PHYSICS IN DEMAND:

The labour market for physics skills in the UK and Ireland

An Emsi Burning Glass report produced for the **Institute of Physics**

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This report employs a number of specific terms to aid interpretation of what can be quite a complicated subject. For that reason, we set out the key definitions here:

'**Physics-demanding roles'** are those roles which require a relatively high level of physics skills and knowledge to perform them. In the earlier part of this report, physics-demanding roles are defined at the occupational level – this definition is set out in the Introduction. In Chapter 3 we widen the definition to include a further group of occupations in those cases where employers specifically call for physics skills and knowledge.

'Physics skills' are defined in three groups, again explained further in Chapter 3. **Science** skills are those with an unequivocal connection to physics as a scientific subject. Reflecting physics' role as an underpinning science for many practical activities, there are two further groups where physics is applied in practice: **Medical** and **Engineering**. All skills are taken from the Emsi Burning Glass skills library, reflecting the language employers use to describe the skills, knowledge, technologies and methodologies they look for when hiring in online job advertisements.

These skills are defined in terms of specific, technical requirements – **transferable** skills are also discussed later in the report. These are more general skills, being found in some form in almost any jobs, but as we shall see they are an important part of finding a successful career.

During discussion in this report, we all refer to **high skill**, **middle skill** and **low skill** jobs. High skill jobs are those which typically require a Bachelor's degree or higher qualification, and are typically managerial, professional or technical in nature. Middle skill jobs are those which require intermediate skill level qualifications – apprenticeships, A-levels, Highers or Leaving Certificates – and range across administrative and skilled trades roles. Low skill jobs are then those which require no or low qualifications, and are often production or elementary roles.

The following interviewees shared their reflections on their experiences recruiting and employing in workplaces which need physics skills – we wish to thank them for their time. Interviewees were approached in a personal capacity and their comments should not be taken as indicating any corporate position for their respective organisations:

Allan Colquhoun, University Liaison and Emerging Technologies Manager – Leonardo
Chris Meadows, Director – CSconnected
Chris O'Leary, Senior Innovation Engineer – Rolls-Royce
Christopher Dorman OBE, Senior Vice President and General Manager – Coherent
Dr Carol Marsh MBE, Deputy Head of Electronics Engineering – Leonardo
Jed Griffiths, Strategy Partner – Atomic Weapons Establishment (AWE)
John McLaughlin, Chief Commercial Officer – AON
Kim Nilsson, Mentor – Techstars / Pivigo
Laura Probert, previously Chief People Officer – Leading online gaming company
Michelle Child, Operations Manager – Endomag
Nick Grant, Talent Acquisition Manager – Buro Happold
Paul Dowling, Founder and CEO – Mindstream AI
Prof Eoin O'Reilly, Chief Scientist – Tyndall National Institute
Ralph Cordey, Earth Observation Business Development Manager – Airbus Defence and Space
Richard Bray, Partner – Appleyard Lees
Steve Morriss, President, Middle East, Asia Pacific, Latin America and Mining & Metallurgy – SNC Lavalin

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SUMMARY

1. Employers across the UK and Ireland demonstrate a high and growing demand for people with knowledge of physics – as a science, but also in its applications in a range of areas, from engineering to medicine. Understanding physics is critical not only in advancing research in science, but in building, manufacturing, investigating, regulating, analysing and meeting many more needs of commerce and society. This report sets out to quantify and enrich our understanding of the labour market for physics, to help employers, but also those making policy and those shaping education, to better understand how to make the best use of physics knowledge across the UK and Ireland.

2. Occupations with a distinct need for physics knowledge account for 1 in 20 jobs – 1.85 million jobs across the UK and Ireland. Overall, they have grown in line with the UK and Irish economies, but over time that's changing – there are more scientists, more engineers, more construction roles, with slower growth in teaching and skilled trade roles. Physics-demanding occupations can be highly paid, but aren't always – ranging from laboratory technicians (median pay £21,400) all the way to aircraft pilots and flight engineers (median pay £97,400).

3. The demand for physics skills and knowledge is not confined to those with advanced degrees. There are a range of physics-demanding roles at different educational levels, and more than half of the jobs are in roles which typically don't require a degree. That said, the shift towards more science roles is gradually raising the demand for education: physical scientists and science production technicians are seeing some of the fastest growth (40 per cent and 35 per cent respectively, from 2010 to 2020), although job creation remains more of a mixture, rising fastest among construction managers, biological scientists and electrical fitters (between them 74,000 net new jobs from 2010 to 2020).

4. Every part of the UK and Ireland has a significant role for physics-demanding work, with 1.85 million physics-demanding roles present across all regions. Scotland has the largest concentration; 155,000 jobs being 16 per cent more than the UK and Ireland-wide average would suggest. London's size means that its large number – 207,000 – of physics-demanding roles represents the smallest concentration, with 26 per cent fewer physics-demanding roles than the UK and Ireland-wide average would suggest. That said, London is second only to the Republic of Ireland for growth since 2010 (27 per cent and 44 per cent jobs growth respectively over that time), while the North East has seen a slight decline (4 per cent).

5. Physics work concentrates in different industries in different places: Scotland's greatest strength is in its oil and gas and associated industries, while the East of England has scientific R&D, the East Midlands has transport manufacturing and Ireland like London has air transport. Looking at particular geographic hotspots, the north east of Scotland stands out with more than twice as many jobs as the UK and Ireland-wide average – again in oil and gas – with Cumbria second-most concentrated, on account of its nuclear energy and shipbuilding.

6. Using employers' job advertisements, we can explore the demand for physics expertise in much greater depth, looking at the demand for specific skills – separating out the demand for knowledge of physics as a science from the application of that knowledge in medical and engineering settings. This data allows us to identify further categories of roles where physics knowledge isn't normally required, but it can be in niches: in digital settings, in business and finance, and in teaching.

7. Using the same employers' job advertisements, we can get a much richer appreciation of the specific roles these skills are needed in, and what additional skills go around them. For example, we find that in business and finance, science and engineering skills are used by Electrical Engineers using AutoCAD and SolidWorks software; Quantitative Analysts who also need skills in statistics and the R programming language; Engineer Surveyors who need to conduct risk analysis and safety engineering; and Teachers who need to be adept at classroom management.

8. Taking the same employers' job adverts and using them to identify emerging trends, we can define ten roles which bring together physics, engineering, technological and managerial skills and represent clusters of employer demand. These clusters show the kind of skill combinations which create opportunities for employers and employees in today's labour market, and each cluster is explored in terms of the labour market it represents and how it is evolving.

9. At the same time, across all roles there is a need for transferable skills. Subtle differences between the types of physics roles help to explain the different emphases. For example, public and regulatory and business and finance roles place the highest premium on communication; digital and business and finance roles look for mathematical skills; innovation is high among science, digital and business and finance roles, but lower in adverts for health and construction roles.

10. The demand for physics skills and knowledge is growing – faster at the skill level than in the surrounding occupation, a finding particularly important where physics demand is a niche within a wider occupation. Comparing 2019-2021 to 2016-2018, we find medical requirements have grown strongly – a reflection of the Covid-19 pandemic – but, perhaps more interestingly, so have science demands in public and regulatory, business and finance, and construction.

11. Analysis of the length of time job adverts remain online suggests that physics skills demand – especially for science and engineering skills – drives larger numbers of adverts online for more than 40 days, putting them in the top quartile for the time employers spend advertising. As of writing, over 8,500 active job postings have been online for this kind of period, suggesting a significant level of unmet demand: around half for engineering and a third for science, with physics science skills in high demand for digital, engineering and business and finance roles.

12. Looking at the demands for individual skills, some of the greatest differences between the number of recent adverts explicitly seeking skills and the number of professionals declaring it a skill they have are found in physics, applied physics, electrical engineering, and a range of medical physics-related skills. Nearly 1 in 3 job adverts specifically seeking physics as a skill is online for a prolonged period, and around 1 in 5 job adverts citing a salary advertise the role at more than £50,000 per annum. While Science and Physics Teaching roles lead among specific job titles, Data Scientist is the third most frequent; for applied physics, it's a mix of Electronic Design Engineers, Physicists and Systems Engineers.

13. The demand for physics skills is widespread and isn't confined to jobs which are generally physics-demanding – new roles such as Data Scientists and Quantitative Analysts are often the ones that face most difficulty in finding physics talent. As different demands for physics skills grow, the current signs of labour market tightness seem likely to increase, creating opportunities to improve labour market performance if we can improve routes to improve the supply and use of physics skills.

14. Physics skills have a vital role to play in the future of the UK and Ireland economies, and meeting skills needs presents challenges for government, employers and education. Key messages are:

    a. **Physics is valuable at many skill levels.** While the pipeline at all levels matter, physics education needs foundations at school because the demand for physics skills is large at intermediate qualification levels.

    b. **Physics continues to evolve – with demands for new specialisms alongside general skills.** New technologies are driving new employer needs, but specialisation needs to be balanced by broad knowledge of fundamental physics.

    c. **Physics skills are in high demand – especially outside of "physics jobs".** The demand for physics skills is rising fast outside of traditional physics workplaces – in business and finance and in digital.

    d. **Physics skills offer some of their greatest value in concert with other skills.** There is already a pressing demand for physics skills in data science and software, but physics-trained workers need additional skills to be ready for these roles.

    e. **Physics skills need transferable skills to be used effectively at work.** Job adverts and employer testimony all place heavy emphasis for physics skills to be balanced with transferable skills to be able to apply them in the workplace.

INTRODUCTION

- **Physics is an underpinning science, and physics skills and knowledge have applications far beyond academia.**
- **There were 1.85 million jobs in physics-demanding occupations across UK and Ireland in 2020, with the number growing over the past decade.**
- **While most physics-demanding jobs require significant education, the majority don't require a Bachelor's degree – while some employers do need physics skills for research and innovation, many are much more concerned with the applications of physics.**

Since the early 2000s, employers and policymakers have been motivated by concern with meeting the rising demands for STEM (science, technology, engineering and mathematics) skills driven by economic and technological change. But 'STEM' is an abstraction: employers' demands are often much more specific, and there has been much less understanding of the role of different sciences and their application in a changing labour market. This report sets out to provide that understanding for physics.

Through its role in understanding matter, energy, mechanics, radiation and more, physics has a central role in the changing economy. Physics is fundamental to tackling net zero and understanding how we can cleanly and sustainably produce energy and use materials in new ways. Improving health outcomes uses tools and therapies driven by the application of physics. Even outside of the physical realm, physics knowledge can teach advanced skills essential in making use of Big Data and in breaking down the most complex questions facing business and government.

"Physics is absolutely central given the mission and what we do." – Jed Griffiths, Strategy Partner at the Atomic Weapons Establishment (AWE)

As part of the research for this report, we spoke to senior decision-makers from 14 organisations with an interest in recruiting and employing workers with physics skills and knowledge. They represent a diverse range of industry settings and skills demands including:

- Developing nuclear reactor systems for submarines
- Manufacturing lasers and optic systems
- Manufacturing compound semiconductors
- Researching and developing breast cancer care technology
- Designing and producing equipment for use in space
- Accelerating technology start-ups through software engineering and data science
- Analysing weight distribution and acoustics to inform the construction of buildings and infrastructure
- Modelling risks in the insurance industry
- Advising and informing the application and management of patents
- Researching new materials and their use in new devices

This range of applications highlights that if the role of physics in today's labour market is to be properly understood, the focus should not be too narrow. Physics is an underpinning science, a foundation for many other scientific and technological endeavours. The science sector certainly does have a critical role to play in advanced economies today, given the economic importance of the university sector and research and development, but we cannot ignore that much of physics' economic value is found well beyond the scientific world and in various industry settings.

[1] See e.g. Committee of Public Accounts (2018). Delivering STEM skills for the economy. Forty-Seventh Report of Session 2017-19. House of Commons, HC 691. A general analysis of the STEM labour market can be found in UKCES (2015). High level STEM skills requirements in the UK labour market. United Kingdom Commission for Employment and Skills. **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/444048/High_level_STEM_skills_requirements_in_the_UK_labour_market_FINAL.pdf** and Emsi (2018). Focus on the demand for STEM jobs & skills in Britain. See **https://www.economicmodelling.co.uk/wp-content/uploads/2018/12/STEM-Report_vWEB.pdf**

Developments in technology and the economy continue to create new opportunities for those with physics skills, even outside of the science's traditional domain. Appleyard Lees, a leading intellectual property law firm draws on physics specialists' expertise to enable their clients to protect their innovations, while professional services giant AON recruits physicists to build risk models – while these roles are not the exclusive preserve of those with a background in physics, the skills and knowledge gained from a physics education can add a competitive edge to those seeking careers.

With that broad view as its starting point, this report aims to paint a comprehensive picture of the labour market for physics. This first chapter looks to evaluate the place of physics in the jobs market, and how it varies and is changing across occupations, industries and regions. Later chapters move to a skills-specific dimension, looking at employers' specific demands – how they are changing, how they converge around distinct physics-demanding roles, and how well they are being met in the current labour market.

The report has been produced by Emsi Burning Glass, commissioned by the Institute of Physics (IOP), the professional body and learned society for physics in the UK and Ireland. The IOP's strategy 'Unlocking the Future' aims to transform the physics landscape for the UK and Ireland, working to unlock the powerful potential of physics, engaging and influencing government, funders and decision makers in industry and business. This report contributes to the IOP's ambitions by establishing a new, robust evidence base on the role of physics within the UK and Irish economies.

DEFINING PHYSICS

This report takes an emphatically quantitative approach to understanding the labour market for physics across the UK and Ireland. The report starts by understanding how many jobs there are, explores how they are distributed, and then goes on to explore different dimensions of change and content. We use a range of data sources – from survey-based intelligence to Big Data sourced from employers' online job adverts – to allow us to quantify and break down the labour market (see the Appendix for more on the data used in this report).

Physics is a science, not an industry sector – there are relatively few 'physics jobs' in the explicit sense outside academia. But much of the impact of physics is in its application, and that takes place across a wide range of industry sectors, present in many parts and places. From discussions with employers for this report, it is clear that not only are physics skills and knowledge valuable in their own right for employers – with many real-world applications – but also in very different settings, with physics-trained workers valued in driving new technology start-ups and in solving complex business and financial problems.

The first challenge is therefore to define what employers' demand for physics looks like in different places. We do this at two levels. First, we look at the jobs that people do. The Office for National Statistics (ONS) in the UK maintains a Standard Occupational Classification (SOC), which classifies all jobs into a range of occupational groups, recognising much of the variation while also looking to recognise the commonalities between many different types of jobs. With 369 different groups, our starting point in quantifying the physics labour market was to identify which of these occupations demanded a high level of physics skills and knowledge in their work, identifying 35 occupations (see BOX A on page 8).

Second, we look at the skills employers look for in the adverts they publish online. Some jobs may not typically have high expectations of physics knowledge and skills, but sometimes there can be subsets within occupations which have distinct patterns of demand. Being able to look at this level of detail – impossible before the arrival of Big Data into labour market intelligence – allows us to explore physics-related demands with much greater subtlety than was possible before. We look further at how we define physics through skills and what we can learn from it in chapter 3.

