occupations that are likely to be affected by greening as opposed to jobs that are inherently green.

This reflects the idea that a wide range of jobs will increasingly adopt or engage with green activities or technologies, to varying degrees, as a result of the transition to a greener economy. But it also means that the O*NET-based classification is comparatively broad since it includes all of the jobs within a given occupation regardless of whether the work is currently directed towards green tasks or duties.[12]

In practice the jobs within an occupation can vary considerably in their task make-up and economic sector. It is important to bear this point in mind when interpreting the findings in this paper. As noted above, the O*NET-based classification should be seen as complementary to other definitional approaches that remain useful for monitoring and quantifying the impact of those sectors, including those contained in the LCEGS grouping, that are key to enabling the transition to a greener economy.

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[12] For example, a marketing manager would usually be counted as a 'green job' if the worker was employed in a firm in the renewable energy sector, but not if they were working for a firm in a 'non-green' sector, even if the tasks and skills involved were mostly the same. The O*NET classification includes all marketing managers as being affected by greening (also see Bowen et al., 2018).

Table 2: Summary of O*NET methodology for classifying green occupations

In the United States, the National Center for O*NET Development, as part of efforts to keep up with the changing world of work, investigated the 'impact of green economy activities and technologies on occupational requirements' (Dierdorff et al., 2009; 2011; also see Bowen et al., 2018).

The research, first produced in 2009 and updated again in 2011, involved identifying and classifying different categories of green jobs using a multi-stage research and screening process:

- Collected and reviewed numerous publications related to the green economy from reputable sources such as academic journals and governmental technical reports

- Accumulated a list of specific job titles that were referenced in these sources, along with the sectors commonly used to categorise these green jobs.

- Sorted job titles into relevant clusters matched to O*NET occupations and organised them into an interpretable schema of broad sector groups.

- Reviewed the overlap with existing O*NET occupations and assigned jobs to different categories depending on whether they were:

  o a direct match (green increased demand)

  o a close but not exact match (green enhanced skills)

  o possibly new and unique (green new and emerging).

Two occupational analysts conducted this assignment process independently and then resolved any disagreements among themselves.

- Carried out further rigorous research to assemble and consolidate the evidence related to possible green new and emerging occupations.

This multi-stage process identified 204 green O*NET occupations from 467 initial green job titles (64 as green increased demand, 60 as green enhanced skills, and 78 as green new and emerging).

2.2   Identifying green occupations

This section summarises our approach to mapping between US and UK occupational taxonomies. It then provides a brief overview of the occupations we identify as being affected by greening. More detail on each of these areas can be found in Appendix A and Appendix B.

Mapping from O*NET to UK SOC

To apply the O*NET classification of green jobs in a London and UK context, we map between US and UK occupational taxonomies using a 'crosswalk' based on the application programming interface for the LMI for All database (under o-net/onet2soc/).[13]

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[13] A 'crosswalk' is a process for matching up the elements or variables of one list with the closest equivalent on another. In this case US occupation categories were 'crosswalked' to UK occupation categories.

This approach builds on the work of Sofroniou and Anderson (2021) by mapping directly from green O*NET occupation codes to the UK Standard Occupational Classification (SOC2010).[14] We also identify occupations at the most detailed, four-digit level of the UK classification.

It is important to note that this mapping process is not entirely automated, and for a variety of reasons the match between US and UK taxonomies cannot be perfect. There are, for example, significantly more occupations in the O*NET database than in the UK SOC2010 framework. Appendix A discusses our methodology for mapping between taxonomies in detail. There are three key points to be aware of:

- Where a direct single match between taxonomies is not possible, we apply judgement to identify the most appropriate UK SOC code to match to.

- In cases where a UK SOC code matches to multiple green O*NET codes, we also apply judgement to determine which green category to assign to the relevant UK SOCs.

- We have also manually added one UK SOC code (SOC 5113: Gardeners and landscape gardeners) to reflect GLA policy priorities.

It is worth reiterating that the research underpinning this approach was originally carried out in the United States and was last updated in 2013.[15] Ideally our analysis would be based on present-day research focused on London or the UK. However, the extensive analysis and screening process required to produce the O*NET green jobs classification (see Table 2, on page 9) was beyond the scope of this paper.

Notwithstanding these limitations, the approach outlined here provides a broad and inclusive framework for exploring the potential impacts of the transition to a greener economy in London.

The occupations we identify as being subject to greening appear reasonable and coherent with other recent green-occupational analyses (e.g. Department for Business, Energy and Industrial Strategy (BEIS), 2020). As Table 3 shows – and as we come on to in section 4 – there are also clear benefits to adopting an occupation-based approach; for example, to gain an understanding of skills and workforce requirements and for linking with other relevant datasets.

Table 3: Example use case for occupation-based approach

> The GLA recently commissioned RCU Ltd to undertake research to understand the landscape for green skills provision in London.
>
> The classification of occupations affected by greening presented here played a key role in that work. It was used by the research team to map between 'green' four-digit SOC2010 codes and the Sector Subject Area system used to classify post-16 qualifications (refined at the level of individual courses).
>
> This approach allowed the research team to identify areas of green skills provision across a broad range of jobs and sectors; explore provision in relation to occupations at different skills levels; and investigate skills requirements in terms of different green occupational categories.
>
> The final outputs from this research are forthcoming.

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[14] A similar crosswalking exercise is also adopted by Bakhshi et al. (2017). For more information about the LMI for All database, see Barnes et al. (2021), Enhancing a labour market information database: LMI for All.
[15] See: National Center for O*NET Development (2013), Greening of the World of Work: O*NET Project's Book of References.

Identifying green occupations

Overall, we identify 100 out of 369 UK SOC unit groups as occupations potentially subject to or affected by greening ('green occupations').

As outlined above, these are occupations where jobs are likely to undergo changes as a result of the transition to a greener economy. These changes could be in relation to an increase in demand for existing jobs; changes in the duties and tasks being carried out within existing jobs; or the appearance of new job roles with unique skill areas. While we do not focus on the occupations most at risk from greening, many of the changes in skills and workforce requirements in green enhanced skills and green new and emerging occupations reflect the pressure for economic activities to become more sustainable.

More specifically, we identify:

- 41 green 'increased demand' occupations – where the impact of green activities and technologies is expected to lead to increased demand for jobs without significant changes in skills requirements (e.g. for electricians, construction operatives, bus drivers)

- 33 green 'enhanced skills' occupations – where the impact of green activities and technologies is expected to lead to significant changes in work or worker requirements within existing jobs (e.g. for construction managers, financial advisers, plumbers and heating engineers)

- 26 green 'new and emerging' occupations – where the impact of green activities and technologies is enough to create the need for new work and worker requirement (e.g. for sustainability consultants, green marketers, environmental economists).

Two further points are worth highlighting before we examine our findings. First, for the purpose of this paper there is considerable overlap between the 'green new and emerging' and 'green enhanced skills' categories. Both imply important changes in skills requirements as a result of greening and we are not advocating changes to the UK SOC system here.[16] Setting aside imperfections in our mapping process, the distinction may be understood as one of degrees, with inclusion in the 'green new and emerging' category indicating the potential for unique green job roles within an occupation.

Second, due to data limitations (see section 3) most of the analysis presented in this paper is at the level of these three green occupational categories rather than for individual occupations. However, it is important to note that where analysis is based on aggregate-level data, it is likely to conceal variations at the level of individual occupations and jobs. The relative presence of different occupations (in jobs terms) in London compared to other parts of the country will also have an impact on our findings.

Figure 1 shows the 10 largest occupations, in terms of total jobs by place of work, within each green category in London. Appendix B provides a full breakdown of our green occupations.

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[16] Whereas in the original research, the inclusion of occupations in the green new and emerging category was related to established criteria for incorporating new occupations into the O*NET occupational taxonomy. In relation to the O*NET system, new and emerging occupations are defined as occupations that: involve significantly different work from that performed by incumbents of other occupations; and are not adequately reflected by the existing O*NET system (Dierdorff et al., 2009).

Figure 1: Top 10 occupations by green occupational category

London, 2017-19, estimated total jobs in thousands (000s)

Green increased demand

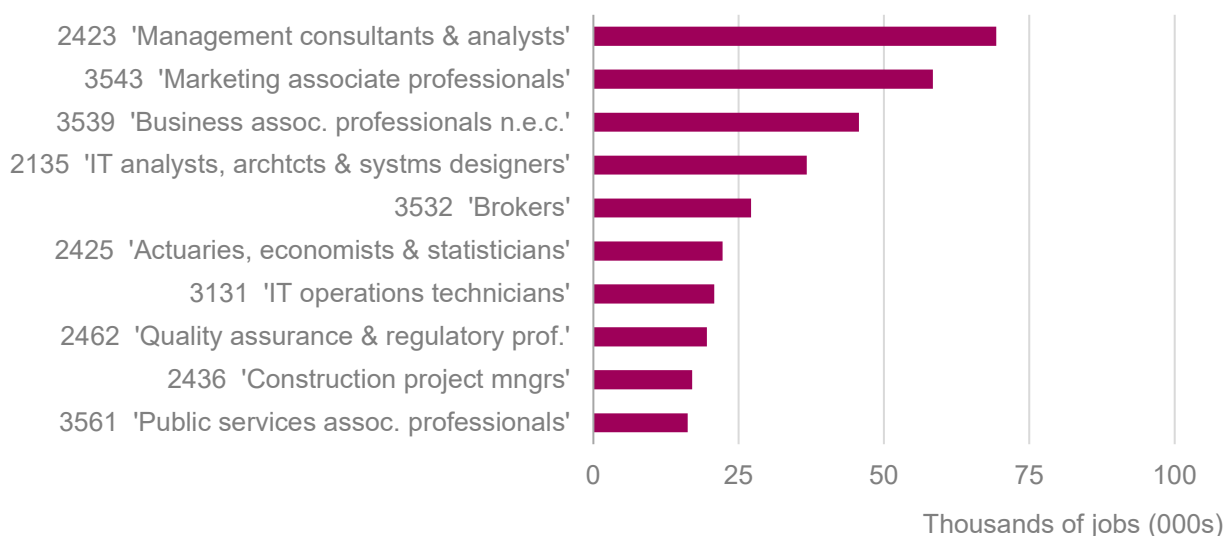|	
2136 'Programmers & software professionals'	
5319 'Construction & building trades n.e.c.'	
7219 'Customer service occupations n.e.c.'	
9260 'Elementary storage occupations'	
5241 'Electricians & electrical fitters'	
5315 'Carpenters & joiners'	
3422 'Product, clothing & related designers'	
8213 'Bus & coach drivers'	
4131 'Records clerks & assistants'	
5113 'Gardeners & landscape gardeners'	

Green enhanced skills

1132 'Marketing & sales directors'	
3534 'Finance & investment analysts & advisers'	
2471 'Journalists, newspaper & periodical editors'	
1122 'Production mngrs in construction'	
1121 'Production mngrs in manufacturing'	
2472 'Public relations professionals'	
9120 'Elementary construction occupations'	
3563 'Vocational & industrial trainers'	
5314 'Plumbers & heating & ventilating engineers'	
3542 'Business sales executives'	

Green new & emerging

2423 'Management consultants & analysts'	
3543 'Marketing associate professionals'	
3539 'Business assoc. professionals n.e.c.'	
2135 'IT analysts, archtcts & systms designers'	
3532 'Brokers'	
2425 'Actuaries, economists & statisticians'	
3131 'IT operations technicians'	
2462 'Quality assurance & regulatory prof.'	
2436 'Construction project mngrs'	
3561 'Public services assoc. professionals'	

Thousands of jobs (000s)

Source: GLA Economics analysis of ONS Annual Population Survey (2017-19, three-year pooled).

3   Data sources

A feature of our approach to identifying green occupations is that it allows us to carry out further analysis using standard UK labour market datasets. As we come onto in the next section, this includes analysis of the types of jobs affected by greening as well as breakdowns of workforce characteristics.

The findings presented in this paper draws on three main datasets: the ONS Annual Population Survey (APS), the ONS Annual Survey of Hours and Earnings (ASHE) and the UK Employer Skills Survey (ESS). In addition to limitations related to our methodological framework, our analysis of these datasets is also subject to several sources of data-related uncertainty. This includes issues related to the following:

- Data sources – imperfect (e.g. survey) data means that confidence intervals can be large. This is especially true for detailed occupations and at a sub-national level. As a result, most of the analysis in this paper is at the level of green occupational categories as opposed to four-digit occupations. For more robust estimates we also draw on three-year pooled data from the APS for 2017-19.

- Assumptions – where data is missing at a London level, we also impute figures based on what information is available. For example, where there is missing data at the London level, we impute estimates of median weekly earnings. As with any labour market modelling, this requires the use of judgement and modelled estimates should be treated as indicative rather than exact.

- COVID-19 impacts – there are, for example, concerns around the reliability of recent APS estimates related to changes in data collection and changes in demographic trends as a result of COVID-19.[17] Our analysis therefore focuses on 2019 as the latest year of data rather than 2020. This means that our findings do not reflect the (ongoing) impacts of the coronavirus pandemic.

It's also worth noting that where possible our analysis is carried out on a 'workplace jobs' basis, i.e. based on the sum of main and second jobs based in London. This includes people working but not living in London; but excludes residents who (only) work in jobs based outside of the capital. The total number of jobs in London also differs from the number of workers, because some people have more than one job.

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[17] This is particularly because LFS responses, from which the APS data are derived, were at the time of producing this analysis based on demographic trends pre-dating the pandemic (see ONS, 2021).

4   Findings

4.1   Jobs in green occupations

Having outlined our approach, we now turn to look at the number of London-based jobs in occupations affected by greening and how this has changed over time. We also present analysis on the profile of jobs by green occupational category, in terms of both broad occupation and industry groups.
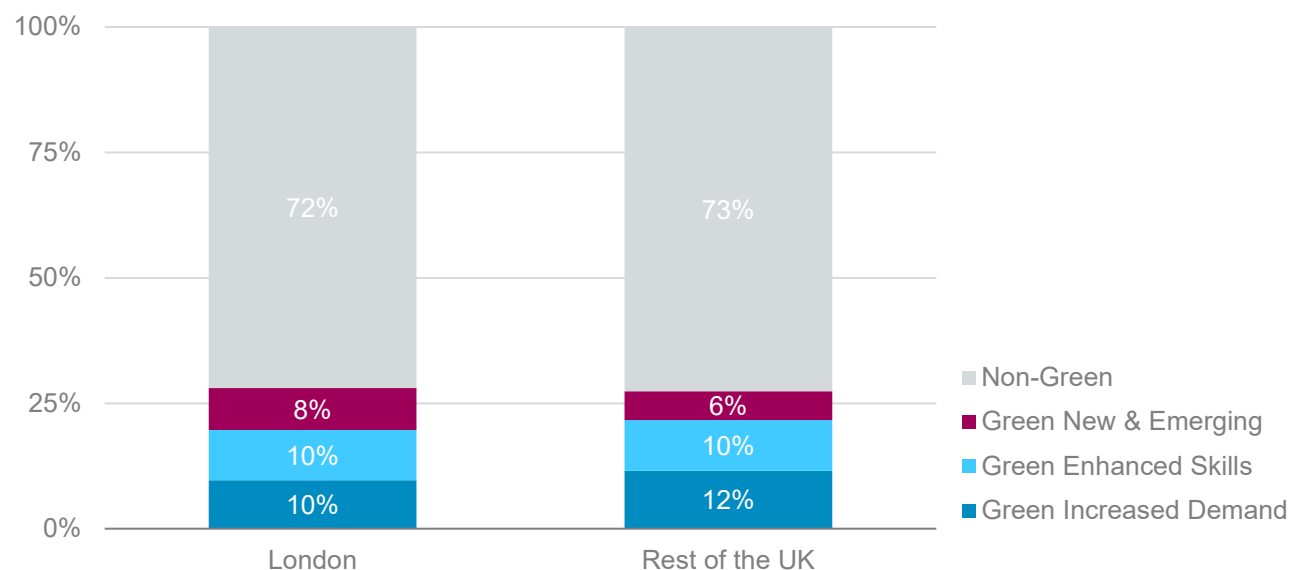
Proportion of jobs affected by greening

Figure 2 shows the proportion of total jobs (by place of work) by green occupational category for London and the rest of the UK. It shows that while the majority of jobs are in non-green occupations, over a quarter (28%) of jobs in London were in occupations subject to greening in 2019: 10% green increased demand, 10% green enhanced skills, and 8% green new and emerging.

Together these green occupations account for around 1.5m jobs in the capital. This figure is higher than estimates derived from other definitional approaches and is likely to represent an upper bound.[18] The difference is largely down to the way green jobs are defined. Our approach is relatively broad and includes all of the jobs in an occupation affected by greening, whereas other methodologies tend to focus on jobs or businesses directly involved in low-carbon or environmental activities (section 2.1).

Figure 2: Estimated proportion of jobs by green occupational category

Percentage of total jobs, London and rest of the UK, 2019

Source: GLA Economics analysis of the ONS APS.

The overall proportion of jobs in occupations affected by greening is similar for London and the rest of the UK. But there is variation at the sub-national level and between green categories (Figure 3). By UK region/country, the total proportion of jobs in green occupations ranges from almost 30% of jobs in the East Midlands to 26% in the North East of England. London had the highest share of jobs in green new and emerging occupations in 2019, but the lowest share of jobs in green increased demand occupations.

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[18] For example, employment in London's LCEGS sector was estimated at around 317,000 in 2018-19 (kMatrix, 2020). Using the O*NET classification Bowen et al. (2018) also estimate that around 20% of jobs in the US were green in 2014. Our estimate may be higher in part because UK SOC codes are generally more aggregated than the detailed O*NET occupations that are being mapped to them.

Figure 3: Estimated proportion of jobs by green occupational category
Percentage of total jobs, by UK country/region, 2019
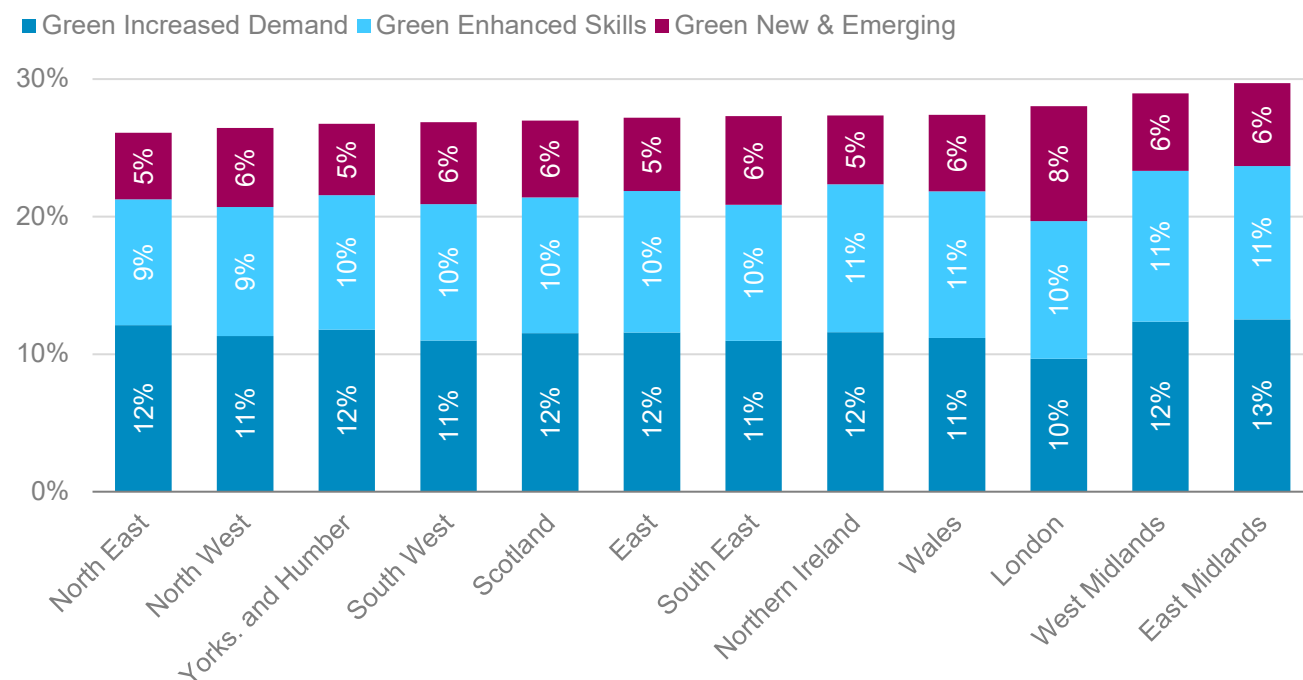
Source: GLA Economics analysis of the ONS APS.

There are also differences in employment trends between different green occupations in London. Figure 4 compares the annual rate of jobs growth for green and non-green occupations from 2015 to 2019. It shows that occupations affected by greening recorded a relatively strong increase in jobs during this time (increasing by 4.1% per year on average), with a faster rate of growth in each green occupational category than in non-green occupations (which increased by only 0.6% per year on average).

Figure 4: Estimated jobs growth by green occupational category
Compound annual growth rate, London, 2015-19
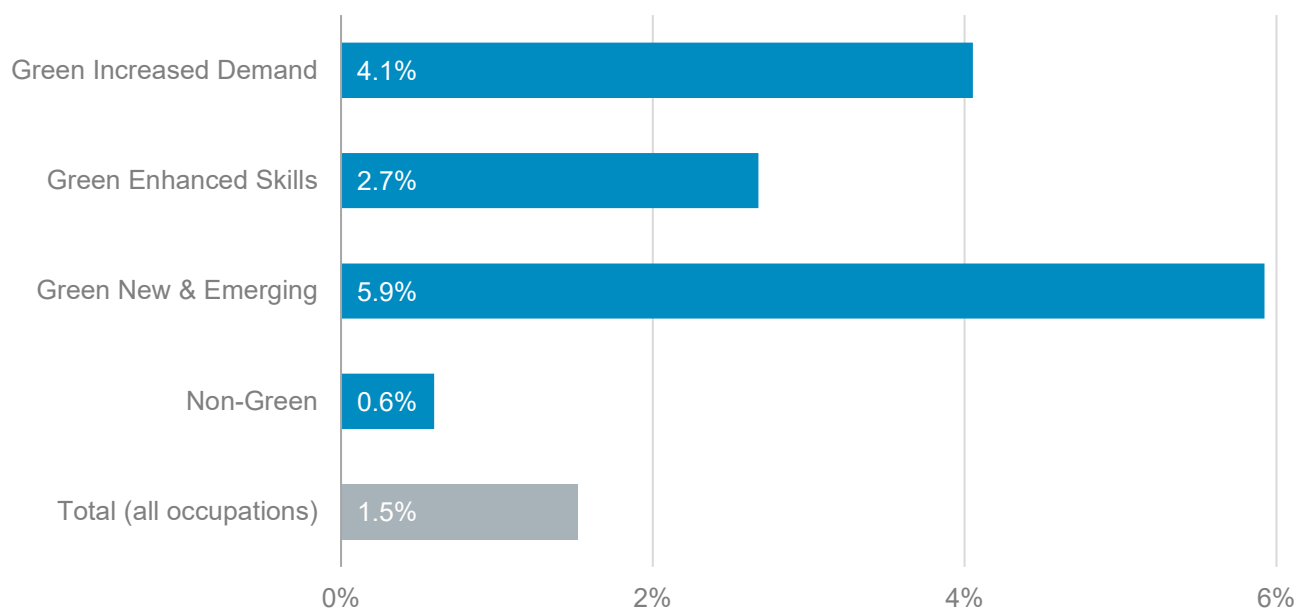
Source: GLA Economics analysis of the ONS APS.

These trends are not necessarily a direct consequence of the transition to a greener economy. Several other factors also influence labour market demand and jobs growth.

However, as we might expect as greening occurs, the number of jobs in green increased demand occupations has shown strong growth since 2015 (rising by 4.1% per year on average).[19] This suggests that, to some extent, the impact of greening could already be taking place within these occupations and may continue in future. At the same time, it is jobs in the green new and emerging category that have recorded the strongest rate of growth recently (up by 5.9% per year on average since 2015).[20]

Green occupations by major occupational group

To see what kinds of jobs will be affected by greening, we can look at green occupations by SOC2010 major group.[21] These occupational groups reflect the nature of qualifications, training and experience associated with jobs at different skill levels. For example, major groups 1 to 3 typically have degree-level qualifications associated with entry routes, while occupations in major group 9 only require a general level of education, usually acquired by this time a person completes compulsory education.

As Figures 5 and 6 show, the transition to a greener economy is likely to have an impact on a wide range of occupations across various fields and skill levels. That said, we get a different picture depending on whether we look at jobs by major occupational group in absolute terms or in relative terms.