In pursuing these definitional challenges, there is always a balance to be struck between the focus on physics and the reality that some practical applications of physics have long since transferred into distinct disciplines. In particular, branches of engineering and medicine which draw heavily on physics are now so well established – think of mechanical engineering, structural engineering, radiation therapy – that they have become autonomous from their origins in the science. Understanding the use of physics at work requires us to tread into these different domains, although we have done so cautiously.

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[2] The science and R&D workforce including physics has seen sustained growth for two decades in the UK and generally across Europe, see Jeisson Cardenas Rubio and Terence Hogarth (2022). Warwick Institute for Employment Research The R&D Pipeline. BEIS Research Paper No 2021/22. Department for Business, Energy and Industrial Strategy. **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1004824/r_d-pipeline-report.pdf**

[3] **https://www.iop.org/strategy**

BOX A: PHYSICS JOBS

Emsi Burning Glass worked with the IOP to identify physics-related occupations with assistance from the US Department of Labor's O*NET database. [4] O*NET measures occupations across standardised scales for knowledge, skills and abilities – including physics knowledge. O*NET was mapped by Emsi Burning Glass to the ONS's UK SOC 2010 classification, and occupations were chosen where the importance of physics was scored above the middle of the range across occupations, or where some of the O*NET occupations within a UK SOC group also had a particularly high physics importance. In addition, using data supplied by IOP, percentages (noted in the table) were applied to secondary, further and higher education teaching job counts to reflect the shares in physics-related roles in the initial evaluation of job numbers and trends. The selected occupations reflect a range of skill levels and seniority, and exist across a range of professional specialisms, as seen in the group structure below:

Table 1.1

Group	SOC	Occupation
Construction	1122	Production managers and directors in construction
	2121	Civil engineers
	3114	Building and civil engineering technicians
	3122	Draughtspersons
Engineer	2122	Mechanical engineers
	2123	Electrical engineers
	2124	Electronics engineers
	2126	Design and development engineers
	2127	Production and process engineers
	2129	Engineering professionals n.e.c.
	2461	Quality control and planning engineers
	3112	Electrical and electronics technicians
	3113	Engineering technicians
	3116	Planning, process and production technicians
	3119	Science, engineering and production technicians n.e.c.
	3512	Aircraft pilots and flight engineers
Health	2214	Ophthalmic opticians
	2217	Medical radiographers
Public & Regulatory	1173	Senior officers in fire, ambulance, prison and related services
	2141	Conservation professionals
	2463	Environmental health professionals
	3550	Conservation and environmental associate professionals
	3567	Health and safety officers
Scientist	2112	Biological scientists and biochemists
	2113	Physical scientists
	2150	Research and development managers
	3111	Laboratory technicians
Skilled Trade	5225	Air-conditioning and refrigeration engineers
	5235	Aircraft maintenance and related trades
	5236	Boat and ship builders and repairers
	5241	Electricians and electrical fitters
	5245	IT engineers
	5314	Plumbers and heating and ventilating engineers
	8118	Electroplaters
	8124	Energy plant operatives
Teaching[5]	2311	Higher education teaching professionals (1.7%)
	2312	Further education teaching professionals (3.8%)
	2314	Secondary education teaching professionals (13.9%)

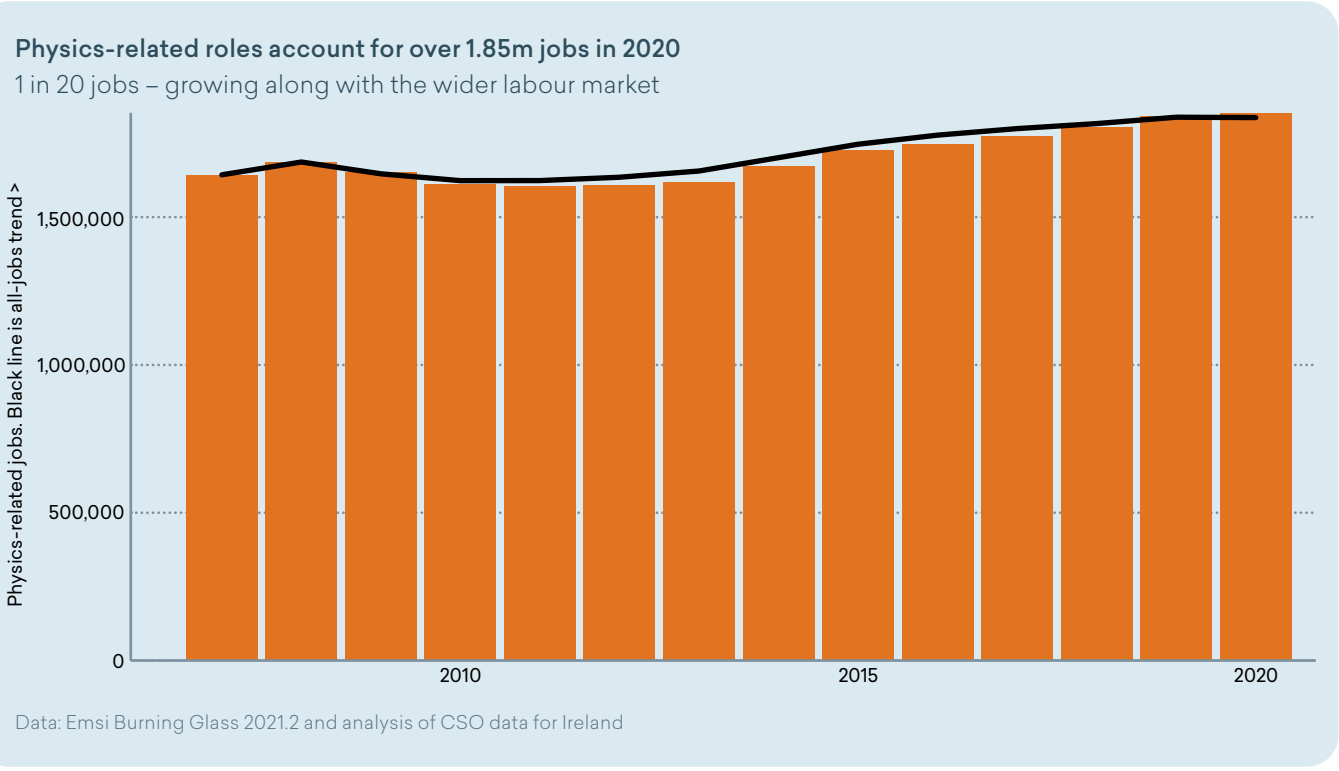
[4] See **https://www.onetonline.org/**

[5] Percentages for teaching roles with physics requirements, drawn from education workforce data gathered and analysed by IOP.

QUANTIFYING PHYSICS

With this job-based definition, we can begin to establish a baseline of the physics labour market across the UK and Ireland. These 35 physics-demanding roles together accounted for 1.85 million jobs in 2020, 5.2 per cent of the labour market (as seen in Figure 1.1). Since the financial crisis and global recession of 2008-09, demand has grown a little faster than the wider labour market across the UK and Ireland: 242,200 net new jobs, equating to 15 per cent growth (compared to 13.1 per cent across the economies).

Figure 1.1: Change in UK and Ireland physics job demand from 2007 to 2020



Data: Emsi Burning Glass 2021.2 and analysis of CSO data for Ireland

This picture of sustained, moderate growth obscures some of the changes happening under the surface; the demand for physics jobs is changing over time. Fastest growing have been roles as scientists: 24 per cent higher since 2010, 48,300 net new jobs; demand for engineering roles have grown only a little faster than the wider market (17 per cent) but added 87,200 net new jobs. Although this report takes a broad view of physics at work, it is clear that science roles are a critical part of the physics labour market. Outside traditional academia, there remains a demand for physics practised as science: to give a concrete example, the UK's Atomic Weapons Establishment (AWE) based at Aldermaston recruits and retains significant numbers of physics-trained scientists and engineers. Jed Griffiths, Strategy Partner at AWE told us that "physics is absolutely central given the mission and what we do".

At the other end of the scale, slowest growing are roles for teachers[6] and skilled trades (6 and 9 per cent respectively), although the size of the skilled trade workforce means that this group still added 40,500 net new jobs. During 2020 and 2021, the Covid-19 pandemic has created a sharp disruption across the labour market and economy, and the physics labour market has not been exempted from this. The contingent and hopefully short-lived nature of these events mean there is only limited data from online job adverts; the data is reviewed in BOX B on page 14.

[6] It should be noted that these reflect the growth patterns of the teaching workforce, as physics-related teaching is estimated as a fixed fraction of different levels of teaching professional, given that physics or science teachers are not separately represented in the SOC taxonomy.

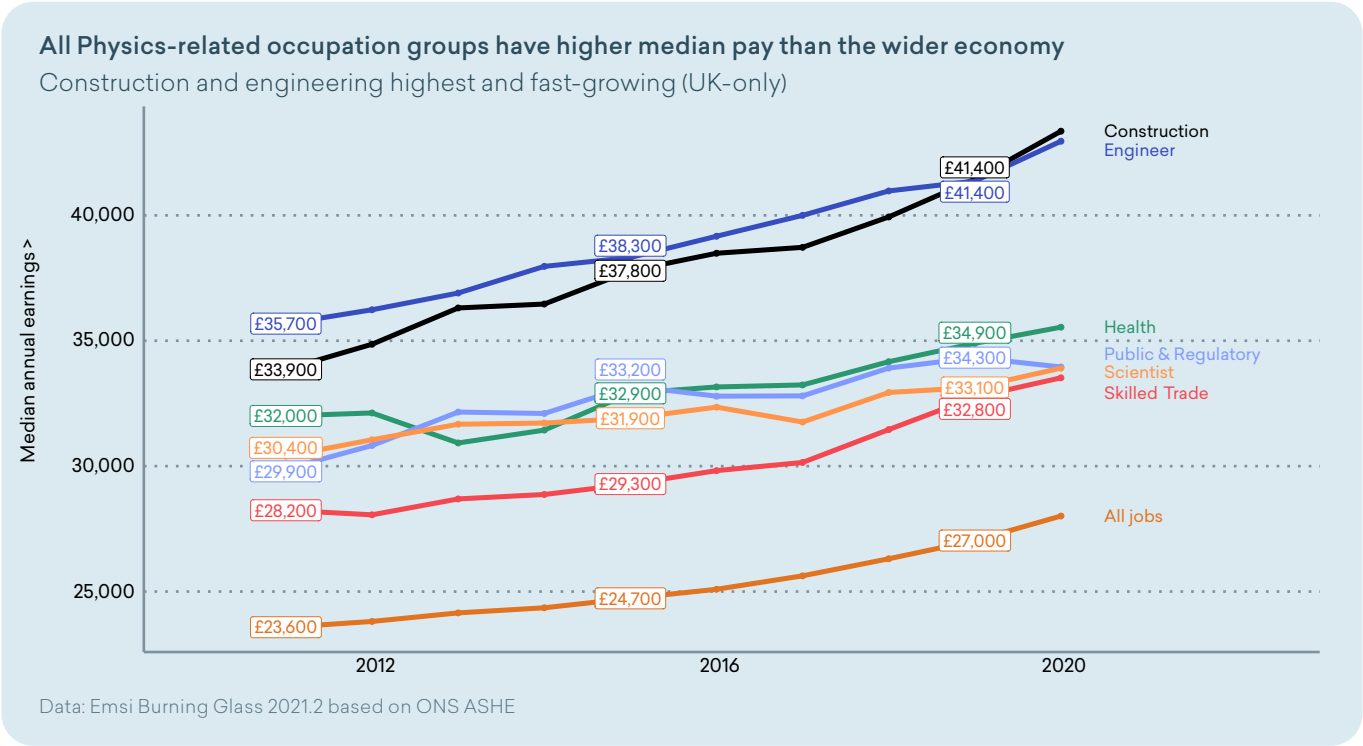
Table 1.2

Group	Jobs 2010 (000)	Jobs 2020 (000)	Change (000)	Growth (%)
Construction	257.9	300.6	42.7	16.5
Engineer	509.1	596.3	87.2	17.1
Health	47.6	55	7.3	15.4
Public & Regulatory	84.2	96.8	12.6	14.9
Scientist	205.3	253.6	48.3	23.5
Skilled Trade	449.5	490	40.5	9.0
Teaching	57.1	60.6	3.6	6.3
All physics-related jobs	***1,610.9***	***1,853.00***	***242.2***	***15.0***
UK and Ireland, all jobs	30,371.9	34,362.9	3,991.0	13.1

Over the same period and looking within the scientist category, physical scientists are the fastest growing individual occupation overall (40 per cent, 7,500 net new jobs (see Table 1.4 on page 12)), followed by science, engineering and production technicians n.e.c.[7] (35 per cent, 10,300 net new jobs), although laboratory technicians have seen much slower growth (14 per cent). Construction managers added the most jobs by volume (28,100 net new jobs, 21 per cent growth), followed by biological scientists and biochemists (24,500 net new jobs, 32 per cent growth). Some individual roles see declines – boat and ship builders and repairers (down 25 per cent), electrical engineers (down 3 per cent).

Reflecting the skills requirements of the roles, six groups of physics-demanding roles see significantly higher median earnings than jobs within the wider economy.[8] Construction and engineering roles see the highest rates of pay, reaching medians of around £43,000 in 2020 (see Figure 1.2).

Figure 1.2: Earning trends by physics-related group, 2011-2020 (UK-only)



Data: Emsi Burning Glass 2021.2 based on ONS ASHE

In the detail (see Table 1.5 on page 13), airline pilots and flight engineers are the highest paid – median salary of £97,400 – followed by electrical engineers (£52,200), construction managers (£48,600) and research and development managers (£46,700). As well as being the highest paid group, construction has seen the strongest growth in median earnings: 28 per cent since 2011, compared to 19 per cent for all jobs. By contrast, health (11 per cent) and scientist (12 per cent) have seen the slowest growth.

[7] n.e.c. denotes 'not elsewhere classified'

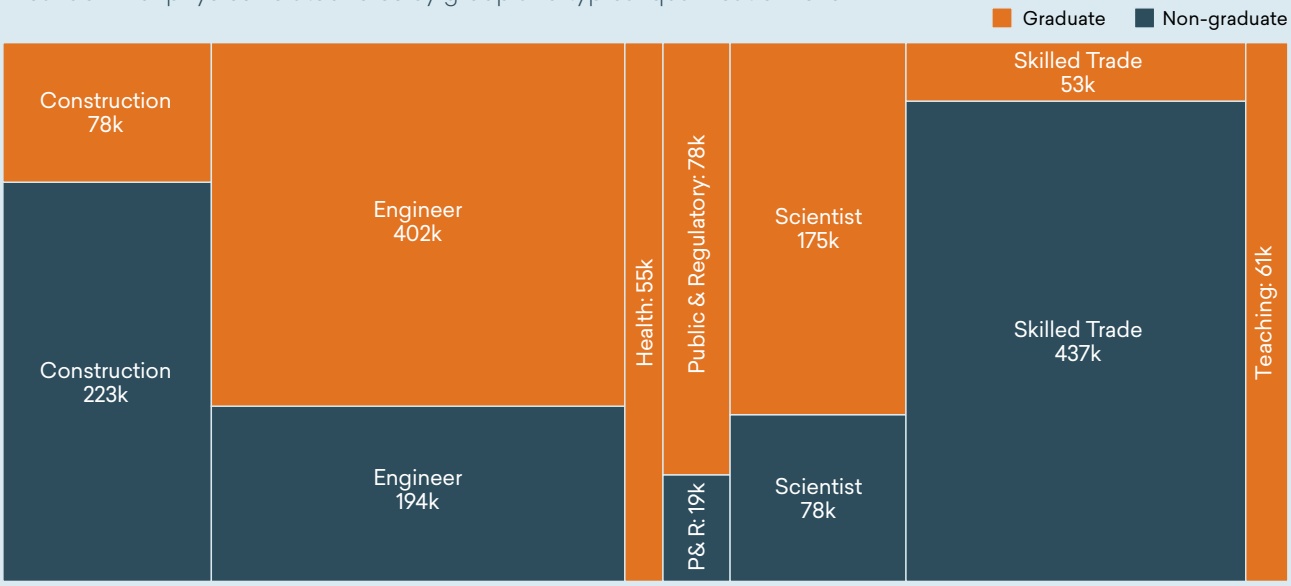
[8] Pay data refers to the UK only; equivalent data was not found for the Republic of Ireland.