In absolute terms, the number of London-based jobs in green occupations is relatively high in the managerial, professional, and associate professional and technical groups (SOC major groups 1-3). More than two-thirds (71%) of jobs in occupations affected by greening were in these groups in 2017-19 and only 14% were in skilled trades (SOC major group 5). Yet this is partly explained by the structure of the capital's economy, which is generally weighted towards jobs in higher-skilled occupations.[22]

To account for this, Figure 6 shows the percentage of jobs in green occupations within each major group. On this basis green occupations still account for around a third of jobs in the professional and associate professional and technical groups (32% and 36%). However, jobs in green occupations are also highly concentrated within skilled trades (55%) and process, plant and making operatives (34%) roles.

Looking more closely at Figures 5 and 6, the profile of jobs also varies between green categories. Jobs in green increased demand occupations are relatively prominent further down the SOC hierarchy, particularly within skilled trades roles. Jobs in green new and emerging occupations are located almost exclusively in SOC major groups 1-3, especially in professional and associate professional roles.

While most green occupations will face changes as a result of the transition to a greener economy, this profile suggests that the need to upskill or reskill could be especially relevant to higher-skilled occupations. By comparison, the changes in skills required in medium- and lower-skilled occupations could be more limited and generic (ILO, 2019). Yet, as we come onto in section 4.2, we also need to account for the existing recruitment challenges associated with green increased demand roles.

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[19] Led by an increase in programmers and software developers, construction and building tradespeople, and natural and social science professionals.

[20] Led by an increase in management consultants and IT systems designers.

[21] The major group structure is a set of broad occupational categories that bring together unit groups that are similar in terms of the qualifications, training, skills and experience commonly associated with the competent performance of work tasks.

[22] In the rest of the UK, less than half of jobs in green occupations were in major groups 1-3 in 2017-19, and a quarter of jobs in green occupations, were in skilled trades positions.

Figure 5: Number of jobs by green occupational category by major group
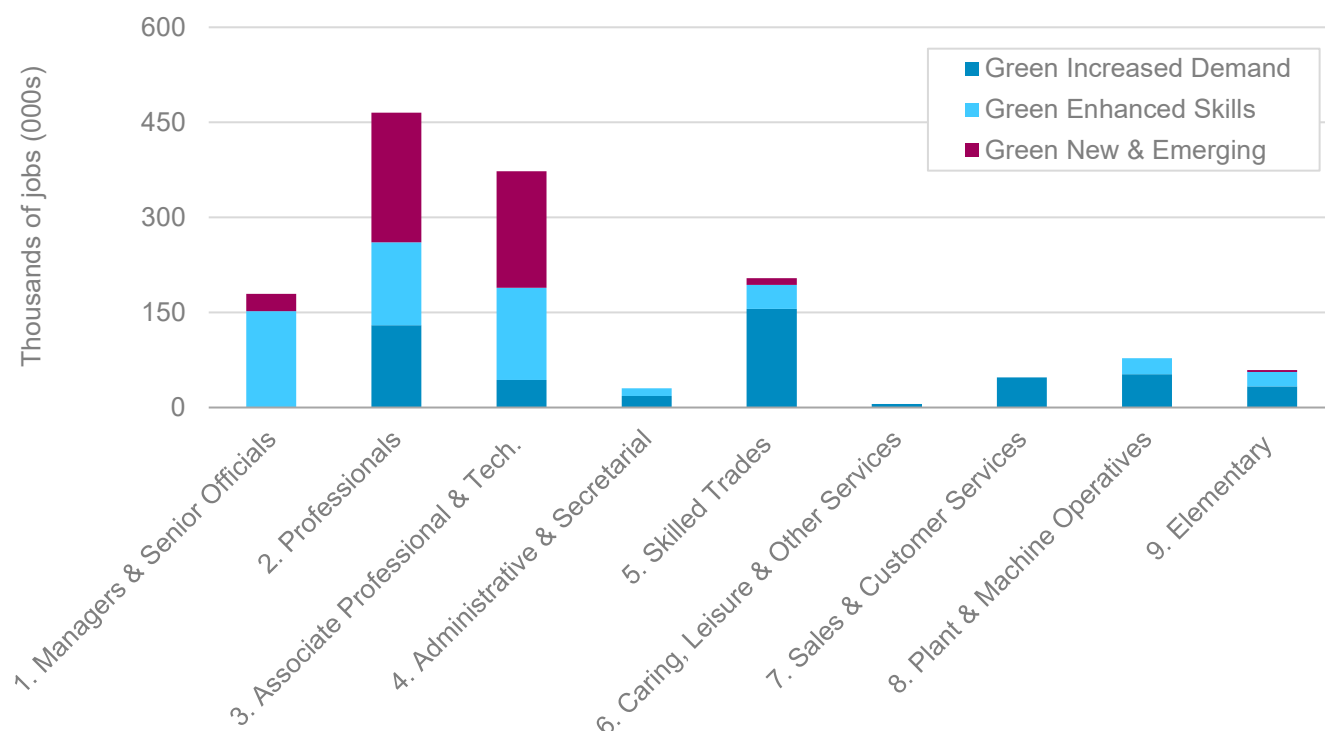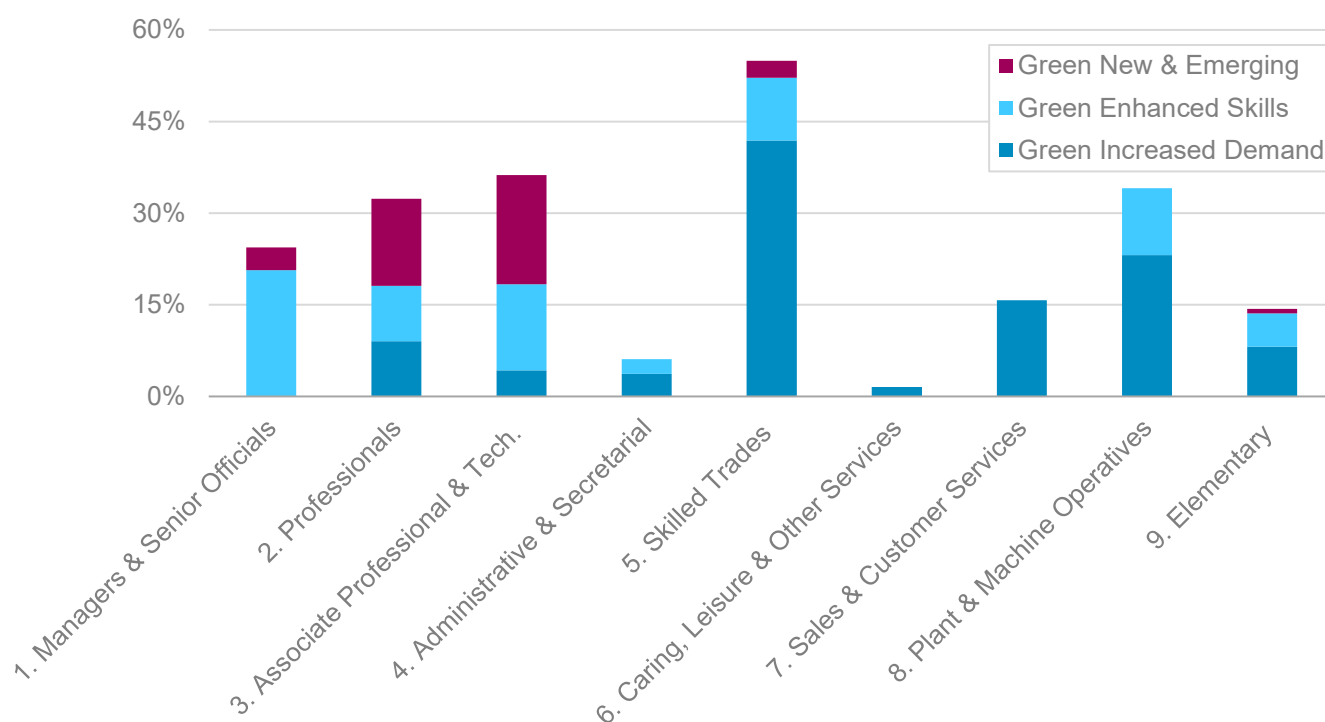Estimated number of jobs in thousands (000s) by major SOC2010 group, London, 2017–19

Figure 6: Percentage of jobs by green occupational category by major group
Estimated percentage of jobs by major SOC2010 group, London, 2017–19

Source: GLA Economics analysis of the ONS APS.
Note: For more robust estimates the analysis uses three-year pooled data from the APS.

Green occupations by industry group

We can also examine where jobs in occupations affected by greening are located by industry group based on the UK Standard Industrial Classification (UK SIC 2007). It's worth noting that this classification relates to the industry where jobs are based, rather than the jobs performed by individual workers.[23] The workers classified to a particular occupation may be found in different industries (see section 2.1).

Figure 7 shows the proportion of jobs in green occupations by industry section. It highlights a cluster of highly affected industry groups where green occupations account for over 40% of jobs in London, including electricity and gas (70% of jobs), construction (65%) and manufacturing (42%) – with a large share of these jobs expected to require upskilling or reskilling to meet new green skills needs.

These are areas where we would expect the transition to a greener economy to have a major impact. They tend to feature prominently in other definitional approaches.[24] They also account for a relatively high share of industrial greenhouse gas emissions (GLA Economics, 2021; Nesta, 2020), and part of the impact of greening will relate to increasing the sustainability of processes in these areas. For example:

- Construction managers (green enhanced skills) will need to apply new green building strategies to reduce energy costs, or minimise carbon output or other sources of harm to the environment, in their approach to construction.

- Engineering technicians (green new and emerging) will need to develop new or improved sustainability of manufacturing technologies to reduce greenhouse gas emissions and minimise environmental impact.

There is another band of industries where jobs in green occupations account for between one-fifth and two-fifths of jobs in London (20-40% of jobs). This includes the transport and storage sector, the industry group with the highest greenhouse gas emissions in London (GLA Economics, 2021). Occupations affected by greening account for around 36% of jobs in this industry sector in London, rising to 45% of transport and storage jobs in the rest of the UK. This largely reflects the need to increase the efficiency and/or reduce the environmental impact of various modes of transportation (Dierdorff et al., 2011).

This also takes in the information and communication, professional, scientific and technical, and finance and insurance sectors.[25] The importance of green occupations here reflects the impact of greening in activities such as architecture and engineering, green finance, energy consulting and research (Dierdorff et al., 2011). These are the kinds of areas where London has traditionally specialised but where there are likely to be significant new green skills requirements associated with greening (including in contribution to climate change mitigation and adaptation efforts in London and across the UK).

Less than a fifth of jobs are in occupations affected by greening in the remaining industry groups. These are mainly people-facing service activities which tend to account for a relatively low share of industrial greenhouse gas emissions.

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[23] SIC classifications are determined according to the principal activity of a unit. For more information see:
www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007.
[24] For example, the ONS environmental goods and services, and low-carbon and renewable energy sector definitions.
[25] In London, around 39% of jobs in information and communication activities were in occupations affected by greening in 2017-19; 36% of jobs in professional, scientific and technical activities; and 36% of jobs in finance and insurance activities.

Figure 7: Jobs in London by green occupational category by industry section
Estimated percentage of jobs by industry group (sections A-S only), London, 2017-19
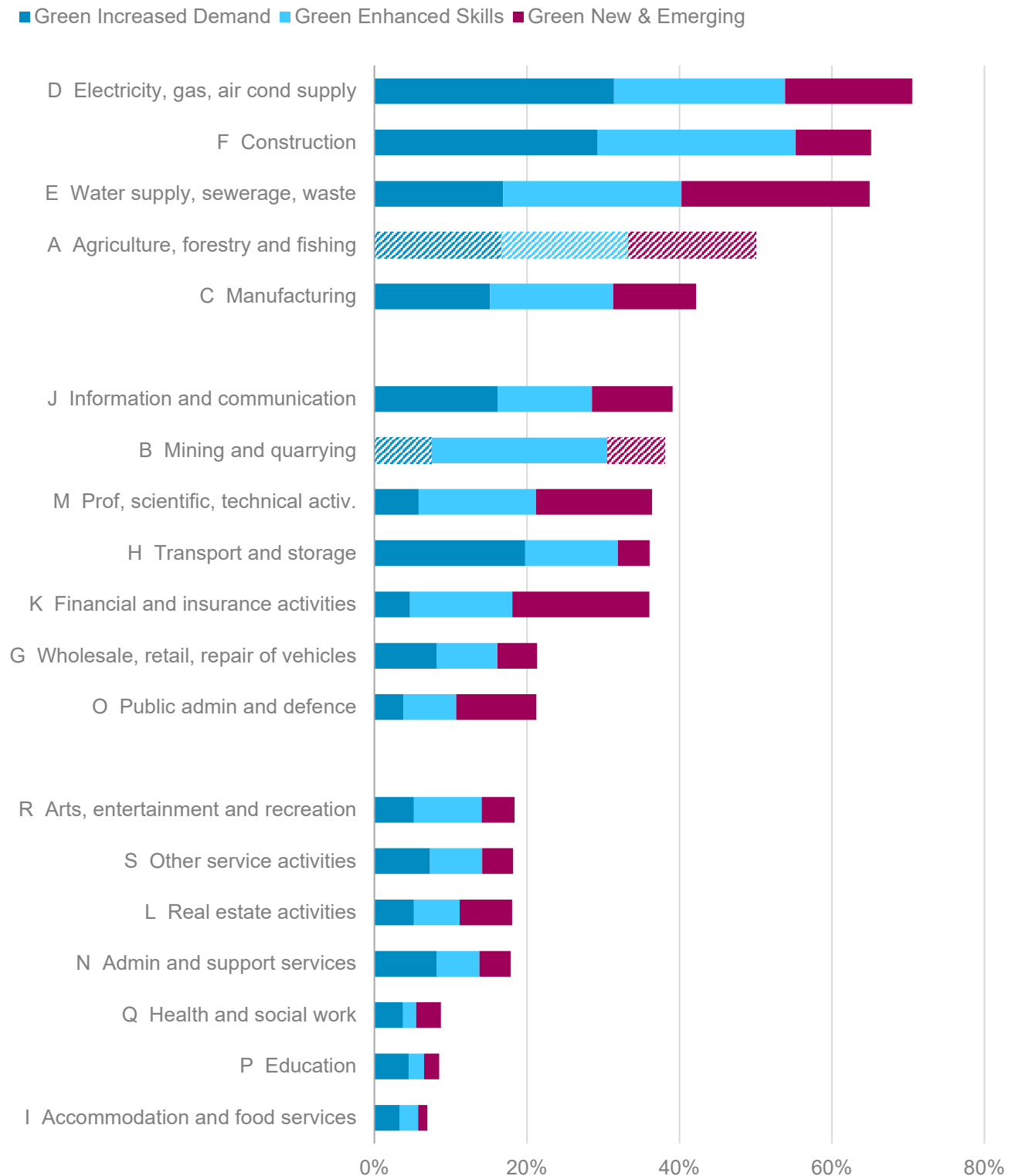
■ Green Increased Demand   ■ Green Enhanced Skills   ■ Green New & Emerging

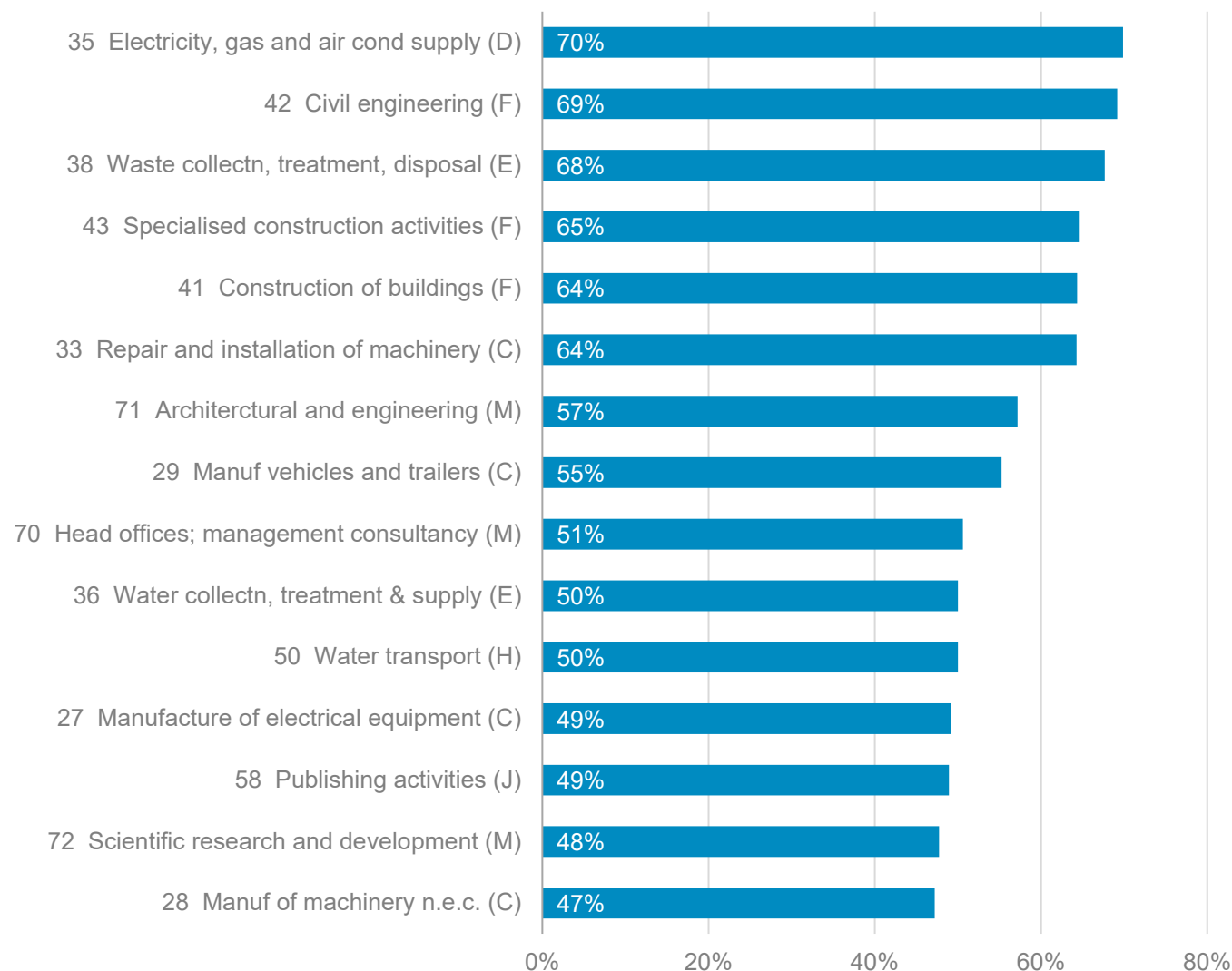Source: GLA Economics analysis of the ONS APS.
Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Full breakdowns by green occupational category are unavailable for sections A and B.

We can also explore where occupations affected by greening are located at the more detailed division level of the SIC framework (although breakdowns by green category are generally unavailable at this level, and some estimates are missing due to small sample sizes).

Figure 8 shows the 15 industries at division level with the highest proportion of jobs in occupations affected by greening. Reflecting our findings at the section level, it draws attention to specific areas of activity where greening is expected to have a major impact – including electricity and gas, civil engineering, waste collection and treatment, and specialised construction activities.[26]

Figure 8: Top 15 industry divisions for jobs in occupations affected by greening
Estimated percentage of jobs by industry division (top 15 only), London, 2017-19

Source: GLA Economics analysis of the ONS APS.
Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Breakdowns by green occupational category are generally unavailable at division level.

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[26] This division includes specialised construction activities, i.e. the construction, or preparation for construction, of parts of buildings and civil engineering works. Also included is the installation of various utilities (e.g. plumbing, air conditioning) and insulation work.

4.2   Qualifications, pay levels and skills challenges

This section looks more closely at the level of qualifications held by job holders in occupations affected by greening. We then explore what existing data sources can tell us about employee earnings and skills-related recruitment challenges in relation to green occupations.

Qualifications

As discussed above, a wide range of different jobs are likely to be affected by the move to a greener economy. This is expected to include a significant number of jobs in occupations requiring higher-level skills and qualifications, particularly in London given the structure of the capital's economy.

This point is further illustrated in Figure 9. It compares the highest level of qualifications achieved by people working in jobs in green and non-green occupations in London for 2017-19. Overall, it suggests that job holders in occupations affected by greening are relatively highly qualified – around 58% held a qualification at degree level or above in 2017-19, compared to just 53% in non-green occupations. Another 6% of job holders in occupations affected by greening held a higher-level qualification below degree-level only; 24% at A-level or GCSE level only; and 11% held other or no formal qualifications.

Figure 9: Jobs in green and non-green occupations by qualification attainment
Highest qualification held by job holders, London, 2017-19
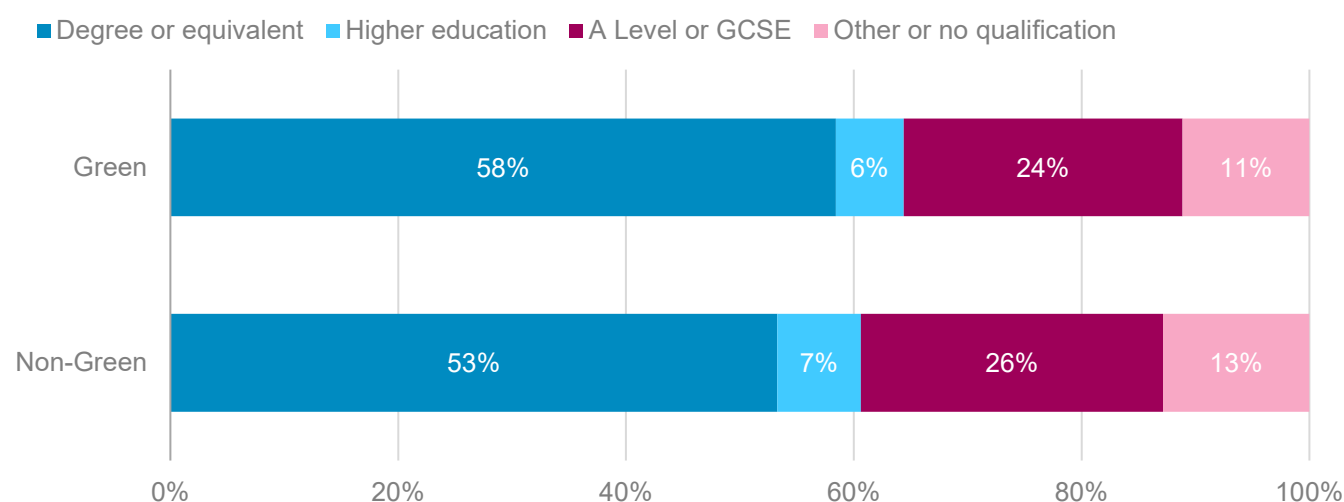
Source: GLA Economics analysis of the ONS APS.
Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Individual figures may not sum to 100% due to the inclusion of unknown/missing values.

These headline findings are partly explained by the general profile of London's labour force. There is, however, a large degree of variation between different green categories. Only 43% of jobs holders in green increased demand roles held a degree-level qualification in 2017-19, considerably below the proportion for green enhanced skills (61%) and green new and emerging (70%) occupations (Figure 10).

At the same time, a relatively high proportion of jobs in green increased demand roles were held by workers whose highest qualification was at A-Level or GCSE (31%); or by workers who had other or no formal qualifications (18%). This reflects the prominence of green increased demand occupations within the skilled trades, and process, plant and machine operative groups (SOC major groups 5 and 8) – areas with typically fewer formal academic entry requirements and a greater emphasis on vocational qualifications.

Figure 10: Jobs by green occupational category and qualification attainment

Highest qualification held by job holders, London, 2017-19

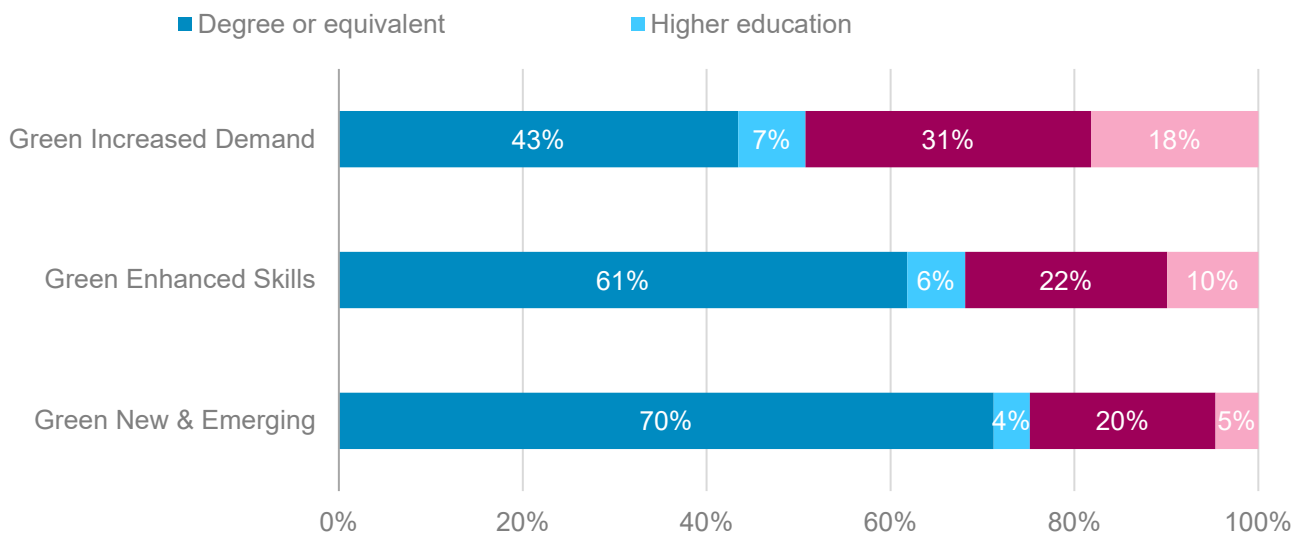Source: GLA Economics analysis of the ONS APS.
Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Individual figures may not sum to 100% due to the inclusion of unknown/missing values.