The skilled trade and scientist groups are the lowest paid; this is reflected in the presence of electroplaters (£20,200) and laboratory technicians (£21,400) as the two lowest paid occupations, one in each group. This mix reflects a wider point about the labour market for physics-demanding roles: that not all roles are graduate. In fact, because of the mix of typical expected qualifications, most of the physics-demanding roles in the construction and skilled trade categories do not require a university degree, meaning that more than half of physics-demanding roles overall are in occupations open to non-graduates.[9]

Figure 1.3: Breakdown of physics-related jobs by broad group and education level, 2020

Not just graduates: more than half of physics-related roles typically don't require a degree

Breakdown of physics-related roles by group and typical qualification level



Data: Emsi Burning Glass 2021.2 and analysis of CSO data for Ireland

Table 1.3

Qualification	Jobs 2020
Low or no qualifications	24,600
GCSEs/Nationals/Junior Certificate	4,700
A levels/Highers/Leaving Certificate/most Apprenticeships	817,600
HND/HNC/Advanced and Higher Certificates	105,500
Bachelor's degree and above	841,100

It can be easy to think of scientific knowledge as being necessary only for high-skills occupations, but there are many uses of physics skills and knowledge at middle and sometimes low skill level occupations. As Table 1.3 shows, there are almost as many physics-demanding roles in occupations which typically require intermediate level qualifications as require a Bachelor's degree, and a significant number requiring post-secondary qualifications below Bachelor's degree level.[10]

[9] Typical expected qualifications data provided by Emsi Burning Glass, reflecting Labour Force Survey data on median qualification levels within occupations and known regulatory requirements in certain cases.

[10] Within the UK, and especially within England, the relative underdevelopment of these qualifications between intermediate and Bachelor's degree level has been observed for some years and this may in turn shift employer expectations above or below them. See Sainsbury Panel (2016). Report of the Independent Panel on Technical Education. **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/536046/Report_of_the_Independent_Panel_on_Technical_Education.pdf**

Discussions with employers bear this out. In the most physics-demanding workplaces in advanced manufacturing, there are demands for physics skills and knowledge at all levels – from technicians on the shop floor through to the chief executive. Physics related skills are useful in different ways at different levels. At the Tyndall National Institute in Cork, Chief Scientist Prof Eoin O'Reilly sees physics as central to all the work done – and this ranges from the purest science undertaken by PhD students and post-doctoral researchers to work by technicians at the Institute's large fabrication facility to apply the science in production.

Physics demands are widespread across engineering, construction and manufacturing, as well as in science, teaching, health, and the public and regulatory sector – that is why the reach of physics amounts to 1 in 20 jobs across the UK and Irish economies. Strong, sustained growth in demand highlights their importance, and the variations in skill levels and the changing mix all point to a dynamic labour market demand which needs to be understood if it is to be fully served.

Table 1.4: Physics-demanding occupations: UK and Ireland job trend, 2010 to 2020

SOC	Occupation	Jobs 2010	Jobs 2020	Change	Growth (%)
1122	Production managers and directors in construction	131,500	159,600	28,100	21.4
1173	Senior officers in fire, ambulance, prison and related services	9,100	8,600	-500	-5.5
2112	Biological scientists and biochemists	76,700	101,200	24,500	31.9
2113	Physical scientists	18,700	26,200	7,500	40.1
2121	Civil engineers	68,900	77,800	8,900	12.9
2122	Mechanical engineers	57,100	66,400	9,300	16.3
2123	Electrical engineers	47,900	46,600	-1,300	-2.7
2124	Electronics engineers	27,600	28,500	900	3.3
2126	Design and development engineers	56,500	71,200	14,700	26.0
2127	Production and process engineers	36,900	47,200	10,300	27.9
2129	Engineering professionals n.e.c.	91,900	111,200	19,300	21.0
2141	Conservation professionals	13,100	14,700	1,600	12.2
2150	Research and development managers	41,100	47,800	6,700	16.3
2214	Ophthalmic opticians	16,400	18,600	2,200	13.4
2217	Medical radiographers	31,300	36,400	5,100	16.3
2461	Quality control and planning engineers	24,500	31,300	6,800	27.8
2463	Environmental health professionals	6,100	7,100	1,000	16.4
3111	Laboratory technicians	68,900	78,500	9,600	13.9
3112	Electrical and electronics technicians	21,800	26,000	4,200	19.3
3113	Engineering technicians	69,100	75,900	6,800	9.8
3114	Building and civil engineering technicians	24,700	28,200	3,500	14.2
3116	Planning, process and production technicians	23,000	27,900	4,900	21.3
3119	Science, engineering and production technicians n.e.c.	29,300	39,600	10,300	35.2
3122	Draughtspersons	32,800	35,000	2,200	6.7
3512	Aircraft pilots and flight engineers	23,500	24,600	1,100	4.7
3550	Conservation and environmental associate professionals	8,600	10,500	1,900	22.1
3567	Health and safety officers	47,300	55,800	8,500	18.0
5225	Air-conditioning and refrigeration engineers	16,100	18,800	2,700	16.8
5235	Aircraft maintenance and related trades	20,200	21,400	1,200	5.9
5236	Boat and ship builders and repairers	9,700	7,300	-2,400	-24.7
5241	Electricians and electrical fitters	225,600	247,300	21,700	9.6
5245	IT engineers	45,800	53,100	7,300	15.9
5314	Plumbers and heating and ventilating engineers	123,600	132,700	9,100	7.4
8118	Electroplaters	4,600	4,600	0	0.0
8124	Energy plant operatives	3,900	4,800	900	23.1

Data: Emsi 2021.2 and analysis of CSO data for Ireland

Table 1.5: Physics-demanding occupations, median earnings, 2011 to 2020 (UK only)

SOC	Occupation	Median earnings 2011 (£)	Median earnings 2020 (£)	Change	Growth (%)
1122	Production managers and directors in construction	36,500	48,600	+12,100	+33.2
1173	Senior officers in fire, ambulance, prison and related services	40,800	46,100	+5,300	+13.0
2112	Biological scientists and biochemists	32,400	35,200	+2,800	+8.6
2113	Physical scientists	38,500	39,800	+1,300	+3.4
2121	Civil engineers	34,600	43,400	+8,800	+25.4
2122	Mechanical engineers	39,400	42,400	+3,000	+7.6
2123	Electrical engineers	39,700	52,200	+12,500	+31.5
2124	Electronics engineers	35,300	44,200	+8,900	+25.2
2126	Design and development engineers	35,100	42,000	+6,900	+19.7
2127	Production and process engineers	34,500	41,400	+6,900	+20.0
2129	Engineering professionals n.e.c.	36,800	44,000	+7,200	+19.6
2141	Conservation professionals	24,700	30,700	+6,000	+24.3
2150	Research and development managers	40,500	46,700	+6,200	+15.3
2214	Ophthalmic opticians	32,000	36,100	+4,100	+12.8
2217	Medical radiographers	32,000	35,200	+3,200	+10.0
2461	Quality control and planning engineers	32,100	38,800	+6,700	+20.9
2463	Environmental health professionals	28,300	36,700	+8,400	+29.7
3111	Laboratory technicians	19,600	21,400	+1,800	+9.2
3112	Electrical and electronics technicians	26,400	33,200	+6,800	+25.8
3113	Engineering technicians	30,800	36,400	+5,600	+18.2
3114	Building and civil engineering technicians	27,200	27,100	-100	-0.4
3116	Planning, process and production technicians	27,000	31,800	+4,800	+17.8
3119	Science, engineering and production technicians n.e.c.	23,700	27,100	+3,400	+14.3
3122	Draughtspersons	26,100	30,100	+4,000	+15.3
3512	Aircraft pilots and flight engineers	66,600	97,400	+30,800	+46.2
3550	Conservation and environmental associate professionals	20,200	22,600	+2,400	+11.9
3567	Health and safety officers	31,400	34,800	+3,400	+10.8
5225	Air-conditioning and refrigeration engineers	29,500	37,500	+8,000	+27.1
5235	Aircraft maintenance and related trades	26,800	40,000	+13,200	+49.3
5236	Boat and ship builders and repairers	26,800	32,900	+6,100	+22.8
5241	Electricians and electrical fitters	29,400	33,500	+4,100	+13.9
5245	IT engineers	26,000	30,700	+4,700	+18.1
5314	Plumbers and heating and ventilating engineers	27,500	33,200	+5,700	+20.7
8118	Electroplaters	20,200	25,700	+5,500	+27.2
8124	Energy plant operatives	26,800	35,400	+8,600	+32.1
Average		31,577	38,123	+6,546	+20.1

Data: Emsi 2021.2 and analysis of CSO data for Ireland

BOX B: PHYSICS JOBS IN THE COVID LABOUR MARKET

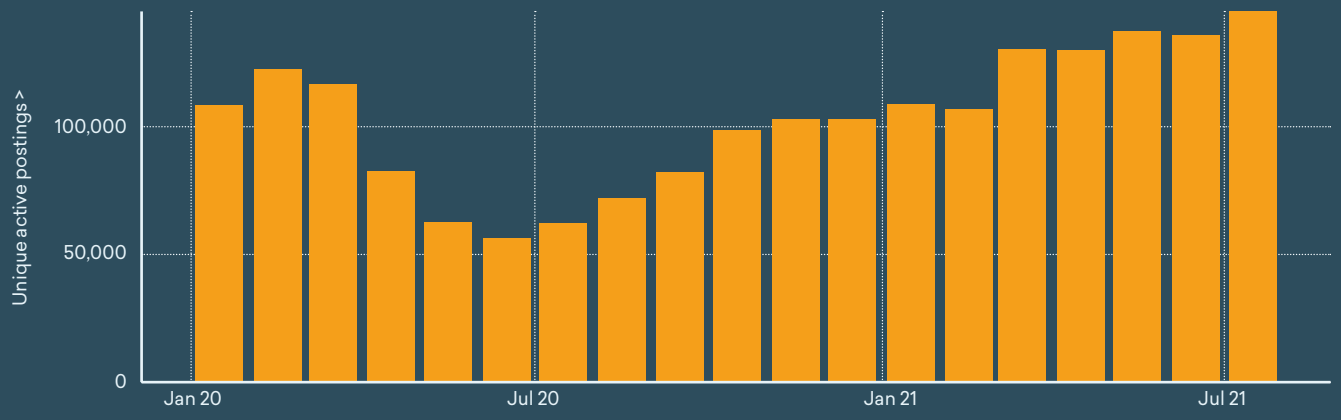
The arrival of the Covid-19 pandemic into Europe in March 2020 heralded a period of labour market and economic disruption unprecedented in the postwar era. Many labour market data sources have yet to be updated, and the use of novel interventions – such as the UK's Coronavirus Job Retention Scheme (CJRS) allowing employers to furlough affected workers – have confused traditional measures of labour market performance.

The availability of online job adverts has provided an invaluable source in tracking the impact of the pandemic in the months since it started, and allows us to identify the direct effect on recruitment demand and its recovery since then. From February 2020 to June 2020, active job postings for physics-demanding occupations fell by 54 per cent, similar to the 52 per cent drop seen in the wider labour market.

Figure 1.4: Recruitment trend in physics-related jobs since Jan 2020

54 per cent drop in job postings from February to June 2020, now into record territory

Active job postings for physics-related occupations January to July 2021



Data: Emsi Burning Glass Job Postings Analytics

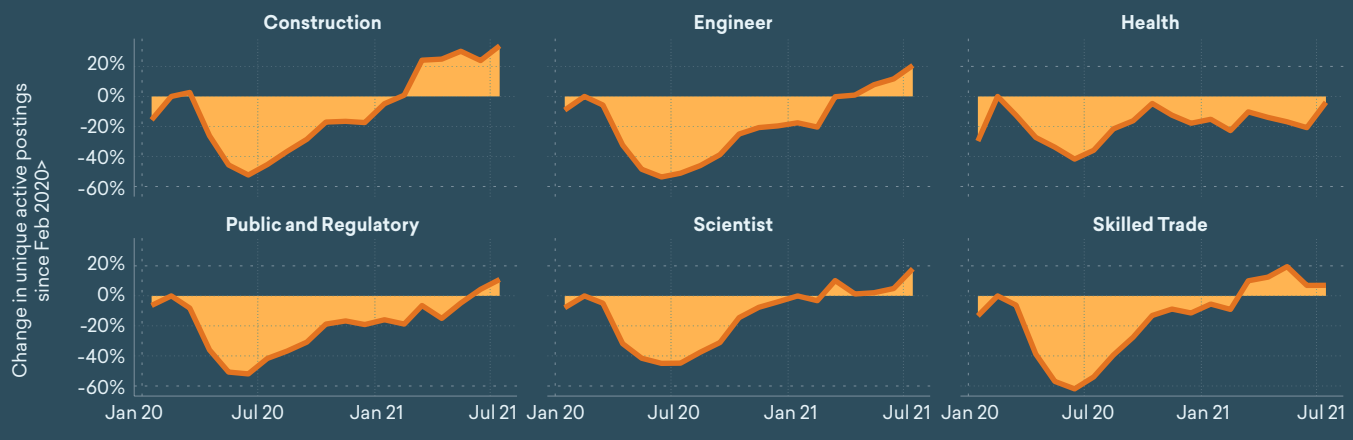
Recruitment demands have now more than recovered. During 2020, the recovery picked up into the autumn, with a pause during the second wave of winter and a resurgence in the spring – which is still ongoing: 138 per cent higher in July 2021 than a year before, a level seen only in one month in 2019. Postings are 18 per cent higher than the level in February 2020 and back to the levels of July 2019, in line with if a little slower than wider trends, with all job postings being 26 per cent higher than in February 2020.

Looking at the individual occupation groups, construction (35 per cent above February 2020 levels) and engineering (22 per cent) lead the way, reflecting the strong performance in those industry settings. As of writing, recovery is trailing mostly in consumer-facing services sectors – e.g. hotels and restaurants, entertainment and arts – in which physics-demanding occupations are less common.