Again, it is notable that more jobs in occupational categories expected to require new green skills[27] are held by workers with higher-level qualifications. As Table 4 shows, the nature of occupational and skill change is likely to vary according to skill level (ILO, 2019). That said, the need to address existing skills shortages could also generate training and retraining requirements at intermediate levels (see below).

Table 4: Indication of main changes in skills required by skill level of occupation

Broad skill level	Nature of change	Typical skills response	Example job roles
Lower-skilled occupations	Job roles mainly change in a generic way, e.g. requiring increased environmental awareness or adaptations to work procedures	On-the-job learning or short reskilling/upskilling programmes	Bus and coach drivers; refuse and salvage occupations
Medium-skilled occupations	• Some new green job roles • Significant changes to some existing job roles in terms of technical skills and knowledge	Short-to-longer upskilling and reskilling programmes; TVET* courses	• New job roles: wind turbine technicians; solar panel installers • Changing job roles: roofers, plumbers; ventilation and air conditioning installers
Higher-skilled occupations	• Locus of most new green job roles • Significant changes to some existing job roles in terms of technical skills and knowledge	University degree; longer upskilling programmes	• New job roles: energy auditors, environmental economists; climate change policy analysts • Changing job roles: civil engineers, architects, town planners

*Source: adapted from ILO (2019). * Technical and vocational education and training.*

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[27] That is, jobs in the green enhanced skills, and green new and emerging occupational categories.

Pay levels

Reflecting this overarching pattern of occupations and qualifications, occupations affected by greening also cover jobs with varying levels of pay. Figure 11 shows estimates of median weekly earnings for full-time employee jobs at the level of different green categories. Due to data limitations our analysis only covers employee jobs and not the self-employed; it is also based in part on modelled pay estimates at the London level. As a result, this analysis should only be regarded as indicative of likely trends.[28]

Notwithstanding these limitations, there appears to be a considerable disparity in average pay levels between different green occupational categories. On average, employee jobs in occupations affected by greening are relatively highly paid compared to non-green occupations. Median weekly earnings for full-time employees reached approximately £814 per week for green occupations in April 2019. This was considerably above the average for non-green occupations (£721 per week).

Figure 11: Illustrative gross weekly earnings (£) for full-time employee jobs
London, weighted average, 2019 (includes imputed estimates)

Source: GLA Economics analysis of the ONS ASHE 2019.
Notes: Values imputed for 117 out of 369 four-digit occupations – this is done by applying the ratio of pay between two-digit and four-digit occupations at the UK level to two-digit occupations in London.

With median weekly earnings of around £911 per week, the green enhanced skills group was the highest-paying green occupational category in April 2019, closely followed by green new and emerging occupations (£863 per week). By contrast, average median weekly pay in green increased demand occupations was significantly lower than the average for non-green occupations – at only £668 per week. There is also significant variation within each green category (see Figure 12).

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[28] Our analysis is based on published estimates from the ONS ASHE. Where median earnings are missing for four-digit occupations at a London level, but are available at the UK level, we impute an estimate – this is done by applying the ratio of pay between two-digit and four-digit occupations at the UK level to two-digit occupations in London; and affects 117 out of 369 occupations. Pay data is missing for 13 out of 369 four-digit occupations, all of them non-green occupations.

Figure 12: Gross weekly earnings (£) for full-time employee jobs by occupation by green category

London, 2019, circle size = total jobs, horizontal axis = London average (includes imputed estimates)

Green increased demand (estimates for 28 out of 41 four-digit occupations)
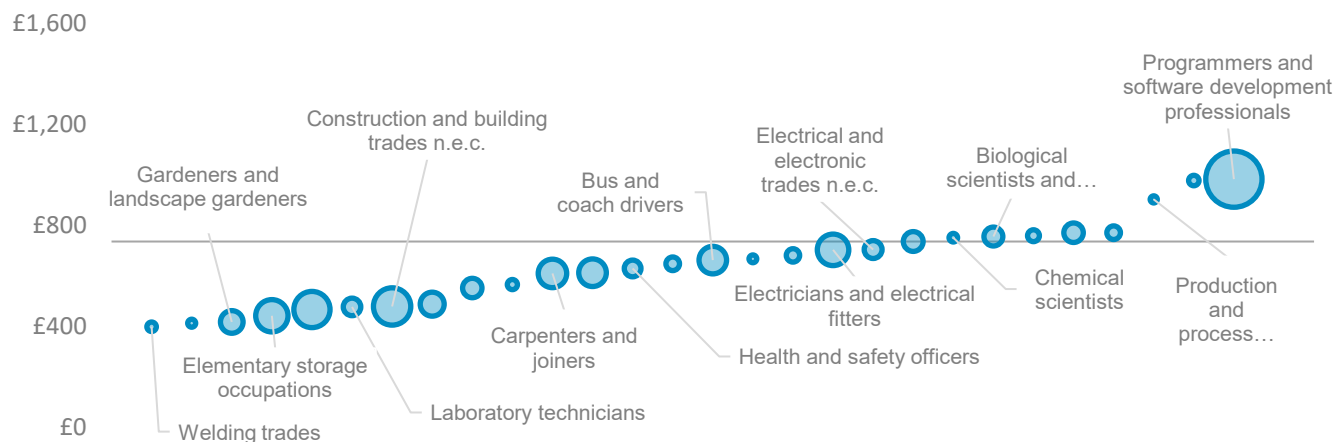
Green enhanced skills (estimates for 28 out of 33 four-digit occupations)
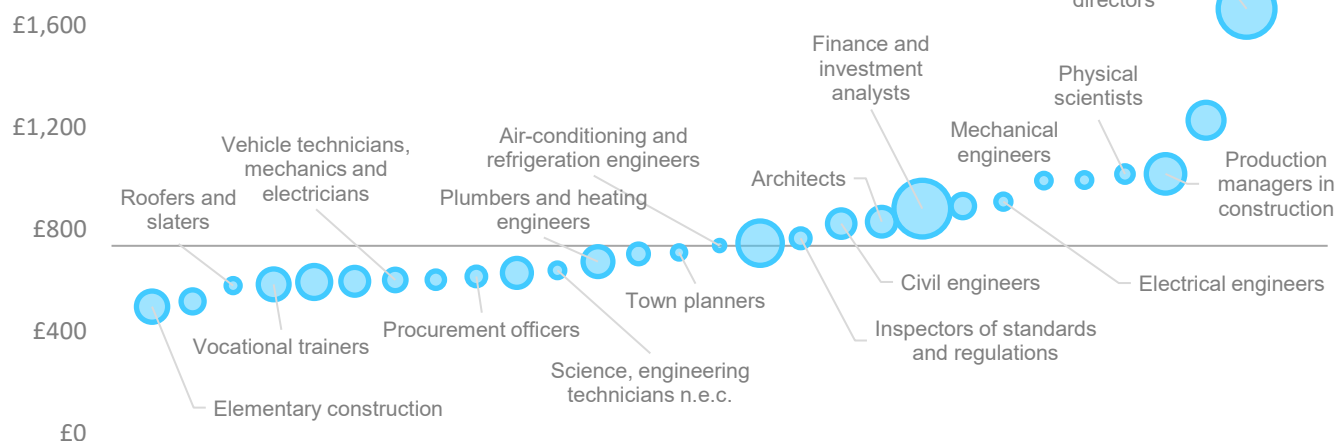
Green new and emerging (estimates for 22 out of 26 four-digit occupations)
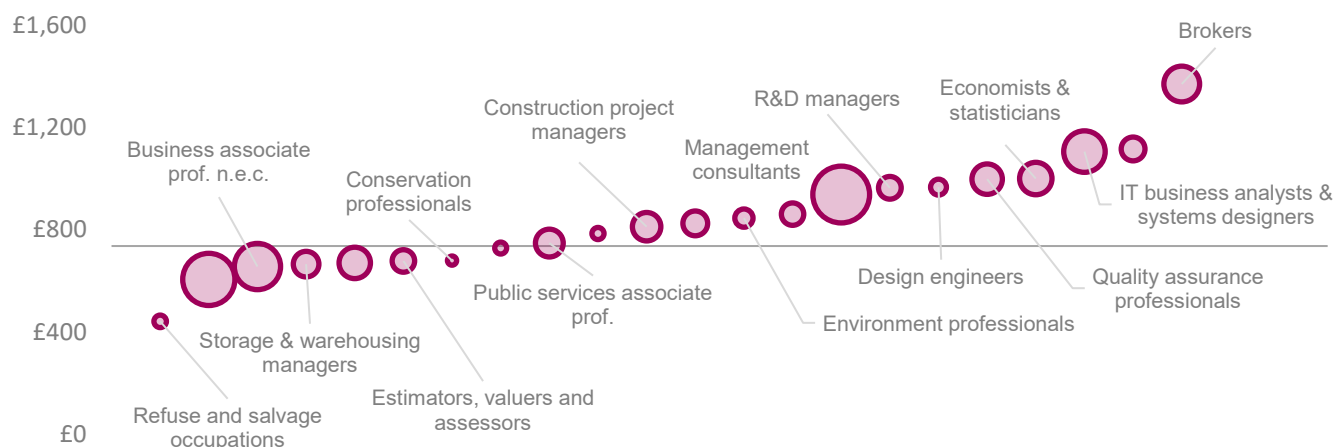
Source: GLA Economics analysis of ONS ASHE 2019.
Notes: Excludes 22 occupations where London-level jobs data is missing. Pay estimates imputed for 16 green increased demand, five green enhanced skills, and seven green new and emerging occupations (see footnote 21).

Skills challenges

To get an idea of where current skills challenges are likely to be most significant among occupations affected by greening, we can turn to London data from the Employer Skills Survey 2019.[29] Since reliable estimates are generally unavailable at the level of four-digit SOC codes in London, we explore data at the two-digit level of the SOC framework for London and the UK.[30] As with our analysis of employee pay levels, these weighted estimates should only be taken as indicative of likely skills challenges.

On this basis Figure 13 shows the proportion of 2019 vacancies reported as hard to fill due to skill shortages or other reasons for each green occupational category. A stark picture emerges. Although the overall level of pay and qualification attainment associated with jobs in green increased demand occupations is lower on average, our analysis suggests that the percentage of hard-to-fill vacancies is likely to be higher than for other green categories or non-green occupations.

We estimate that a third (33%) of 2019 vacancies in green increased demand roles would have been hard to fill due to skills-related reasons, and another 6% of vacancies for other reasons. This compares with just over a quarter of vacancies being hard to fill in enhanced skills (22% skills-related and 5% other reasons) and a fifth in green new and emerging occupations (17% skills-related and 4% other reasons).

Figure 13: Illustrative vacancies that are hard to fill due to skills shortages or other reasons
Percentage of vacancies, London, 2019 (includes imputed estimates)
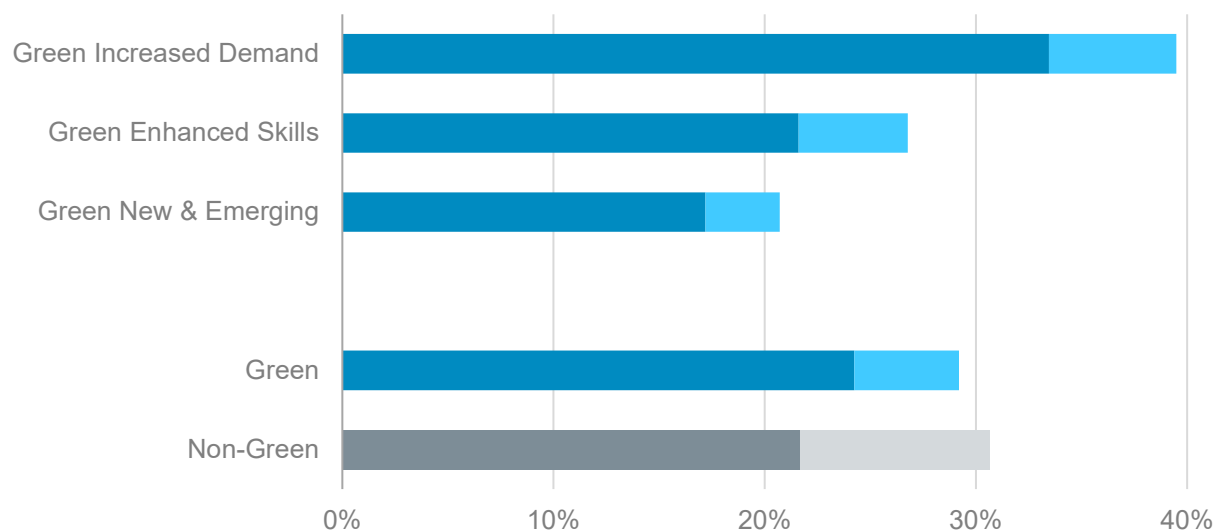
Source: GLA Economics analysis of Employer Skills Survey data, accessed via LMI for All API.
Note: In most cases these weighted estimates are based on hard to fill vacancy data for two-digit SOCs.

These high-level findings are consistent with the long-standing difficulties reported by employers when recruiting for skilled trades positions (e.g. electricians, plumbers, carpenters and joiners). They suggest that, as well as meeting the demand for new green skills, addressing existing shortages of technical and intermediate level skills also has an important role to play in the transition to a greener economy.

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[29] The Employer Skills Survey is a biennial survey conducted by IFF Research on behalf of the Department for Education.
[30] Our analysis is based on estimates from the UK ESS accessed via the LMI for All API (under ess/region/{region}/{soc}). Reliable estimates of recruitment difficulties are missing in most cases for four-digit occupations at a London level. So in most (73%) cases we apply the estimate for the relevant two digit-occupational group at the London-level. This approach generally assumes that estimates at the two-digit level provides a reasonable indication of recruitment difficulties at the four-digit level. In a minority (23%) of cases where data at the two digit-level isn't available for London, we apply the UK level estimate for the relevant two-digit occupational group.

Of course, these aggregate-level findings may conceal recruitment-difficulties at the level of individual occupations or jobs. And while providing an initial insight, difficulty in filling vacancies is not always a precise way of measuring skills shortages. Reported skills shortages can in some cases reflect issues related to pay or wider working conditions rather than a genuine lack of skills or qualifications. [31]

It is also important to note that this analysis only reflects how prevalent skills challenges were in 2019. Although recruitment issues currently seem less pressing in green enhanced skills and green new and emerging occupations, it is these areas that are expected to see more significant changes in work and worker requirements as a result of the transition to a greener economy. This could lead to an increase in skills-related recruitment challenges, especially if education and training provision fails to keep pace.

4.3   Quality of work and workforce diversity

Occupations affected by greening are also not the same in terms of other characteristics. In this section we provide initial evidence on the types of jobs and diversity of the workforce in green and non-green occupations. The analysis draws, again, on three years of pooled data from the ONS APS (for 2017-19).

Job-related variables

Table 5 provides a breakdown of descriptive statistics based on selected job-related variables for different categories of occupations affected by greening. It also includes a comparison with non-green occupations. Several points stand out:

- **Job status**: while most (79%) are employees, a relatively high proportion of job holders in occupations affected by greening are self-employed – 21% in 2017-19 compared to 18% for non-green occupations. This is partly driven by the particularly high rate of self-employment in green increased demand occupations (26%) and, to a lesser extent green enhanced skills occupations (23%). Only 13% of job holders in green new and emerging occupations were self-employed.

- **Employee job type**: of those who work in employee jobs, the vast majority are in permanent positions – 94% for job holders in occupations affected by greening in 2017-19 compared to 92% for job holders in non-green occupations. At 8% of employee jobs, the rate of temporary employment among employee job holders in green increased demand roles is higher than in other green occupational categories, although it remains in line with the non-green occupational average.

- **Full-time/part-time**: the majority of workers whose main occupation is affected by greening work full-time (89% in 2017-19). The rate of part-time working is relatively low in green occupations – 11% of job holders were working part-time in 2017-19 compared to 24% for non-green occupations. As we discuss below, this relatively low share of part-time working could be one factor influencing the demographic make-up of the workforce in green occupations.

- **Receipt of job-related training**: the proportion of workers who participate in job-related training in occupations affected by greening is lower than for non-green occupations. Only a fifth (20%) of those surveyed in 2017-19 who worked in a green occupation in their main job reported receiving training in the past three months, compared to a quarter (25%) of workers in non-green occupations. The rate of job-related training was similar for green enhanced skills (20%) but even lower for green increased demand (16%) occupations, which may be linked to higher rates of self-employment.

The low rate of participation in job-related training in green occupations in recent years may be of particular concern here, especially for workers in green enhanced skills occupations. It is worth noting that a variety of factors influence adult participation in education and training. People on low incomes, people who are self-employed, and men in routine and manual roles are all groups who have been shown to receive less training

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[31] In these cases, improving working conditions or salaries can play an important role in resolving skills shortages (ILO, 2019).

than others (Social Mobility Commission, 2019). Current participation in adult learning is also a strong predictor of future learning (Learning and Work Institute, 2019).

Table 5: Selected job-related variables by green occupational category
London, 2017-19

	Green increased demand	Green enhanced skills	Green new and emerging	Green	Non-green
Job status					
Employee	74%	76%	87%	79%	81%
Self-employed	26%	23%	13%	21%	18%
Employee job type					
Permanent	92%	95%	95%	94%	92%
Non-permanent	8%	5%	5%	6%	8%
*Full-time/part-time**					
Full-time	86%	91%	90%	89%	76%
Part-time	14%	9%	10%	11%	24%
*Training in past 13 weeks**					
Yes (in receipt of training)	16%	20%	26%	20%	25%
No (not in receipt of training)	83%	78%	73%	78%	73%

Source: GLA Economics analysis of the ONS ASHE 2017-19.
*Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Individual figures may not sum to 100% due to the inclusion of unknown/missing values (*except for employee job type).*
***Full-time/part-time and receipt of training are based on main job only.*

Demographic variables
Table 6 provides a breakdown of selected demographic variables for different categories of occupations affected by greening and non-green occupations.

- **Age**: overall, workers in green occupations are relatively young compared to the average for non-green occupations. Around 23% of job holders were aged between 16 and 29 years in 2017-19, in-line with the average for non-green occupations (22%). At the same time, only 23% of job holders were aged 50 or over, compared to 27% in non-green occupations. This pattern is consistent across green occupational categories, although there may be variation for individual occupations or jobs.

- **Sex**: nearly three-quarters (73%) of jobs in occupations affected by greening were held by men in 2017-19 and only 27% by women (compared to 49% and 51% in non-green occupations). The share of jobs held by women increases to one-third (33%) in the green new and emerging occupation category; but falls to less than a quarter in green increased demand occupations (23%). This is likely to reflect in part long-standing diversity challenges in areas such as construction and manufacturing. It could also be linked to the low percentage of part-time jobs in occupations affected by greening.

- **Ethnic background**: a relatively high proportion of job holders in occupations affected by greening are from a White ethnic background (74% compared to 67% for non-green occupations). This holds true across all green occupational categories, but especially for green enhanced skills (79%) and to a lesser

extent green new and emerging (74%) occupations. There is a particularly low representation of workers from a Black or Asian ethnic background in jobs in green enhanced skills occupations.

- **Disability**: the overall proportion of workers who are recorded as disabled according to the Equality Act in green occupations is lower than in non-green occupations on average (9% compared to 11%). The representation of disabled workers is lowest for jobs in green enhanced skills occupations (8%).

Table 6: Selected demographic variables by green occupational category
London, 2017-19

	Green increased demand	Green enhanced skills	Green new and emerging	Green	Non-green
Age group					
16-29	25%	20%	25%	23%	22%
30-49	53%	54%	55%	54%	52%
50+	22%	27%	20%	23%	27%
Sex					
Male	77%	73%	67%	73%	49%
Female	23%	27%	33%	27%	51%
Ethnic background					
White	69%	79%	74%	74%	67%
Asian	16%	11%	14%	14%	15%
Black	9%	4%	6%	6%	10%
Mixed	3%	2%	2%	2%	3%
Other	4%	4%	3%	4%	5%
Disability status					
Equality Act disabled	10%	8%	9%	9%	11%
Not Equality Act disabled	89%	91%	90%	90%	88%

Source: GLA Economics analysis of the ONS ASHE 2017-19.
Notes: For more robust estimates the analysis uses three-year pooled data from the APS. Individual figures may not sum to 100% due to the inclusion of unknown/missing values.

These headline findings suggest that there is considerable scope to increase the diversity of employment in occupations affected by greening, including with regards to gender and ethnicity. This is important for increasing the pool of talent available to employers and meeting future recruitment needs (BEIS, 2020). It is also important for distributing the opportunities associated with greening more equally and ensuring a just transition. That said, the key diversity-related challenges facing individual green occupations or jobs are likely to vary, and further research is needed to understand this area in detail.

4.4   Geography

The proportion of jobs in occupations affected by greening is also not evenly distributed across London. The City of London recorded the highest overall percentage of jobs in green occupations in 2017-19, with over a third (34%) of jobs in occupations affected by greening. This was followed by Southwark (31%) and Islington (29%). At the same time, there were three London boroughs where less than a fifth of jobs were in green occupations – Waltham Forest (19%), Barnet (18%) and Lewisham (17%).

As Table 7 indicates, there is also variation in the profile of jobs in different categories of green occupations across London. This suggests that the labour market in some parts of the capital could be more affected by the move to a greener economy than in others, and in different ways. However, it's worth noting that this analysis is based on where jobs were located in 2017-19. That is not the same as where workers live, and is not necessarily where jobs will be located in the future.

Appendix C provides a more detailed geographic breakdown of jobs by green occupational category.

Table 7: Highest and lowest proportions of jobs by green occupational category by London authority
Percentage of total jobs by local authority, London, 2017-19

Green increased demand

Top five with **highest** percentage of jobs in green increased demand occupations (2017-19)		Bottom five with **lowest** percentage of jobs in green increased demand occupations (2017-19)	
Enfield	14%	Havering	8%
Islington	13%	Sutton	8%
Harrow	12%	Lewisham	7%
Barking and Dagenham	12%	Tower Hamlets	6%
Redbridge	11%	Westminster	6%

Green enhanced skills

Top five with **highest** percentage of jobs in green enhanced skills occupations (2017-19)		Bottom five with **lowest** percentage of jobs in green enhanced skills occupations (2017-19)	
Richmond upon Thames	13%	Haringey	7%
Sutton	13%	Newham	7%
Hillingdon	12%	Harrow	6%
City of London	12%	Waltham Forest	6%
Southwark	11%	Barnet	5%

Green new and emerging

Top five with **highest** percentage of jobs in green new and emerging occupations (2017-19)		Bottom five with **lowest** percentage of jobs in green new and emerging occupations (2017-19)	
City of London	13%	Kingston upon Thames	6%
Southwark	9%	Havering	4%
Islington	6%	Waltham Forest	4%
Richmond upon Thames	7%	Barnet	5%
Hounslow	7%	Lewisham	3%

Source: GLA Economics analysis of the ONS APS.

Glossary of key terms

Green economy – economic activity related to reducing fossil fuel usage, decreasing pollution and greenhouse gas emissions, recycling materials, increasing energy efficiency, and developing/adopting renewable energy sources. Otherwise termed the 'low-carbon circular economy'.

Greening – the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements.

Green increased demand – existing jobs that are expected to be in high demand due to 'greening', without requiring significant changes in tasks, skills, or knowledge.

Green enhanced skills – existing jobs that require significant changes in tasks, skills, and knowledge as a result of 'greening'.

Green new and emerging – new jobs with unique worker requirements that meet the specific needs of the green economy.

Green job/occupation – any job classified by O*NET to be affected by 'greening', which could involve increased demand, changes in worker requirements, and the use of new worker requirements. All other jobs are considered 'non-green'.

Green skills – the skills needed by the workforce, in all sectors and at all levels, in order to help the adaptation of the products, services and processes to the changes due to climate change and to environmental requirements and regulations.

Job – defined as a set of tasks or duties to be carried out by one person. The notion of a job represents a basic element in the employment relationship. Jobs are recognised primarily by the associated job title. In occupational classifications, jobs are classified in terms of their skill level and skill content.