Figure 1.5: Recruitment trends by physics-related occupation group since Jan 2020

All physics-related groups affected by downturn, and all have recovered

Construction and skilled trades recovered most strongly, reflecting wider economic picture



Data: Emsi Burning Glass Job Postings Analytics

PHYSICS IS EVERYWHERE

- **Physics-demanding jobs are found in every country and region across the UK and Ireland, with Scotland having the greatest concentration driven by its oil and gas sector.**
- **The Republic of Ireland has seen the fastest growth in physics-demanding roles, with 45 per cent growth since 2010, adding nearly 40,000 roles – London was second-fastest, adding 44,000, particularly notable given its strong service sector.**
- **Different industries draw on physics skills in differing combinations within their business models – and in all cases embedding physics within a set of professional and technical skills needed to perform the role.**

The labour market requirement for physics-demanding roles is high – 1 in 20 jobs across the UK and Ireland – and it also has a presence throughout the economy. While advanced economies always have their concentrations – such as financial services in London, Dublin or Edinburgh – the labour market demand for physics skills is large enough to be significant everywhere.

THE LANDSCAPE OF PHYSICS DEMAND

The map on the following pages sets out the pattern of physics-demanding roles across the nine regions of England, plus Scotland, Wales, Northern Ireland and the Republic of Ireland. The map is coloured according to the Location Quotient (LQ), a metric used in economic geography to understand relative specialisation, where an LQ of 1 represents the number of jobs which would be predicted given the overall trend, and values over 1 demonstrate concentration and specialisation.[11] As well as the key statistics for each region or country, we also highlight industries with high proportions of physics-demanding roles in which the region or country specialises.[12]

The greatest concentration of physics-demanding labour market requirements is Scotland, with 16 per cent more jobs than the overall UK and Ireland position would suggest. Scotland's high concentration reflects the presence of the oil and gas sector – and although that sector has seen struggles, physics-demanding job growth has still outpaced job growth overall in Scotland (8 per cent vs 6 per cent). That reflects a wider range of strengths in Scotland, with photonics and lasers a distinctive example demonstrated by the presence of Coherent in Glasgow and Leonardo in Edinburgh. Coherent, a photonics specialist, uses physics throughout their design and production process. Similarly, Leonardo's electronics facility in Edinburgh relies on physics skills in the design of laser and optics systems - with almost all of its work requiring expertise in the electromagnetic spectrum.

The East of England and the South East stand out for the presence of scientific research and development as a specialised industry, a direct application of physics knowledge. The East of England – with South Cambridgeshire's combination of pharmaceuticals and technology at its heart – has seen physics-demanding roles growing relatively quickly, 18 per cent compared to 15 per cent across all jobs. For this report, we spoke to Michelle Child, Operations Director at medical technology company Endomag, which uses physicists' skills to research and develop new products to improve outcomes for breast cancer care.

Several English regions – South West, East Midlands, West Midlands, North West – follow a similar pattern of slight specialisation driven by manufacturing industries, standing out for relatively rapid growth in physics-demanding roles across the decade: 15 per cent in the South West, 16 per cent in the East Midlands, 15 per cent in the West Midlands compared to overall jobs growth of 9, 10 and 11 per cent respectively. If these trends continue, physics-demanding roles will become more concentrated in these regions.

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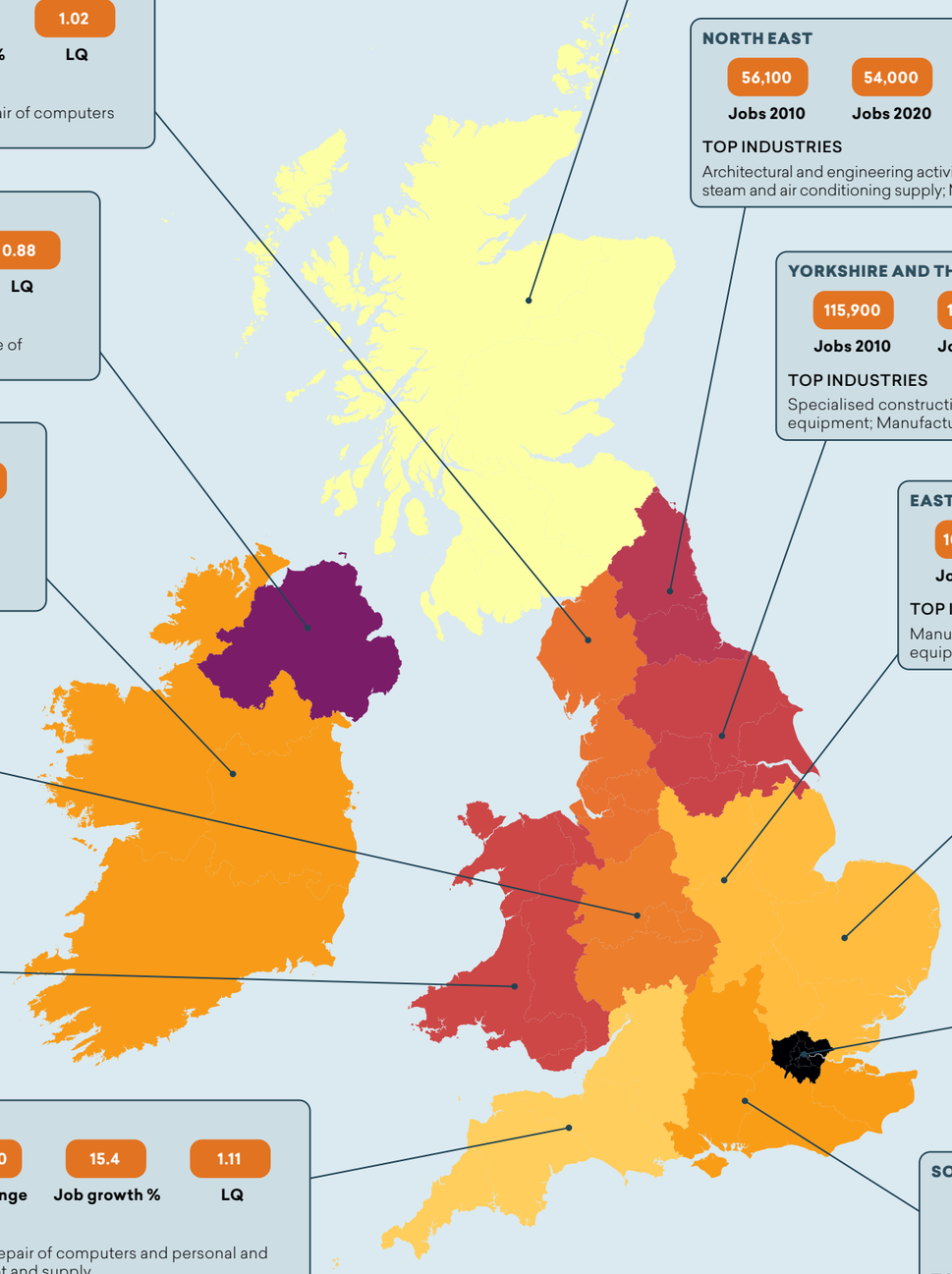
[11] Formally, the Location Quotient takes the ratio of the share of jobs in group i in region j with the share of jobs in group i in a parent geography, i.e. $LQ=(E_{ij}/E_j)/(E_i/E)$; in this case, i is our group of physics-demanding occupations and the parent geography is the UK and Ireland as a whole.

[12] Industries are those where physics-demanding roles make up at least 20 per cent of the industry workforce, measured using Emsi Burning Glass staffing patterns at the SIC 2007 division (2-digit) level. Regional industries are selected as those with a high Location Quotient within the region or country.

PHYSICS IN DEMAND: THE LABOUR MARKET FOR PHYSICS SKILLS IN THE UK AND IRELAND

Figure 2.1



SCOTLAND

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
143,100	155,000	11,900	8.3	1.16

TOP INDUSTRIES

Extraction of crude petroleum and natural gas; Architectural and engineering activities; technical testing and analysis; Electricity, gas, steam and air conditioning supply.

NORTH WEST

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
159,600	185,800	26,200	16.4	1.02

TOP INDUSTRIES

Manufacture of other transport equipment; Civil engineering; Repair of computers and personal and household goods.

NORTH EAST

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
56,100	54,000	-2,100	-3.7	0.95

TOP INDUSTRIES

Architectural and engineering activities; technical testing and analysis; Electricity, gas, steam and air conditioning supply; Manufacture of coke and refined petroleum products.

NORTHERN IRELAND

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
39,200	43,900	4,700	12.0	0.88

TOP INDUSTRIES

Manufacture of other transport equipment; Civil engineering; Manufacture of electrical equipment.

YORKSHIRE AND THE HUMBER

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
115,900	125,900	10,000	8.6	0.96

TOP INDUSTRIES

Specialised construction activities; Repair and installation of machinery and equipment; Manufacture of tobacco products.

IRELAND

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
90,000	129,900	39,900	44.3	1.06

TOP INDUSTRIES

Electricity, gas, steam and air conditioning supply; Air transport; Manufacture of tobacco products.

EAST MIDLANDS

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
106,800	124,100	17,300	16.2	1.09

TOP INDUSTRIES

Manufacture of other transport equipment; Repair and installation of machinery and equipment; Electricity, gas, steam and air conditioning supply.

WEST MIDLANDS

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
124,300	142,800	18,500	14.9	1.03

TOP INDUSTRIES

Repair and installation of machinery and equipment; Water collection, treatment and supply.

EAST OF ENGLAND

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
139,300	163,700	24,400	17.5	1.09

TOP INDUSTRIES

Scientific research and development; Specialised construction activities; Repair and installation of machinery and equipment.

WALES

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
65,700	67,800	2,100	3.2	0.97

TOP INDUSTRIES

Manufacture of other transport equipment; Repair and installation of machinery and equipment; Electricity, gas, steam and air conditioning supply.

LONDON

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
163,800	207,800	44,000	26.9	0.74

TOP INDUSTRIES

Air transport.

Location Quotient 2020

1.1
1.0
0.9
0.8

SOUTH WEST

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
131,800	152,100	20,300	15.4	1.11

TOP INDUSTRIES

Manufacture of other transport equipment; Repair of computers and personal and household goods; Water collection, treatment and supply.

SOUTH EAST

Jobs 2010	Jobs 2020	Job change	Job growth %	LQ
218,200	239,500	21,300	9.8	1.06

TOP INDUSTRIES

Scientific research and development; Repair and installation of machinery and equipment; Repair of computers and personal and household goods.

Data: Emsi Burning Glass 2021.2 and analysis of CSO data for Ireland

By contrast, the North East has seen a decline of 4 per cent for physics-demanding roles since 2010, even as overall jobs have grown by 5 per cent; while the region is strong in heavy industry and infrastructure, these have not seen robust jobs growth and so the region is falling back in terms of physics-demanding roles. Northern Ireland and Wales haven't declined but they also see relatively slow growth, from a relatively low base in Northern Ireland's case (LQ 0.88): physics-demanding roles growth has been 12 per cent in Northern Ireland and 3 per cent in Wales, compared to 16 per cent and 9 per cent overall jobs growth. Although Wales' overall presence is typical for the UK, it has its niche physics demands: in South Wales semiconductor manufacturers like IQE and Newport Wafer Fab depend on physics-trained workers.

While no more specialised than most other areas, the Republic of Ireland has seen particularly rapid growth in physics-demanding roles since 2010, adding 39,900 jobs, 44 per cent growth in that time. That's particularly impressive even given the relative jobs recovery across the labour market seen since the tough times at the start of the decade (all jobs have grown by 18 per cent). Within the data, there is growth across production and construction roles: construction manager jobs more than doubling, quality control and planning engineer roles nearly tripling, and civil engineers and civil engineering technicians up by over 60 per cent representing over 6,600 jobs added. Alongside these more applied settings, we know from discussions with the Tyndall National Institute in Cork that scientific research and development – employing 600 researchers, engineers and support staff – also makes an important contribution to the physics labour market. Eoin O'Reilly, Chief Scientist, says 'physics is essential across the thriving advanced manufacturing sector in Ireland'.

Unsurprisingly perhaps, the part of the UK and Ireland with relatively fewest physics jobs is London, where the concentration of the service sector and the relative absence of production industries means fewer physics-demanding roles. That pattern is changing – just as one example, London's Mindstream AI recruits physicists to help start-ups tackle data science and artificial intelligence challenges – but for now physics remains a smaller presence in services.

While high in absolute terms with the second highest number of physics-demanding roles, London has 26 per cent fewer physics-demanding roles than the UK and Ireland pattern would suggest, and has only one regionally significant industry with a high share of physics-demanding roles (air transport). While it is growing fast – 27 per cent more physics jobs in London in 2020 than 2010 – this primarily reflects the growth in the London economy (25 per cent job growth) more generally.

We can use Location Quotients within our specific occupation groups to shed some light on what kind of roles concentrate in different places: while physics-demanding labour market requirements are found across the UK and Ireland, its composition changes in different places. The East of England's strong base in science and technology shows through as the strongest concentration: 28,800 science jobs, representing 36 per cent more than UK and Ireland trends would suggest (LQ 1.36). Other concentrations include public and regulatory roles in the East Midlands (8,100 jobs, LQ 1.32), health roles in Scotland (4,500 jobs, LQ 1.3), skilled trades in the Republic of Ireland (40,600 jobs, LQ 1.22). London is notable more by its absences – engineers (LQ 0.65), skilled trades (LQ 0.65).

Figure 2.2

National and regional specialisms vary – East of England stands out for scientists

Scotland strong across the board

Location Quotient 2020 (UK & Ireland = 1)

0.8 1.0 1.2

	Construction	Engineer	Health	Public & Regulatory	Scientist	Skilled Trade
East Midlands	16,500	44,500	3,500	8,100	16,300	35,200
East of England	28,800	51,300	3,900	9,000	28,800	41,900
Ireland	21,500	41,900	3,000	5,900	16,900	40,600
London	45,300	60,900	6,200	11,100	34,000	50,200
North East	8,300	18,800	1,600	3,200	7,600	14,500
North West	30,500	65,200	6,800	10,700	26,200	46,400
Northern Ireland	8,500	12,000	1,300	2,200	7,000	12,800
Scotland	25,700	51,300	5,300	8,700	23,100	40,800
South East	40,100	78,600	8,100	11,700	34,700	66,300
South West	24,800	52,400	4,000	7,600	19,000	44,400
Wales	11,000	22,700	2,600	4,600	8,200	18,600
West Midlands	20,700	54,300	4,100	6,500	16,200	41,000
Yorkshire and The Humber	18,800	42,400	4,600	7,400	15,500	37,200

Data: Emsi Burning Glass 2021.2 and analysis of CSO data for Ireland

REGIONAL HOTSPOTS

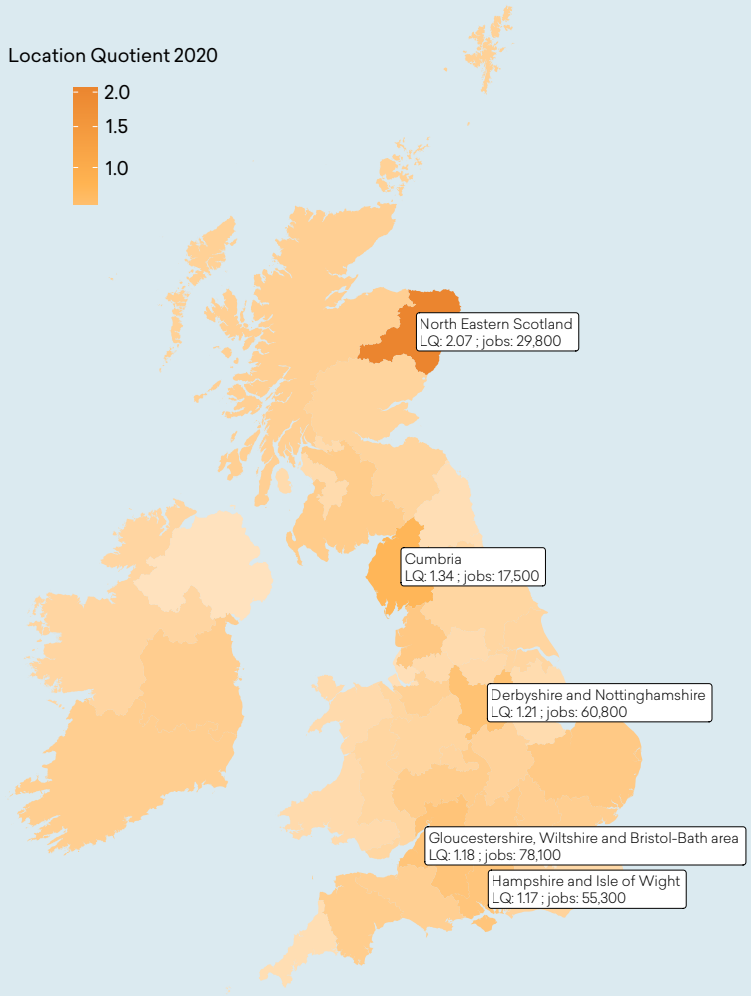
While these broad geographies are helpful, they can sometimes obscure the richer stories of specific local and regional economies – after, all it is often at this scale that employers and employees typically match up with jobs. Here we look at the UK and Ireland according to more local geographies,[13] again with the Location Quotient used to illustrate the variation in regional concentrations and the five 'hotspots' for concentration highlighted.