LMI for All – a careers labour market information database that uses several data sources to inform and support decision-making about careers. This service is provided by the Department for Education, and delivered by the Institute for Employment Research at the University of Warwick.

O*NET – a main source of occupational information in the United States. The O*NET database contains a rich set of variables that describe work and worker characteristics, including skill requirements. The O*NET-SOC taxonomy currently includes a total of [923 occupations](#).

Skill – 'skill level' is defined in terms of the nature and duration of the qualifications, training and work experience required to become competent to perform the associated tasks in a particular job. A related concept is 'skill specialisation' which refers the field of knowledge required for competent, thorough and efficient conduct of the tasks.

UK SOC 2010 – the ONS's Standard Occupational Classification 2010. Provides a common classification of occupational information. Classifies different job roles in terms of their skill level and skill content.

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Appendix A – bespoke crosswalk from O*NET to UK SOC2010

A comprehensive list of occupations identified as green is published on the O*NET website.[32] This is a list of 204 six-digit O*NET-SOC codes.

To apply this O*NET classification in a London and UK context, we perform a bespoke crosswalk between US and UK occupational taxonomies based primarily on the application programming interface for the LMI for All database (under o-net/onet2soc/).

However, this mapping process is not entirely automated and for a variety of reasons the match between US and UK taxonomies cannot be perfect. There are, for example, significantly more occupations in the O*NET database than in the UK SOC 2010.

We take the following steps to generate our bespoke crosswalk.

O*NET matches to more than one UK SOC
For each of the 204 green O*NET codes, we use the general LMI for All crosswalk to identify the three most likely four-digit UK SOC2010 matches (if there are that many).

- In around half (103) of cases, the LMI for All crosswalk matches the green O*NET code directly to one UK SOC code; in these cases, we continue with the direct single match.

- In another 70 cases the LMI for All crosswalk matches a green O*NET code to two UK SOCs, and in 31 cases it matches to three UK SOCs (101 multiple matches); in these instances, we need to identify the best possible single match.[33]

The results of the LMI for All crosswalk are in order of closest match, so in theory the first-matched occupation should be the most relevant. But an element of judgement is also called for with regards to this research.[34] To inform that judgement, we check each O*NET to UK SOC2010 match against a similar existing crosswalk (Bakhshi et al., 2017) and carry out additional checks using the Cascotweb tool.

- In 43 cases where there is a multiple match, we stick with the first-matched UK SOC code.[35]

- In 41 cases we match to the second-matched UK SOC code.

- in 12 cases we match to the third-matched UK SOC code.

- In five cases we select a match informed by an alternative crosswalk rather than the original LMI for All results.

UK SOC matches to more than one O*NET group
From the 204 O*NET codes we identify 99 unique UK SOC2010 codes. Of these, there were 50 UK SOC codes that match against a single green O*NET code. There is no problem in determining which green occupational category (green increased demand, green enhanced skills, or green new and emerging) to assign these occupations to.

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[32] https://www.onetcenter.org/dictionary/22.0/excel/green_occupations.html.

[33] A feature of O*NET is that there are significantly more occupations in the database than there are at the four-digit level of the UK SOC. However, matching to multiple UK SOC codes in each case identifies a disproportionate share of employment as green in the UK context.

[34] There is, for example, a risk that some highly relevant UK SOC2010 occupations would be excluded from our green classification if only first matches were kept. This is the case with, for example, the UK SOC codes 5319 and 5224.

[35] Overall, 146 out of 203 green O*NET occupations are matched to the 'first-matched' UK SOC from the LMI for All crosswalk. So in most cases we have worked with the first result from the LMI for All crosswalk.

However, there are also 49 UK SOC codes that match with multiple green O*NET codes. Of these:

- There are 15 cases where the UK SOC code matches to multiple O*NET codes *with the same green category*. Again, we have no problem determining the green category in these cases.

- But there are also 34 cases where a UK SOC code matches against multiple O*NET codes *with different green categories*. In these cases, we need to determine which green category each UK SOC should be assigned to.[36]

To do this, we look at employment estimates from the Bureau of Labor Statistics (BLS) Occupational Employment Statistics.[37] We assign the relevant UK SOC2010 code to the green occupational category where the highest level of US employment is found. This simple rule weights our final mapping towards the occupational greening categories which would have been more prominent in the original work.

Manual check
We also manually check of our classification of 99 green UK SOC2010 occupations to review their relevance. Through this process we added one UK SOC code (SOC 5113: Gardeners and landscape gardeners) to our list of green increased demand occupations to reflect GLA policy priorities.

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[36] In most of these cases the relevant UK SOC is matched to only two or three O*NET codes. But in a handful of cases the UK SOC is matched to many more O*NET codes in different green categories. This includes UK SOC 2129 (matched to 11 O*NET codes), UK SOC 3113 (matched to 10 O*NET codes), and UK SOCs 2142 and 8124 (both matched to seven O*NET codes).

[37] We use May 2019 data from the BLS National Occupational Employment Statistics (see here). As the O*NET occupational classification (eight-digit) is slightly more detailed than the six-digit 2010 occupational system for which employment is reported, we are required to ignore the last two digits. This approach should be considered approximate.

Appendix B – summary of green occupations

SOC2010 Unit Group Titles	SOC2010 4-digit	Green Category
Production managers and directors in manufacturing	1121	Green Enhanced Skills
Production managers and directors in construction	1122	Green Enhanced Skills
Production managers and directors in mining and energy	1123	Green New and Emerging
Marketing and sales directors	1132	Green Enhanced Skills
Purchasing managers and directors	1133	Green New and Emerging
Managers and directors in transport and distribution	1161	Green Enhanced Skills
Managers and directors in storage and warehousing	1162	Green New and Emerging
Managers and proprietors in agriculture and horticulture	1211	Green Enhanced Skills
Waste disposal and environmental services managers	1255	Green New and Emerging
Chemical scientists	2111	Green Increased Demand
Biological scientists and biochemists	2112	Green Increased Demand
Physical scientists	2113	Green Enhanced Skills
Natural and social science professionals n.e.c.	2119	Green Increased Demand
Civil engineers	2121	Green Enhanced Skills
Mechanical engineers	2122	Green Enhanced Skills
Electrical engineers	2123	Green Enhanced Skills
Electronics engineers	2124	Green Enhanced Skills
Design and development engineers	2126	Green New and Emerging
Production and process engineers	2127	Green Increased Demand
Engineering professionals n.e.c.	2129	Green New and Emerging
IT business analysts, architects and systems designers	2135	Green New and Emerging
Programmers and software development professionals	2136	Green Increased Demand
Conservation professionals	2141	Green New and Emerging
Environment professionals	2142	Green New and Emerging
Research and development managers	2150	Green New and Emerging
Management consultants and business analysts	2423	Green New and Emerging
Actuaries, economists and statisticians	2425	Green New and Emerging
Architects	2431	Green Enhanced Skills
Town planning officers	2432	Green Enhanced Skills
Chartered architectural technologists	2435	Green Increased Demand
Construction project managers and related professionals	2436	Green New and Emerging
Quality control and planning engineers	2461	Green New and Emerging
Quality assurance and regulatory professionals	2462	Green New and Emerging
Journalists, newspaper and periodical editors	2471	Green Enhanced Skills
Public relations professionals	2472	Green Enhanced Skills
Laboratory technicians	3111	Green Increased Demand
Electrical and electronics technicians	3112	Green New and Emerging
Engineering technicians	3113	Green Enhanced Skills
Planning, process and production technicians	3116	Green New and Emerging
Science, engineering and production technicians n.e.c.	3119	Green Enhanced Skills

SOC2010 Unit Group Titles	SOC2010 4-digit	Green Category
IT operations technicians	3131	Green New and Emerging
Product, clothing and related designers	3422	Green Increased Demand
Estimators, valuers and assessors	3531	Green New and Emerging
Brokers	3532	Green New and Emerging
Finance and investment analysts and advisers	3534	Green Enhanced Skills
Business and related associate professionals n.e.c.	3539	Green New and Emerging
Buyers and procurement officers	3541	Green Enhanced Skills
Business sales executives	3542	Green Enhanced Skills
Marketing associate professionals	3543	Green New and Emerging
Conservation and environmental associate professionals	3550	Green Increased Demand
Public services associate professionals	3561	Green New and Emerging
Vocational and industrial trainers and instructors	3563	Green Enhanced Skills
Inspectors of standards and regulations	3565	Green Enhanced Skills
Health and safety officers	3567	Green Increased Demand
Records clerks and assistants	4131	Green Increased Demand
Transport and distribution clerks and assistants	4134	Green Enhanced Skills
Farmers	5111	Green Enhanced Skills
Horticultural trades	5112	Green Increased Demand
Gardeners and landscape gardeners *(added manually)*	5113	Green Increased Demand
Agricultural and fishing trades n.e.c.	5119	Green Increased Demand
Sheet metal workers	5213	Green Enhanced Skills
Pipe fitters	5216	Green Enhanced Skills
Metal plate workers, and riveters	5214	Green Increased Demand
Welding trades	5215	Green Increased Demand
Metal machining setters and setter-operators	5221	Green Increased Demand
Metal working production and maintenance fitters	5223	Green Increased Demand
Precision instrument makers and repairers	5224	Green Increased Demand
Air-conditioning and refrigeration engineers	5225	Green Enhanced Skills
Vehicle technicians, mechanics and electricians	5231	Green Enhanced Skills
Rail and rolling stock builders and repairers	5237	Green Increased Demand
Electricians and electrical fitters	5241	Green Increased Demand
Electrical and electronic trades n.e.c.	5249	Green Increased Demand
Skilled metal, electrical and electronic trades supervisors	5250	Green Increased Demand
Steel erectors	5311	Green Increased Demand
Carpenters and joiners	5315	Green Increased Demand
Construction and building trades n.e.c.	5319	Green Increased Demand
Roofers, roof tilers and slaters	5313	Green Enhanced Skills
Plumbers and heating and ventilating engineers	5314	Green Enhanced Skills
Construction and building trades supervisors	5330	Green New and Emerging
Rail travel assistants	6215	Green Increased Demand
Communication operators	7214	Green Increased Demand
Customer service occupations n.e.c.	7219	Green Increased Demand

| SOC2010 Unit Group Titles	SOC2010 4-digit	Green Category
Chemical and related process operatives	8114	Green Increased Demand
Quarry workers and related operatives	8123	Green Enhanced Skills
Energy plant operatives	8124	Green New and Emerging
Metalworking machine operatives	8125	Green Increased Demand
Assemblers (electrical and electronic products)	8131	Green Increased Demand
Routine inspectors and testers	8133	Green Enhanced Skills
Assemblers (vehicles and metal goods)	8132	Green Increased Demand
Assemblers and routine operatives n.e.c.	8139	Green Increased Demand
Road construction operatives	8142	Green Increased Demand
Rail construction and maintenance operatives	8143	Green Increased Demand
Construction operatives n.e.c.	8149	Green Increased Demand
Bus and coach drivers	8213	Green Increased Demand
Large goods vehicle drivers	8211	Green Enhanced Skills
Mobile machine drivers and operatives n.e.c.	8229	Green Increased Demand
Forestry workers	9112	Green Increased Demand
Elementary construction occupations	9120	Green Enhanced Skills
Refuse and salvage occupations	9235	Green New and Emerging
Elementary storage occupations	9260	Green Increased Demand

Appendix C – breakdown by London authority

Table C1: Percentage of jobs by green occupational category
London authority, 2017-19

	Green Increased Demand	Green Enhanced Skills	Green New and Emerging	Green	Non-Green
Barking and Dagenham	12%	9%	5%	26%	74%
Barnet	8%	5%	5%	18%	82%
Bexley	11%	8%	6%	25%	75%
Brent	11%	8%	5%	24%	76%
Bromley	9%	9%	5%	23%	77%
Camden	9%	10%	8%	27%	73%
City of London	9%	12%	13%	34%	66%
Croydon	9%	8%	6%	23%	77%
Ealing	8%	10%	5%	24%	76%
Enfield	14%	8%	4%	26%	74%
Greenwich	9%	9%	9%	26%	74%
Hackney	9%	9%	4%	22%	78%
Hammersmith and Fulham	10%	10%	6%	26%	74%
Haringey	11%	7%	4%	22%	79%
Harrow	12%	6%	5%	24%	76%
Havering	8%	8%	4%	20%	80%
Hillingdon	9%	12%	6%	27%	73%
Hounslow	10%	10%	7%	27%	73%
Islington	13%	10%	6%	29%	71%
Kensington and Chelsea	9%	11%	7%	27%	74%
Kingston upon Thames	9%	7%	6%	21%	79%
Lambeth	10%	9%	5%	24%	76%
Lewisham	7%	7%	3%	17%	83%
Merton	9%	9%	6%	24%	76%
Newham	10%	7%	7%	24%	76%
Redbridge	11%	8%	4%	24%	76%
Richmond upon Thames	8%	13%	7%	28%	72%
Southwark	10%	11%	9%	31%	69%
Sutton	8%	13%	6%	26%	74%
Tower Hamlets	6%	9%	10%	25%	75%
Waltham Forest	9%	6%	4%	19%	81%
Wandsworth	8%	9%	5%	22%	78%
Westminster	6%	11%	10%	27%	73%
London (total)	9%	10%	8%	27%	73%

Source: GLA Economics analysis of the ONS APS. Note: Figures may not sum due to rounding.