For each of these five we again look at the specific industry sectors driving their specialisation at the local level – and at a more detailed level than before, reflecting the finer geographic lens.[14] Unsurprisingly, we see the north east of Scotland performs highly, reflecting its specialisation around oil and gas, and Cumbria's second place reflecting its presence in the nuclear and submarine-building industries. The next three hotspots all again have a heavy presence of manufacturing: heavy industry for Derbyshire and Nottinghamshire; defence, aircraft and appliances for the Gloucestershire, Wiltshire and Bristol-Bath area, and then electronics driving Hampshire and the Isle of Wight.

Figure 2.3

Regional hotspots: top 5 geographics for physics-intensive job concentrations

NUTS2 regional physics-intensive jobs in 2020



KEY INDUSTRIES

North Eastern Scotland
- Support activities for petroleum and natural gas extraction
- Extraction of crude petroleum
- Manufacture of gas

Cumbria
- Processing of nuclear fuel
- Building of ships and floating structures
- Collection of hazardous waste

Derbyshire and Nottinghamshire
- Manufacture of central heating radiators and boilers
- Manufacture of cutlery
- Manufacture of railway locomotives and rolling stock

Gloucestershire, Wiltshire and Bristol-Bath area
- Manufacture of military fighting vehicles
- Manufacture of air and spacecraft and related machinery
- Manufacture of electric domestic appliances

Hampshire and Isle of Wight
- Repair and maintenance of ships and boats
- Manufacture of wiring devices
- Manufacture of loaded electronic boards

Data: Emsi Burning Glass 2021.2 and analysis of CSO data for Ireland

[13] NUTS2 regions, compared to the NUTS1 geography used previously.

[14] SIC 2007 classes (4-digit) industries are used here, again using the 20 per cent threshold for physics-demanding roles.

THE ROLE OF INDUSTRIES

This difference in industry composition highlights the way in which occupations interact around different industry sectors, creating different patterns in employment. Later in this report, we will take this to a much deeper level of analysis, using the combinations of skills that employers use to look for talent to identify 'clusters' which represent specific physics-demanding roles from the bottom up.

At the occupation level, it is valuable to explore the different ways in which industries with high shares of physics-demanding businesses specialise around specific roles, combining those with physics knowledge with others. Here we focus on four specific industries in different environments, selected to illustrate the different applications of physics in manufacturing, construction, professional services and oil and gas settings. All of them have a physics focus, but also have different needs driving that focus. To explore these differences, we pick out the 10 most concentrated occupations in each industry (see Figure 2.4 on the following page). There may be other occupations in the industry, but they are more generic in nature: think of administrative occupations.

By looking at the most concentrated occupations, we can better understand the skills mix within an industry: so in bridge and tunnel construction, for example, we find that construction managers and civil engineers are the first and third most concentrated, but all other roles are not counted as physics-demanding. The physics-demanding roles are central to the civil engineering sector more generally, and testimony from employers for this report shows that their work mixes their physics skills with their expertise in project and programme management, and in providing professional advice.

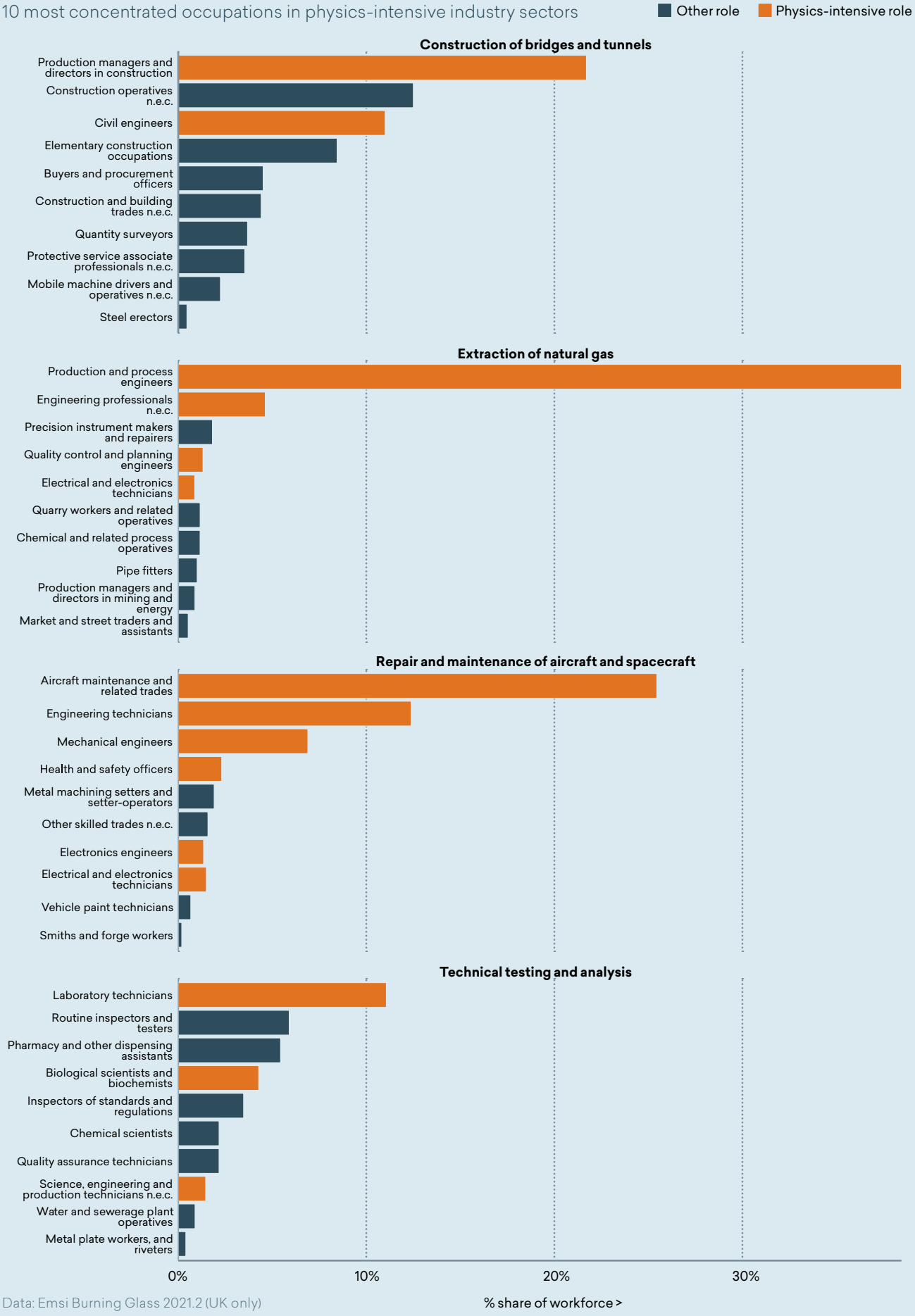
Extraction of gas has four of its ten most concentrated occupations as physics-demanding – but one role, production and process engineers, accounts for a third of the workforce on its own. Repair and maintenance of aircraft and spacecraft is a more balanced picture – but the top four occupations, and six of the top ten, are physics-demanding, accounting for a large share of the workforce. Ralph Cordey, himself a physicist now working in Business Development at Airbus Defence and Space in Stevenage, highlighted the role of physics skills and knowledge across scientists, engineers and technicians to develop bespoke systems for clients. Advanced manufacturing employers highlight the critical pairing of physics with engineering skills. At Coherent, Senior Vice President Christopher Dorman OBE highlights the need for all physicists within the company to be trained as engineers; similarly, at Endomag, Michelle Child sees engineering skills as essential to bringing physics to real-world problems.

Each industry has its own business model, and each places a particular set of physics-demanding roles within that business model. Each of those roles reflect a required mix of skills and knowledge, only some of them physics-related – one of the themes that emerges from conversations with employers is that physics skills and knowledge is important, but becomes valuable in combination with other skills needed in their industry – be they commercial and professional skills in some fields, or technology skills in others. How employers set about staffing their business models, and how they seek out the mix of skills they want within different roles, requires us to turn our investigation to their recruitment activities and to look at the specific demands made in online job adverts.

Figure 2.4

Physics roles specialise within physics-intensive industries

10 most concentrated occupations in physics-intensive industry sectors



Data: Emsi Burning Glass 2021.2 (UK only)

JOBS IN PHYSICS, PHYSICS IN JOBS

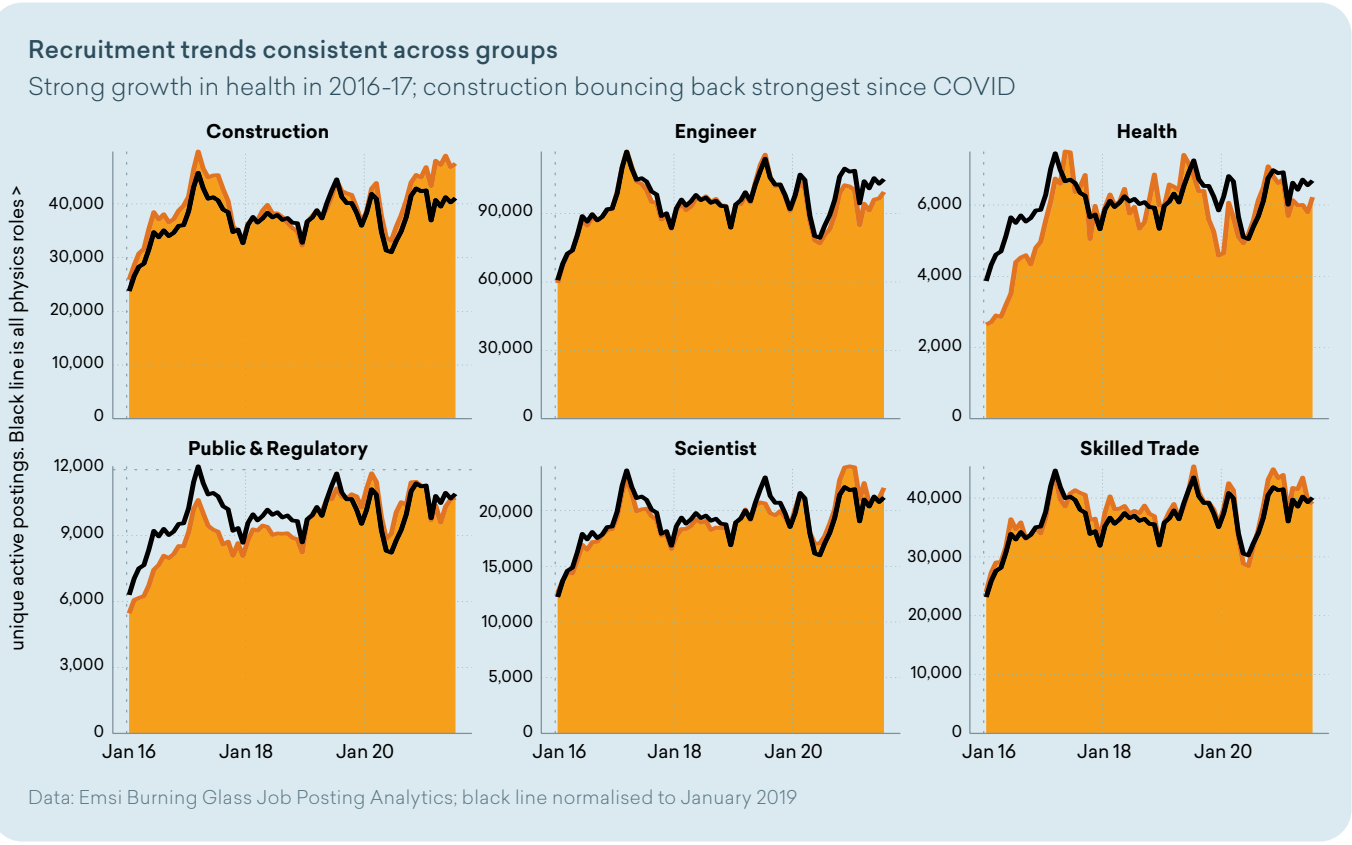
- **Using online job adverts, we can measure not only the current scale of employment, but the changing pattern of employers' need for new physics-demanding roles.**
- **Using groups of physics-related skills – Science, Engineering and Medical – we see increasing demand for physics outside of traditional physics-demanding occupations, including for example in Digital or Business and Finance.**
- **Every occupation and skill group emerges as having particular sets of skill needs – but transferable skills are in high demand across all groups, and employer discussions also emphasise the need for physics skills to be matched with transferable skills.**

Over the past ten years, job advertising has been transformed, with almost all of it having moved online. Through collection, curation and deduplication of those online job adverts, it is now possible to gain insights into employers' demands in a way that would not have been possible before. Emsi Burning Glass continuously analyses online job adverts, with a database of over 50 million unique job postings used to drive this analysis.

Recruitment demand as measured through online job adverts offers rich insight into labour market demand, but it is not the whole story. We have drawn on survey-based measures of job numbers in the previous chapter because recruitment demand only refers to the change in labour market demand – where employees stay in their job for many years, their work is not measured in recruitment. But when used in combination with survey-based intelligence, job adverts' ability to drill deep into skills offers an invaluable resource. Job adverts have to be handled with care and require substantial investment to make them comprehensible given the vagaries of employer language. At the same time – and especially important in a time of great change as we have had with the Covid-19 downturn and subsequent recovery – online job advertising trends can be very noisy and are best used as part of a wider analysis of data, as in this report.

Immediately, we can use online job adverts to measure recruitment trends across our physics-demanding occupation groups, comparing each one to the wider set. We find that health and public and regulatory roles have seen the strongest growth since 2016, which is when the time series starts (see Figure 3.1). But there is even greater potential when we add some of the other facets of the data into the analysis, and specifically around skills. To do this, we used the Emsi Burning Glass Skills library to define a family of skills around physics and its applications, as described in BOX C on page 25.

Figure 3.1: Online job posting trends by physics-related occupation groups



BOX C: PHYSICS-RELATED SKILLS

Using Emsi Burning Glass's Skill Library and working with the IOP, we identified and refined a list of skills which cover physics as a science, but also give a conservative representation of its two most established applications, in engineering and medicine. The approach taken in selecting skills was that all of them must have an unequivocal link to physics knowledge.

To establish the initial list, Emsi Burning Glass used keyword searches on the Skills Library (which has over 30,000 skill and knowledge items), and used a skills classification model on several descriptions of physics educational content provided by the IOP. Transferable skills which tend to be softer and more generic, were taken out of the analysis as being too broad to be helpful in defining job adverts as physics-related.

This process performed well to identify skills around physics as a scientific discipline and around physics-demanding medical practice. Through the process, Emsi Burning Glass and IOP recognised that physics-related engineering skills were not being sufficiently recognised. For that reason, additional skills with an unequivocal link to physics were selected to define a further group.

The group structure around Science, Engineering and Medicine is retained here and in the analysis used in this report. While it is possible for an online job advert to include skills in any of the three groups, in practice there is very little overlap between them, suggesting the groups are a powerful lens through which to distinguish employer demands. 1.17m postings from January 2016 mention at least one of our physics skills across Engineering, Science and Medicine.

Table 3.1

Group	Skill	Unique job postings since 2016	Median advertised salary (£)
Engineering	Mechanical Engineering	396,253	34,528
	Electrical Engineering	336,797	35,040
	Structural Engineering	93,659	39,136
	Microwave Engineering	912	40,128
Medicine	Radiography	76,930	37,088
	Radiology	60,063	37,600
	Radiation Therapy	18,347	38,112
	Nuclear Medicine	9,268	38,080
	Medical Physics	5,367	38,112
	Intensity-Modulated Radiation Therapy	1,893	38,592
	Radiation Oncology Physics	1,848	40,128
	Diagnostic Radiology	1,634	48,576
	Image-Guided Radiation Therapy	1,557	36,800
	Health Physics	1,163	37,568
Science	Physics	229,151	35,040
	Physical Science	17,700	35,008
	Radiation Protection	8,372	36,544
	Torque (Physics)	8,255	30,016
	Biophysics	4,653	35,264
	Photonics	4,365	35,776
	Geophysics	3,821	35,808
	Plasma Cutting	3,252	24,768
	Applied Physics	2,692	36,544
	Astrophysics	2,376	35,008
	Radioactive Waste	2,182	44,992
	Electromagnetism	2,112	35,264
	Comsol Multiphysics	2,015	40,128

Table 3.1 (cont)

Group	Skill	Unique job postings since 2016	Median advertised salary (£)
Science (cont)	Plasma (Physics)	1,604	25,024
	Atmospheric Sciences	1,244	35,776
	Multiphysics	1,123	37,568
	Particle Physics Experiments	1,103	36,032
	Experimental Physics	828	36,544
	Computational Physics	667	36,032
	Biophysical Techniques	617	34,752
	Radiologic Physics	613	38,528
	Petrophysics	597	37,568
	Hypercompact Stellar Systems (Astrophysics)	569	33,984
	Mathematical Physics	560	37,056
	Optical Physics	505	37,056
	Quantum Physics	492	36,032
	Geophysical Survey	437	32,448
	Chemical Physics	348	35,264
	Physics Engine	263	44,992
	Mesoscopic Physics	260	33,472
	Statistical Physics	237	35,776
	Game Physics	226	35,008
	Atomic Physics	224	35,776
	Accelerator Physics	165	35,968
	Atmospheric Physics	144	36,544
	Exploration Geophysics	130	39,040
	Material Physics	101	30,016
	Heliophysics	94	36,032
	Polymer Physics	89	36,032
	Molecular Biophysics	87	36,032
	Marine Geophysics	66	33,152
	Modern Physics	43	27,584
	Medical Imaging Physics	25	35,840
	Classical Physics	10	28,992

Using the skills definition allows us to explore the differing strategies taken to using physics skills within the workplace. For advanced manufacturing employers, physics is often central to the role – Chris O'Leary, Senior Innovation Engineer at Rolls-Royce, recruits explicitly for physicists because of the nature of his work with submarine nuclear reactors, with a similar story at Airbus Defence and Space when seeking to fill specialist roles in sensor development or gravitational wave detection. For those in research settings, physicist skill requirements can become highly specific – as Jed Griffiths at AWE says, "we definitely have a very bespoke requirement for many of the physicists who work in a very narrow field".

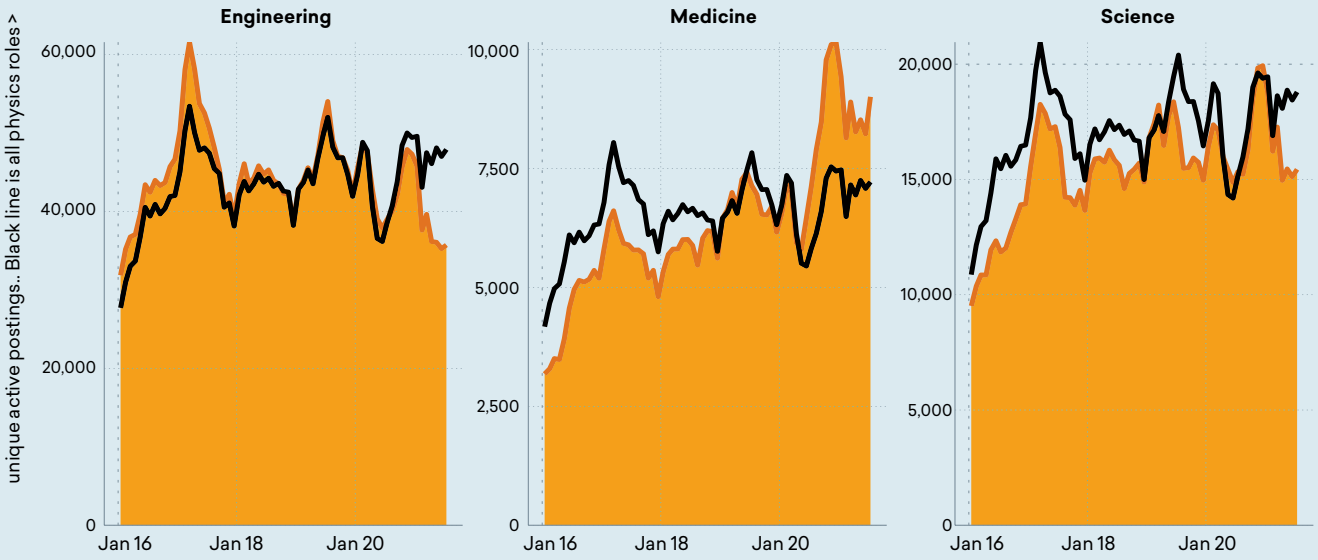
But for others, the role of physics is a more variable quantity in recruitment decision-making. When hiring civil engineers, Nick Grant, Talent Acquisition Manager at Buro Happold, does not look specifically for physics degrees, but often does look for it as a pre-degree qualification. Similarly, while understanding of underpinning physics is important when Richard Bray of Appleyard Lees is hiring for intellectual property experts, other skills are also important and may become more so in future. For John McLaughlin, Chief Commercial Officer EMEA at AON, physical skills are sometimes essential but for many roles – e.g. data scientists – they represent one among several routes to the necessary skills, with people from other academic backgrounds such as mathematics and computer science, also highly valued.

Using the three groups of skills defined for this analysis, we can start by comparing the trends across all job postings, regardless of whether they take place within a physics-demanding occupation. The skills trends have much greater difference than the occupational groups: Medicine skills have seen rapid growth – nearly doubling since 2016, barely affected by the pandemic – and Science skills have also seen strong growth. Physics skills can apply far beyond obvious physics roles. Chris Meadows, Director of CSconnected, a coordinating organisation for the South Wales compound semiconductor cluster, says that while physics skills are of course important for design, process and product engineering, they are also essential for sales and customer service employees - they need to be able to work with customers and speak the same physics language.

Figure 3.2

Skills-based trends differ strongly

Medicine skills group expanded greatly since COVID-19; engineering still delayed



Data: Emsi Burning Glass Job Posting Analytics; black line normalised to January 2019

The skills lens is entirely independent of occupation, although the combination of occupation and skill together allows us to get a much closer examination of employers' demands where we know there are physics-demanding roles. At the same time though, we know there are certain occupations which are not typically physics-demanding but have developed physics-demanding niches, and we can use the presence of the skills groups in other occupations to guide on this point – now that we have the additional skills data to ensure their inclusion only when merited.

Reviewing the full range of occupations where there is a significant presence from the three skills groups (Science, Medicine, Engineering), we identified three new occupation groups to add to the analysis. Business and Finance, and Digital are motivated by anecdotal reports of high demand in analytical, data science and software roles in these settings.[15] In addition, the high presence of science skills among some Teaching roles warranted their inclusion given the presence of the skills groups as a further control.[16]

[15] Business and Finance includes five occupations: management consultants and business analysts (SOC 2423); business and financial project management professionals (SOC 2424); business and related research professionals (SOC 2426); finance and investment analysts and advisers (SOC 3534). Digital includes two occupations: IT business analysts, architects and system designers (SOC 2135) and programmers and software development professionals (SOC 2136).

[16] Teaching includes primary and nursery education teaching professionals (SOC 2315); secondary education teaching professionals (SOC 2314) and teaching and other educational professionals n.e.c. (SOC 2319).

PHYSICS SKILL PREVALENCE

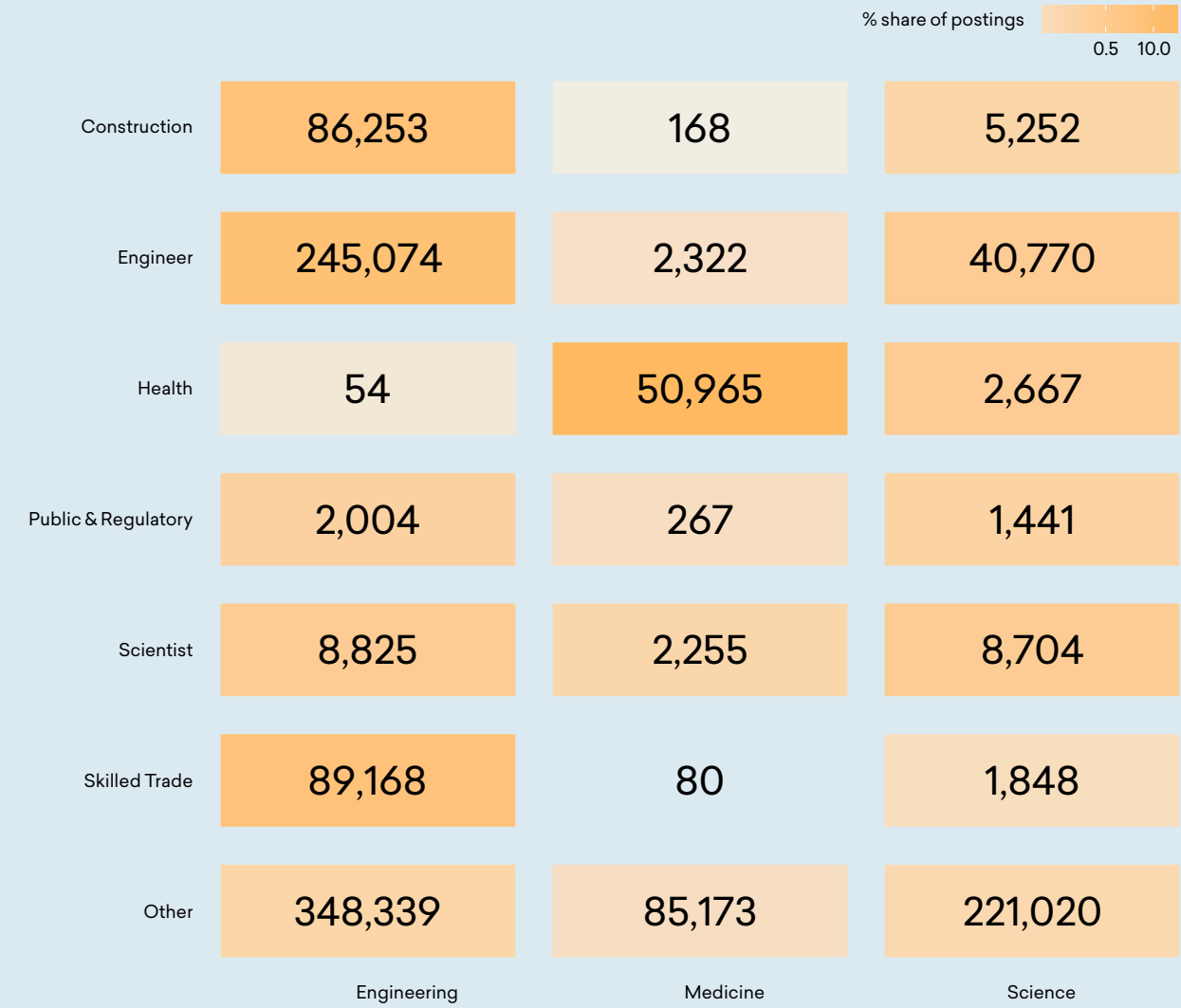
A founding question in bringing skills into the analysis is how demand for skills interacts with our occupational groups. We can see that the relationship is different for each skill group. For skills in Medicine, they are found overwhelmingly in one occupation group: health, where 44 per cent reference one of the skills, but otherwise there is only a small showing for scientists and little other presence.

Science is at the opposite extreme: mention of physics in this context is spread wide across most occupational groups, with skilled trades having the greatest absence. Even among scientist roles, explicit reference to physics as a science is relatively limited – no more than found for digital, engineering, health or teaching.[17] Engineering skills vary in a way which stands between Medicine and Science – noticeably strong in construction, engineering and skilled trade occupation groups, but also present in scientists, public and regulatory roles, and digital roles to an extent as well.

Figure 3.3

Physics science skills small but widespread; applied skills much deeper in related occupations

Skills groups and occupation groups compared, 2016-2021 all unique postings



Data: Emsi Burning Glass Job Postings Analytics

[17] This chiefly reflects salience: many physics science roles will have such an obvious connection to physics that employers won't mention it – online job advert space is scarce, and employers use it to communicate the most important requirements at the margin of the specific labour market. In the same way e.g. few adverts for programmers will ask for basic digital skills.

ADVERTISED SALARIES

Another value of using online job adverts as a source is that job postings often carry advertised salary information. These should be handled with care, as advertised salaries can sometimes vary significantly from what we know about typical salary levels (as established from survey-based sources, seen in the introduction to this report), but they can be useful in understanding the value attached to different skills or groups of skills.