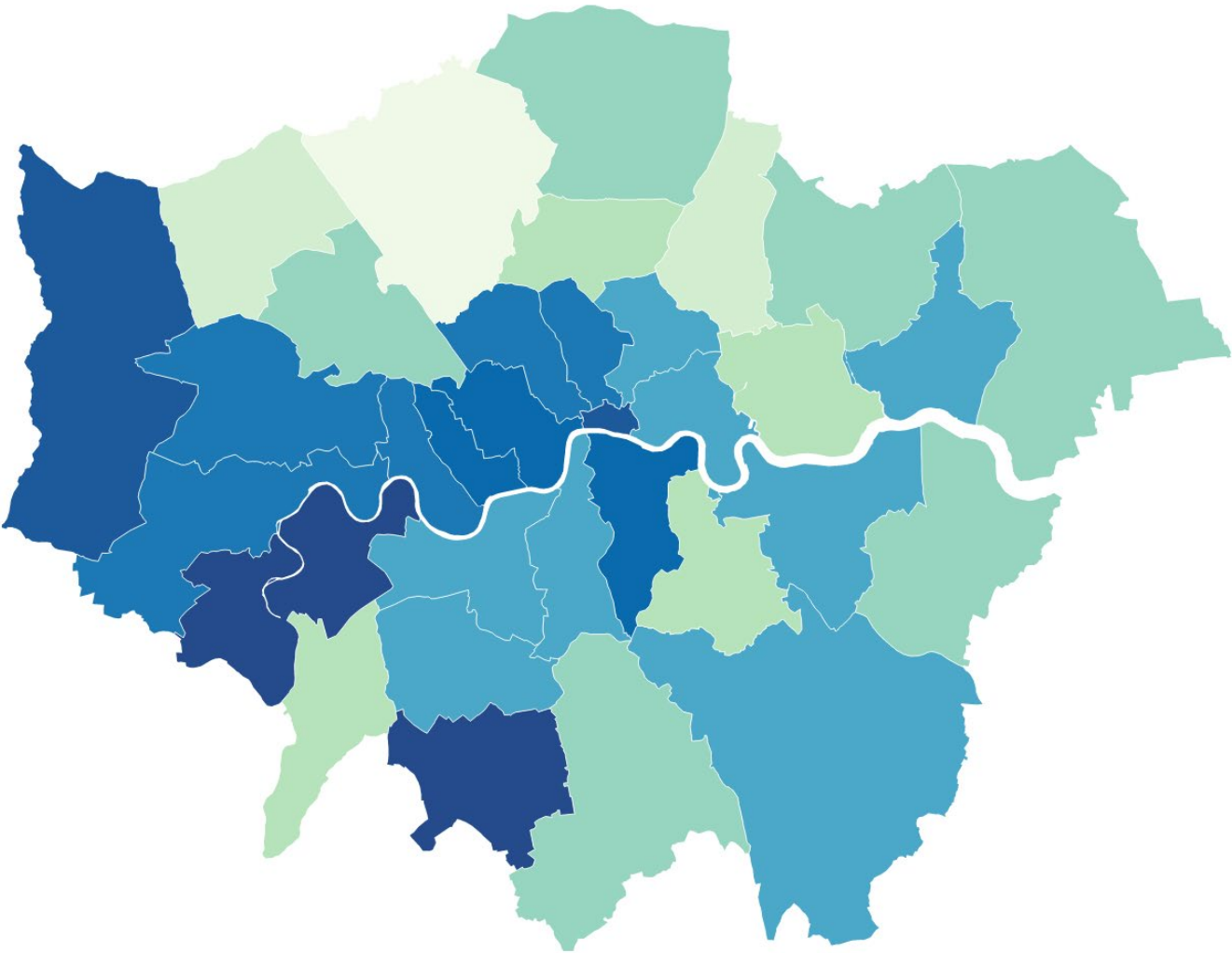## Map C1: Jobs in green increased demand occupations by London authority
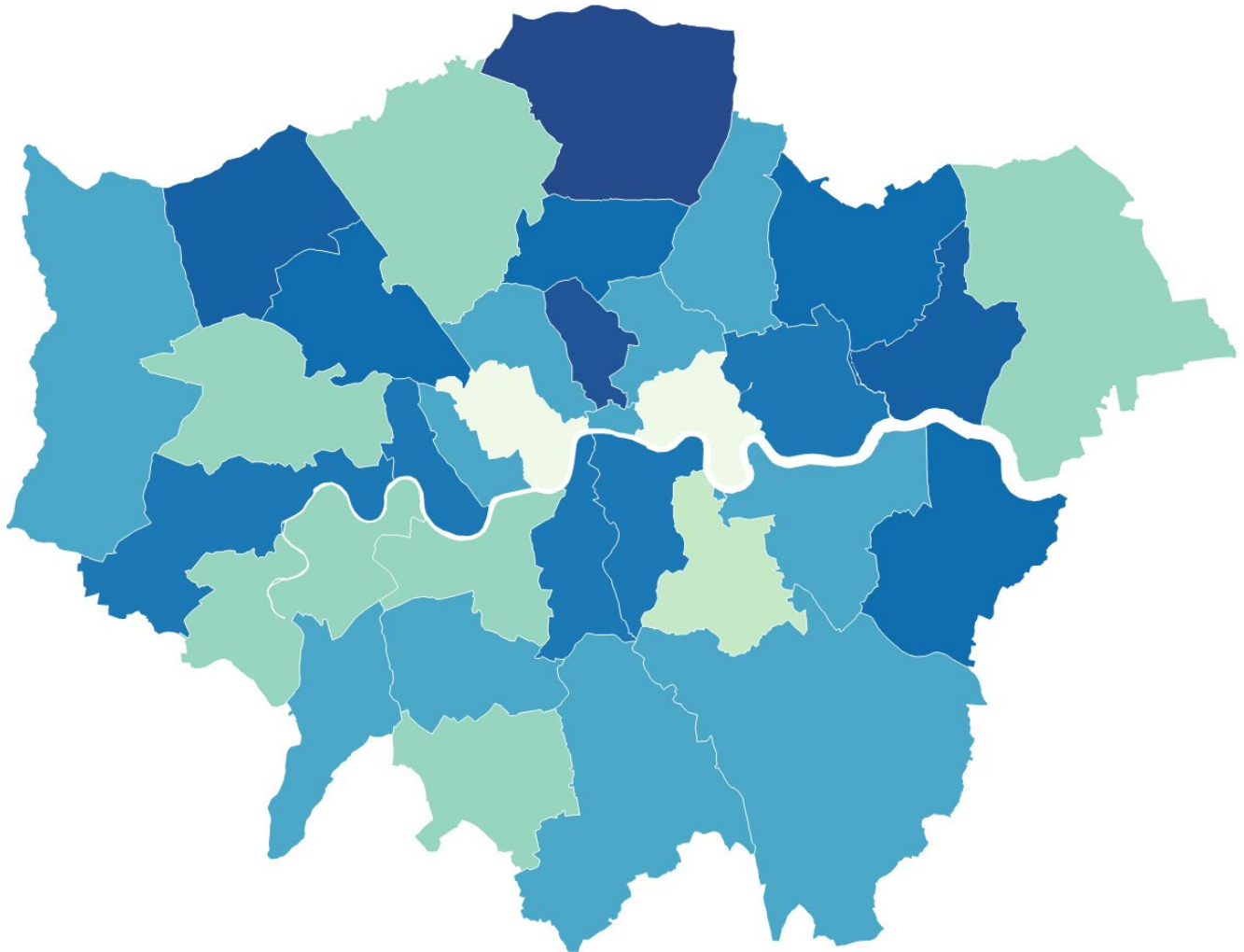
Percentage of total jobs, 2017-19

6%   14%

Map: GLA Economics analysis of ONS APS • Map data: © Crown copyright and database right 2018

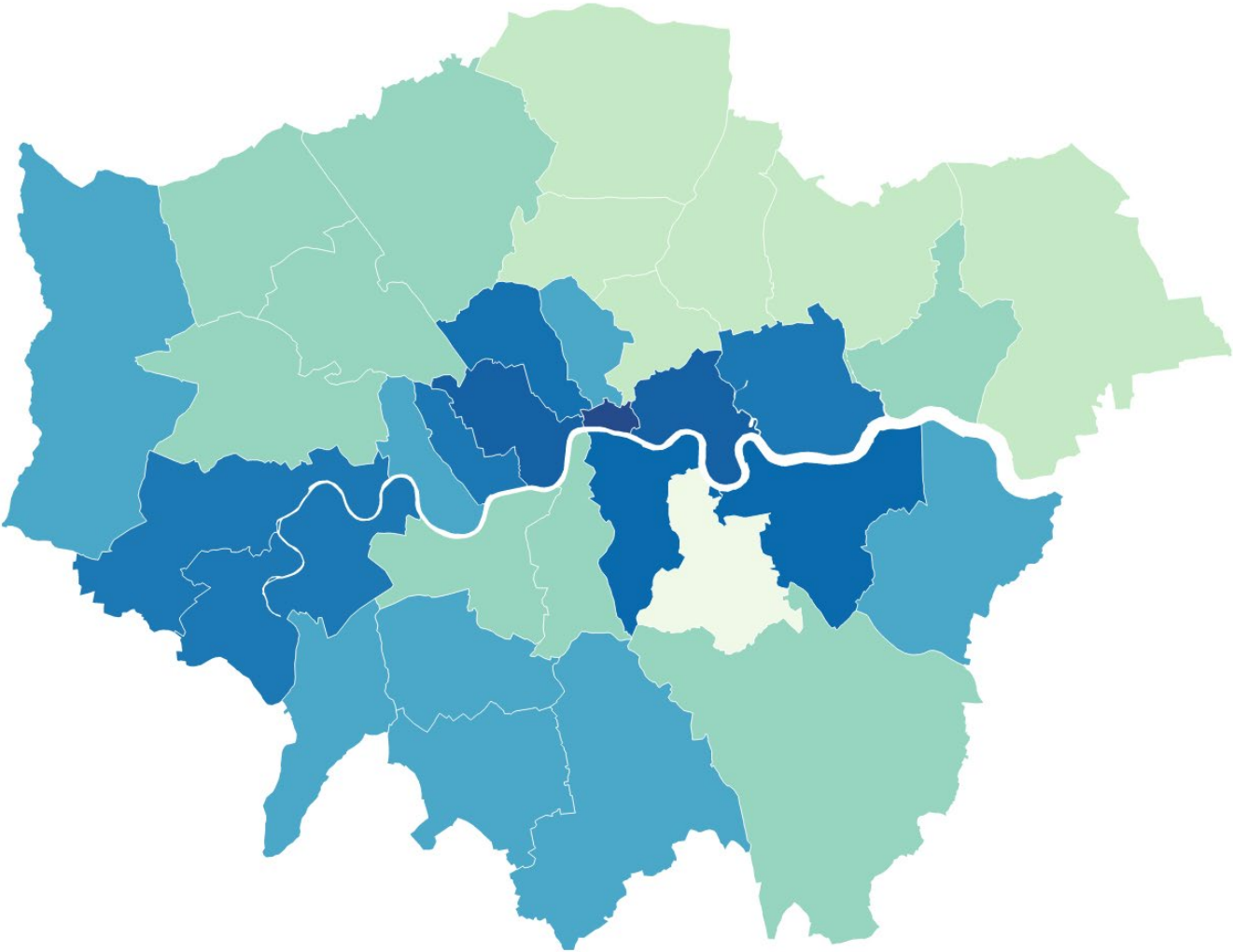## Map C2: Jobs in green enhanced skills occupations by London authority

Percentage of total jobs, 2017-19

5%   13%

Map: GLA Economics analysis of ONS APS • Map data: © Crown copyright and database right 2018

Map C3: Jobs in green new and emerging occupations by London authority

Percentage of total jobs, 2017-19

3%   13%

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