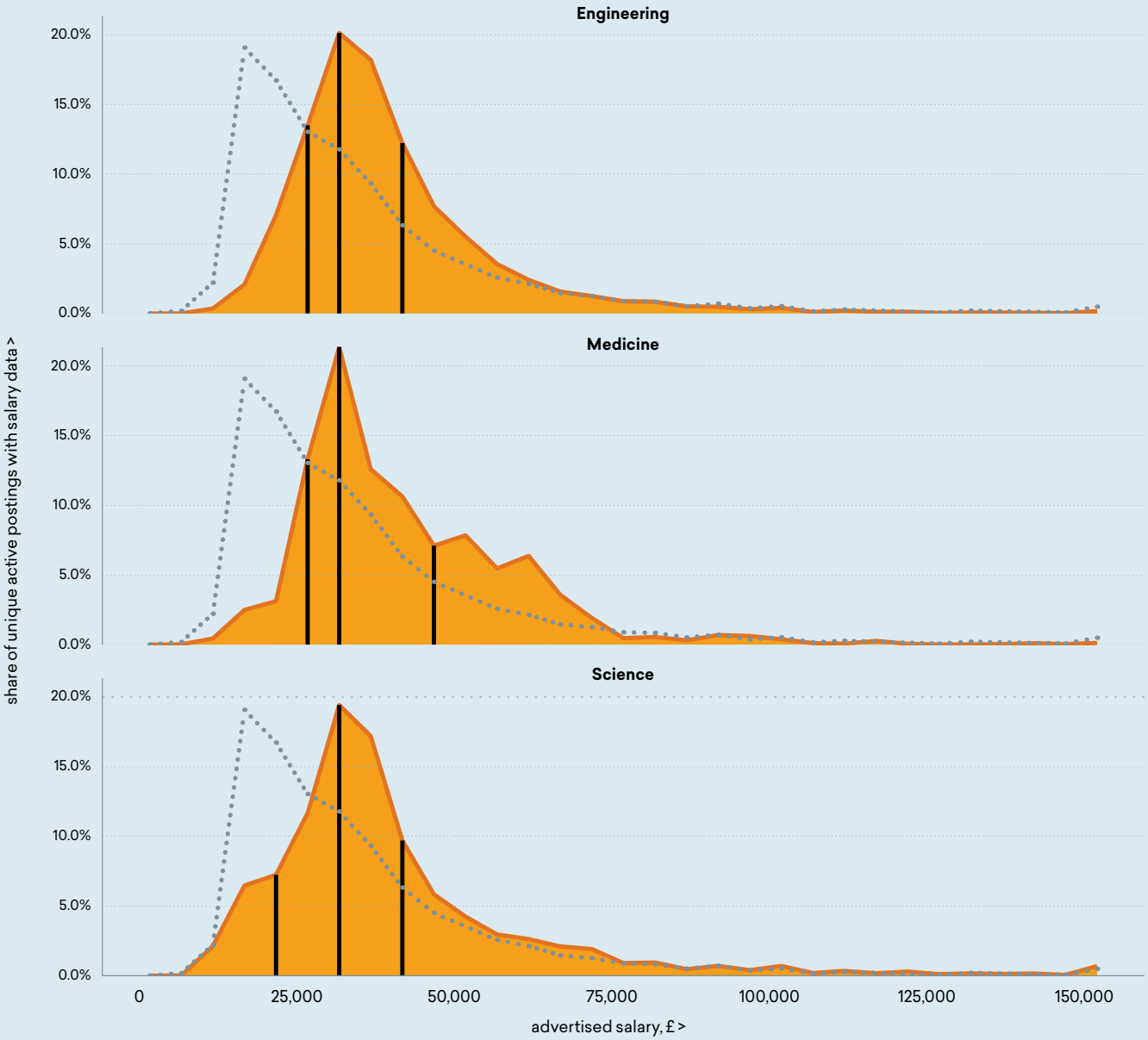
Here we set out the advertised salary distributions for each of the Engineering, Medicine and Science skill groups, compared to the advertised salary distribution across all online job adverts. The vertical lines represent the lower, median and upper quartile thresholds for each distribution.

Median advertised salaries are similar for each of the three groups (around £32,000 in each case), but the real difference is in the range above or below the median. Science skill jobs – reflecting in part the low earnings attaching to laboratory technicians discussed earlier in this report – see the second quartile starting at £22,500; in contrast, for Medicine and Engineering, it starts above £27,000. Similarly, the third quartile of Medicine ends at £48,000, for Engineering at £41,000, but for Science at £36,500.

Figure 3.4

Advertised salaries show all physics-related skills mean higher salaries

Medicine roles have the highest upside, with the top quartile advertised over £48,000



Data: Emsi Burning Glass Job Postings Analytics 2016-2021; dotted line is distribution for all job postings

INVESTIGATING JOB CONTENT

Using the match of occupation groups and skills groups, we can further explore what physics-demanding roles look like in greater depth, using the rich information on job titles and skills available through job posting data. In table 3.2 below, we use analyses of each occupation and skills group to identify the most distinctive – compared to other job postings – titles and skills, in the latter case, focusing on technical skills which are not defined in our physics skills groups (transferable skills are covered separately in BOX D on page 31).

This data provides us reassurance that our new occupation groups, when galvanised by skill groups, do direct us to the roles which we would expect – Teaching leads to Science Teachers and Physics Teachers; Business and Finance to Quantitative Analysts; Digital leads to Systems Engineers and Data Scientists. The distinctive skills are also useful in highlighting that the more general disciplines identified in the Science, Engineering and Medicine skills groups are often paired with much more specific technology and methodology skills: from Quantitative Analysts using the R programming language, to Mechanical Engineers using AutoCAD, to Radiographers using X-Ray Computed Tomography, to Engineer Surveyors using Risk Analysis.

Understanding the mix of job titles and skills in this way can help to provide valuable intelligence on what kinds of work employers are looking for employees to do. But rather than establishing these distinctions from top down, having categorised employers' job adverts according to the occupations and skills they mention, the next step is to look from the bottom up – establishing the emerging pattern of employer demand by looking at how different adverts overlap, as we do in the next chapter.

Table 3.2

Group	Distinctive job titles	Distinctive skills
Business & Finance	Project Managers Researchers Quantitative Analysts Graduate Analysts Research Assistants/Associates	Computer Science Statistics R (Programming Language) MATLAB Project Management
Construction	Structural Engineers Structural Design Engineers Graduate Structural Engineers Civil/Structural Engineers Mechanical Design Engineers	AutoCAD Civil Engineering Computer-Aided Design Engineering Design Process Autodesk Revit
Digital	Software Engineers Data Scientists Software Developers Systems Engineers Graduate Engineers	Computer Science C++ (Programming Language) Software Engineering Python (Programming Language) Software Development
Engineer	Electrical Engineers Mechanical Engineers Mechanical Design Engineers Electrical Design Engineers Design Engineers	AutoCAD Building Services Engineering Computer-Aided Design SolidWorks (CAD) Project Engineering
Health	Radiographers Diagnostic Radiographers Sonographers Interventional Radiographers Mammographers/Radiographers	Magnetic Resonance Imaging Ultrasound Fluoroscopy Mammography X-Ray Computed Tomography
Public & Regulatory	Engineer Surveyors Nuclear Safety Engineers Functional Safety Engineers Health and Safety Advisors	Risk Analysis Environment Health And Safety Nuclear Power Functional Safety Safety Engineering
Scientist	Design Managers Clinical Scientists Laboratory Technicians Mechanical Design Engineers Scientific Technicians	Chemistry AutoCAD Engineering Design Process Biology Computer-Aided Design
Skilled Trade	Electrical Engineers Electrical Maintenance Engineers Multi-Skilled Operators Maintenance Electricians Electricians	Electrical Wiring Building Services Engineering Electrical Systems Programmable Logic Controllers HVAC
Teaching	Science Teachers Physics Teachers Physical Science Teachers Secondary Teachers Secondary Science Teachers	Chemistry Biology Science Education Classroom Management National Curriculum

BOX D: TRANSFERABLE SKILLS

Transferable skills are more general – they apply to workers in many different settings, and are rarely particularly distinctive to a specific group of workers. Understanding them remains valuable, as they are essential in the workplace and complement and strengthen more domain-specific skills, but a different approach is needed for their analysis – here, we take the top 15 most-cited common skills across the different occupational groups and evaluate their prevalence.

Discussions with employers with an interest in hiring physics skills highlights the importance of transferable skills to allow for physics skills to be fully valuable in the workplace. As the data here highlight, there are subtle differences in the transferable skills valued in different industry settings, but also a lot of overlap between them:

- Chris O'Leary at Rolls-Royce finds his main focus is on wider engineering skills, but team collaboration, written and oral communication are all particularly important, a theme echoed by Ralph Cordey at Airbus Defence and Space.
- Paul Dowling, CEO at Mindstream AI, looks for physicists with an entrepreneurial drive – not always common among those coming from the advanced academic background he often recruits from.
- Kim Nilsson, Mentor at Techstars and Chairman at the data science hub Pivigo, places an emphasis on communication skills but also a wider ability to apply the scientific method to solving business problems.
- Nick Grant at Buro Happold sees transferable skills as essential for allowing cross-pollination between teams and effective communications with clients and stakeholders – he is most keen to see the potential to acquire these skills.
- Jed Griffiths at AWE looks for physicists who can work well in a team environment, who apply their academic knowledge with a practical sense, able to evaluate resource decisions and see the bigger picture.

Using the job postings data, we can see that this consensus on matching the technical physics skills with a foundation of transferable skills applies across employers. Demand for Communications is most widespread, but shows significant variation – sought in nearly a third of Business and Finance and Public and Regulatory roles but only 13 per cent of Skilled Trade and 10 per cent of Teaching roles. Research skills are in high demand for Scientists (28 per cent) and in Business and Finance (14 per cent), but much lower elsewhere; Innovation skills are prized for Digital (14 per cent), Science (15 per cent), Teaching (10 per cent) and Business and Finance (8 per cent).

Understanding the mix of transferable skills can be important in balancing the more specific, technical requirements of any role – informing those looking to develop workplaces around physics-demanding roles as well as those seeking a career in them.

Table 3.5

Transferable skills apply across all physics-related groups

Demand density for top 15 transferable skills, across 2016-2021

10% 20% 30%

	Business and Finance	Construction	Digital	Engineer	Health	Public and Regulatory	Scientist	Skilled Trade	Teaching
Basic Maths	4.6%	1.8%	5.8%	5.2%	0.4%	1.4%	3.3%	1.8%	12.8%
Communications	32.8%	21.1%	23.4%	25.1%	17.9%	32.3%	27.3%	12.9%	10.0%
Consulting	4.7%	2.1%	3.5%	1.2%	4.0%	1.4%	2.2%	0.5%	0.1%
Coordinating	4.2%	3.3%	0.9%	2.5%	0.2%	2.6%	3.7%	0.4%	0.2%
Innovation	9.7%	6.3%	13.8%	8.0%	3.5%	5.0%	14.9%	2.0%	10.3%
Integration	3.0%	1.2%	10.5%	2.6%	0.0%	0.9%	1.5%	0.8%	0.1%
Investigation	0.9%	2.7%	0.5%	2.2%	0.7%	15.5%	2.9%	0.3%	0.0%
Mentorship	2.6%	3.3%	4.9%	2.2%	1.7%	3.2%	3.8%	0.7%	1.6%
Operations	8.8%	6.9%	5.0%	8.1%	0.5%	9.4%	5.6%	3.0%	0.1%
Planning	14.2%	10.4%	5.0%	8.9%	1.5%	8.9%	10.1%	2.1%	9.7%
Problem Solving	8.8%	4.5%	10.7%	10.3%	0.7%	3.7%	6.3%	4.2%	0.3%
Reliability	0.1%	0.5%	0.5%	1.4%	0.0%	0.7%	0.2%	0.3%	0.1%
Research	13.4%	1.4%	4.8%	3.5%	2.9%	2.4%	27.2%	0.5%	0.6%
Self-motivation	6.9%	5.0%	4.7%	7.0%	8.7%	6.3%	6.5%	3.9%	5.1%
Troubleshooting	0.9%	0.7%	4.7%	2.9%	0.1%	0.2%	2.2%	4.3%	0.0%

Data: Emsi Burning Glass Job Posting Analytics

PHYSICS AT WORK

- **We can use employers' demands across online job adverts to identify the patterns of key emergent roles by looking at the interactions between skills demands.**
- **10 Skills Clusters are profiled, each of them reflecting a different combination of skills, and each being pursued by different families of employers and framed in terms of typical job titles and salary levels.**
- **The importance of non-traditional physics comes through strongly, with many of the emergent roles being in software, data science or financial settings.**

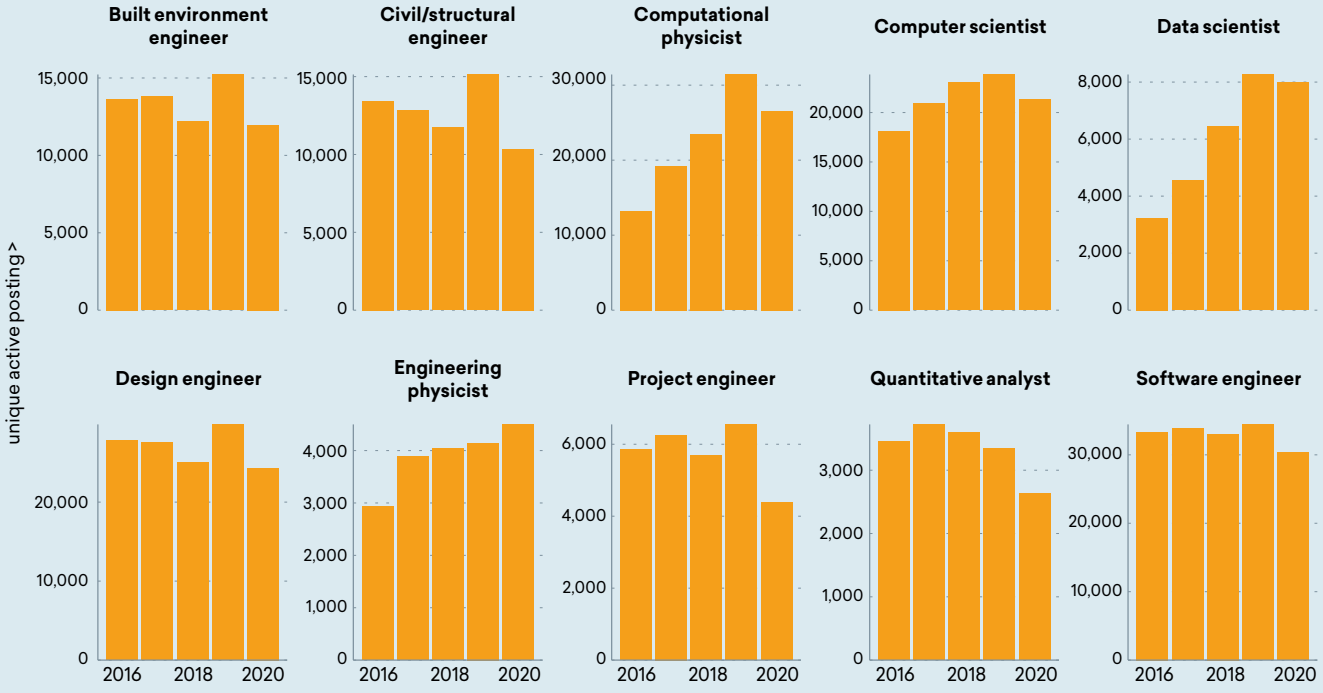
Understanding the size, trend and change in the labour market for physics is valuable, but understanding the content of demand can shape actions for employers, government, and education and training providers. While in the previous chapter we were able to understand how different occupation groups make use of physics skills, in this chapter we develop Skills Clusters, which can tell us about how physics skills are being used in the labour market, in concert with other skills and knowledge. As the testimony from employers in the last chapter shows, many of the most pressing demands for physics skills call on other skills alongside them – transferable skills but also various technical skills to be used in combination with physics.

As a part of the investigation for the report, Emsi Burning Glass worked with the IOP to define and refine ten Skills Clusters (see BOX E on page 33 for how this was approached), and in this chapter we explore each of the ten clusters to illustrate the emergent concentrations of skills demand around distinct professional roles.[19] While the same process was used to explore a series of Medical skills clusters, the results were not found to define sufficiently distinct and coherent roles and have not been included.

Figure 4.1

Strong growth in computing roles

Skills cluster membership by year, 2016-2020



Data: Emsi Burning Glass Job Postings Analytics

[19] It is a feature of online job adverts data that they are more prevalent for managerial and professional jobs, and that they contain richer skill and knowledge content for managerial and professional jobs, and so the Skills Cluster process works much better in shedding light on emerging patterns of skills demand at these levels than it does for middle- and lower-skilled jobs.

BOX E: SKILLS CLUSTERS

Analysis of online job adverts provides an unrivalled granularity in quantifying employer demands. Emsi Burning Glass's Skills Library has more than 30,000 individual items – specific words and phrases which have been identified as referring to knowledge and skills that employers seek out. This granularity is very useful, but it makes it harder to make sense of the commonalities between job postings – employers using slightly different knowledge and skill references can seem further apart.

To address this, we want to be able to spot where employers' demands relate to each other, and to spot emerging patterns: rather than using top-down categorisations such as the ONS SOC classification for occupations, we want to be able to identify, from the bottom up, the way that skills 'cluster' together.

Skills clusters are formed by taking a body of job adverts – in this case, over 1 million job postings referring to physics skills, separated by broad occupational groups – and running them through a large factor analysis process to identify the leading groups of skills which explain the largest parts of the variance between adverts. We have then selected which of these groups seem to offer the most potential as coherent stories about skills, which we have then curated in collaboration with the IOP, and given a title according to most prominent occupation associated with the cluster of skills.

Once that process was completed, we scored all job postings against the curated clusters to identify those with a significant presence in each cluster, and used these sets of postings to identify the trends in demand for each cluster.

BUILT ENVIRONMENT ENGINEER

This is a role driven by the connection between Building Services Engineering, Physics and the management skills around Planning, Cost Management, Governance. Heavy on Engineering skills, demands range from Schematic Diagrams to Engineering Design Process, Building Information Modelling and Prototyping. Management and Engineering skills are highly popular among job adverts seeking to recruit for this category.

Demand for the cluster tends to be a mix between professional and middle skill roles – 20 per cent of postings identified in the associate professional and technical SOC major group, and 17 per cent skilled trade. As the list of job titles suggest, titles are primarily Engineering based. Leading advertising employers are AECOM, W S Atkins, Arup, Interserve, and Mott MacDonald.

75,868
Total posting

£35,000
Median Advertised Salary
18.8% above £50K advertised

30 days
Median posting duration
32.4% above 40 days

Most popular skills

- Building Services Engineering
- Planning
- Management
- Construction
- Communications
- Physics
- Engineering Design Process
- Electrical Engineering
- Mechanical Engineering
- Innovation

Most popular titles

- Mechanical Design Engineers
- Electrical Design Engineers
- Building Service Engineers
- Building Services Managers
- Electrical Engineers
- Mechanical Engineers
- Quantity Surveyors
- Science Teachers
- Project Managers
- Mechanical Project Managers

BOX E: SKILLS CLUSTERS (cont)

CIVIL/STRUCTURAL ENGINEER

This is a role driven by the connection between Building Services Engineering, Structural Engineering and Mechanical Engineer, with an emphasis on building infrastructure – ranging across Pumps, Boilers, Fire Alarm System, Masonry, and Hydraulics. The most popular skills are again Building Services Engineering and Mechanical Engineering, along with the technologies: HVAC, Boiler, Pumps, Plumbing.

Demand for the cluster is especially middle-skilled, with 40 per cent of postings in the skilled trade category. Leading advertising employers are AECOM, W S Atkins, Interserve, and Mott MacDonald.

71,302
Total posting

£35,000
Median Advertised Salary
11.8% above £50K advertised

31 days
Median posting duration
32.9% above 40 days

Most popular skills
- Building Services Engineering
- Mechanical Engineering
- HVAC
- Management
- Communications
- Boilers
- Pumps
- Construction
- Facility Management
- Plumbing

Most popular titles
- Mechanical Engineers
- Mechanical Design Engineers
- Building Service Engineers
- Gas Engineers
- Multi-Skilled Operators
- Electrical Maintenance Engineers
- Electrical Engineers
- Quantity Surveyors
- Building Services Managers
- Mechanical Project Managers

COMPUTATIONAL PHYSICIST

This is a role driven by the application of analytical technology to the physical science domain. Programming languages with data science capabilities lead the cluster: Python, R, MATLAB, followed by the science and engineering domains on which the role touches: Electronics, Physics, Materials Science, Statistics, Biology, Radiology, Spectroscopy, Optics, Biochemistry. The tools and applications are the most popular skills: the languages, database technology, and research and Machine Learning.

Demand for the cluster is overwhelmingly concentrated in high skill professional and technical occupations – 95 per cent of postings – but with a significant number at the associate professional and technical level (20 per cent). Leading advertising employers are Deloitte, Amazon, Facebook, AstraZeneca, EY and Barclays.

132,713
Total posting

£45,000
Median Advertised Salary
37.6% above £50K advertised

30 days
Median posting duration
34.0% above 40 days

Most popular skills
- Python (Programming Language)
- R (Programming Language)
- SQL (Programming Language)
- Communications
- Basic Maths
- Data Science
- Machine Learning
- Data Analysis
- MATLAB
- Research

Most popular titles
- Data Scientists
- Data Analysts
- Managers/Data Scientists
- Data Engineers
- Lead Data Scientists
- Machine Learning Engineers
- Software Engineers
- Machine Learning Data Scientists
- Quantitative Analysts
- Analytics Managers

BOX E: SKILLS CLUSTERS (cont)

COMPUTER SCIENTIST

This is a role driven by the combination of science knowledge with the application of techniques in other domains. Physics and Electronics lead, with Materials Science and Spectroscopy also featuring. But also in the mix are technologies – C++, Java, Wolfram – as well as a lot of domain-specific skills in the financial world: Derivatives, Equities, Investment Banking, Financial Market, Asset Classes, Hedging. Despite their presence within the cluster, they represent a relatively small core of its membership, which tends to be driven much more by the application of science to technology problems.

Typically advertised in professional and high-skilled settings, the role has a high level of high duration postings – 34 per cent. Leading advertising employers are Leonardo, Goldman Sachs, Morgan Stanley, BAE Systems and J P Morgan Chase.

119,401
Total posting

£30,000
Median Advertised Salary
14.8% above £50K advertised

31 days
Median posting duration
34.0% above 40 days

Most popular skills
- Physics
- Basic Maths
- Chemistry
- Biology
- Communications
- Computer Science
- C++ (Programming Language)
- Research
- Teaching
- Python (Programming Language)

Most popular titles
- Software Engineers
- Graduate Engineers
- Software Developers
- Data Scientists
- Scientific Technicians
- Secondary Science Teachers
- Electronics Engineers
- Graduate Teaching Assistants
- Research Fellows

DATA SCIENTIST

This is a role driven by using computing technology to solve data problems, with a significant role for Physics. Its leading skills are Machine Learning, Software Engineering, Software Development, Statistics, as well as Big Data and Natural Language Processing. Python, Java and Agile Methodology are highly popular among vacancies in the cluster.

One of the smaller clusters, it is overwhelmingly high skill – 93 per cent of postings are in professional occupations – and highly paid, with over 40 per cent of postings with salaries advertised above £50,000, and has a relatively high level of high duration postings (more than a third). Leading advertising employers are Amazon, Oracle, Goldman Sachs, Softbank, J P Morgan Chase, Apple, Facebook, Alphabet and Ocado.

35,996
Total posting

£47,000
Median Advertised Salary
40.5% above £50K advertised

30 days
Median posting duration
33.6% above 40 days

Most popular skills
- Machine Learning
- Software Engineering
- Python (Programming Language)
- Computer Science
- Software Development
- Java (Programming Language)
- Basic Maths
- Big Data
- Agile Methodology
- Communications

Most popular titles
- Software Engineers
- Data Scientists
- Machine Learning Engineers
- Python Software Engineers
- Managers/Data Scientists
- Machine Learning Software Engineers
- Data Engineers
- Software Development Engineers
- Software Developers
- Graduate Engineers

BOX E: SKILLS CLUSTERS (cont)

DESIGN ENGINEER

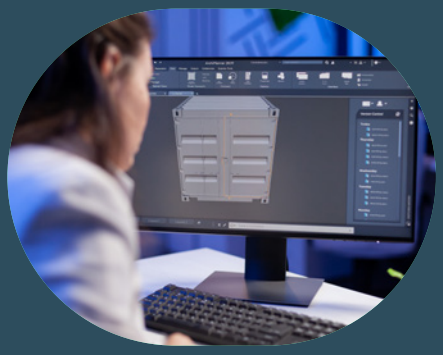
This is a role driven by engineering – Electrical Engineering, Mechanical Engineering, Systems Engineer – and its application in systems. For that reason, Control Systems, Programmable Logic Controllers, Enterprise Architecture, Control Engineering all feature highly as well as Problem Solving and Planning.

The cluster is among the larger skills clusters and compared to the other skills clusters, is relatively middle skill in profile – 36 per cent of posting classified as skilled trades roles, with a range of titles reflecting that. The role also sees a relatively high share of high duration postings. Leading advertising employers are W S Atkins, AECOM, Siemens, Mott Macdonald, Scottish and Southern Electricity, Thames Water, and Babcock International.

152,264
Total posting

£34,000
Median Advertised Salary
12.2% above £50K advertised

31 days
Median posting duration
34.1% above 40 days



Most popular skills
- Electrical Engineering
- Communications
- Mechanical Engineering
- Management
- Planning
- Programmable Logic Controllers
- Commissioning
- AutoCAD
- Control Systems
- Problem Solving

Most popular titles
- Electrical Engineers
- Electrical Design Engineers
- Multi-Skilled Operators
- Maintenance Engineers
- Electrical Maintenance Engineers
- Field Service Engineers
- Project Engineers
- Service Engineers
- Mechanical Engineers
- Commissioning Engineers

ENGINEERING PHYSICIST

This is a role driven by the intersection of Physics, Engineering and Technology. Physics leads, with Electrical Engineering, Mechanical Engineering and Optics following; Materials Science, Electronic Engineering, Photonics, Astronomy and Chemistry feature later. Along the way, the cluster also involves tools such as MATLAB, Python, Applied Mathematics, Simulations and Artificial Intelligence. Physics, Maths, Research and Communications lead among the most popular skills.

Relatively small compared to the other skills clusters, it has a high level of high duration postings, and is highly skilled in nature. Leading advertising employers are W S Atkins, National Grid, Raytheon, Boeing, Corning, BAE Systems, Thorlabs and MBDA.

22,114
Total posting

£32,000
Median Advertised Salary
16.0% above £50K advertised

31 days
Median posting duration
36.0% above 40 days

Most popular skills
- Physics
- Basic Maths
- Research
- Communications
- MATLAB
- Mechanical Engineering
- Electrical Engineering
- Computer Science
- Python (Programming Language)
- Machine Learning

Most popular titles
- Data Scientists
- Graduate Engineers
- Systems Engineers
- Research Fellows
- Software Engineers
- Electronics Engineers
- Algorithm Engineers
- Research Associates
- Optical Engineers
- Modelling and Simulation Engineers

BOX E: SKILLS CLUSTERS (cont)

PROJECT ENGINEER

This is a role driven by Engineering and Design, with AutoCAD, Computer-Aided Design, Engineering Design Process, Autodesk Revit, 3D Modelling, Solidworks and Product Design all featuring. The design technologies and the Engineering Design Process are all highly popular among postings within this cluster.

Compared to the other skills clusters, this cluster is relatively more middle skill – even among high skill postings, 28 per cent are in the associate professional and technical SOC category, and then 22 per cent in skilled trades. The cluster has a high level of high duration postings. Leading advertising employers are W S Atkins, AECOM, Arup, Mott Macdonald, Jacobs, Corning and Thales.

32,114
Total posting

£33,000
Median Advertised Salary
10.9.% above £50K advertised

31 days
Median posting duration
36.6% above 40 days

Most popular skills
- Mechanical Engineering
- AutoCAD
- Computer-Aided Design
- Communications
- SolidWorks (CAD)
- Engineering Design Process
- Electronic Engineering
- 3D Modelling
- Management
- Planning

Most popular titles
- Mechanical Design Engineers
- Mechanical Engineers
- Design Engineers
- Building Service Engineers
- Electrical Design Engineers
- Graduate Mechanical Engineers
- Project Engineers
- Electrical Engineers
- Electronics Engineers
- Graduate Engineers

QUANTITATIVE ANALYST

This is a role driven by the application of analytical skills to financial problems. On the analytical side, technology skills such as C++, MATLAB, VBA, Java, R, Python as well as Probability, Numerical Analysis, and more. On the financial side, Derivatives, Credit Risk, Equities, Investment Banking, Stress Testing are all central to it – and also popular among relevant postings.

The cluster is overwhelmingly high skill – 98 per cent of postings – but with a significant number of postings at the associate professional and technical level (17 per cent). It is highly paid, with more than half of postings citing a salary in excess of £50,000. Leading employers are Goldman Sachs, J P Morgan Chase, Morgan Stanley, Citigroup, Bloomberg, UBS, EY, Barclays, PwC, and Deutsche Bank.

18,464
Total posting

£55,000
Median Advertised Salary
53.0% above £50K advertised

30 days
Median posting duration
32.9% above 40 days

Most popular skills
- C++ (Programming Language)
- Python (Programming Language)
- Java (Programming Language)
- MATLAB
- Basic Maths
- Communications
- Derivatives
- R (Programming Language)
- C# (Programming Language)
- SQL (Programming Language)

Most popular titles
- Quantitative Analysts
- Quantitative Developers
- Data Scientists
- Quantitative Risk Analysts
- Software Engineers
- Model Validation Analysts
- C++ Developers
- Quantitative Researchers
- Quantitative Model Validation Analysts
- Lead Python Developers

BOX E: SKILLS CLUSTERS (cont)

SOFTWARE ENGINEER

This is a role driven by the production of software, with high expectations of Computer Science and Electrical Engineering, but also heavy emphasis around technology: C++, Java, HTML, CSS, JavaScript, Object-Oriented Programming, Scala. Technologies drive the cluster in terms of popular skills, and also in determining job titles.

The cluster is overwhelmingly high skill – 89 per cent of postings are in professional categories. Relatively highly paid, it also has somewhat high levels of high duration postings. Leading advertising employers are Softbank, Amazon, Goldman Sachs, J P Morgan Chase, Facebook, Alphabet, Thomson Reuters, and Apple.

183,900
Total posting

£40,000
Median Advertised Salary
32.9.% above £50K advertised

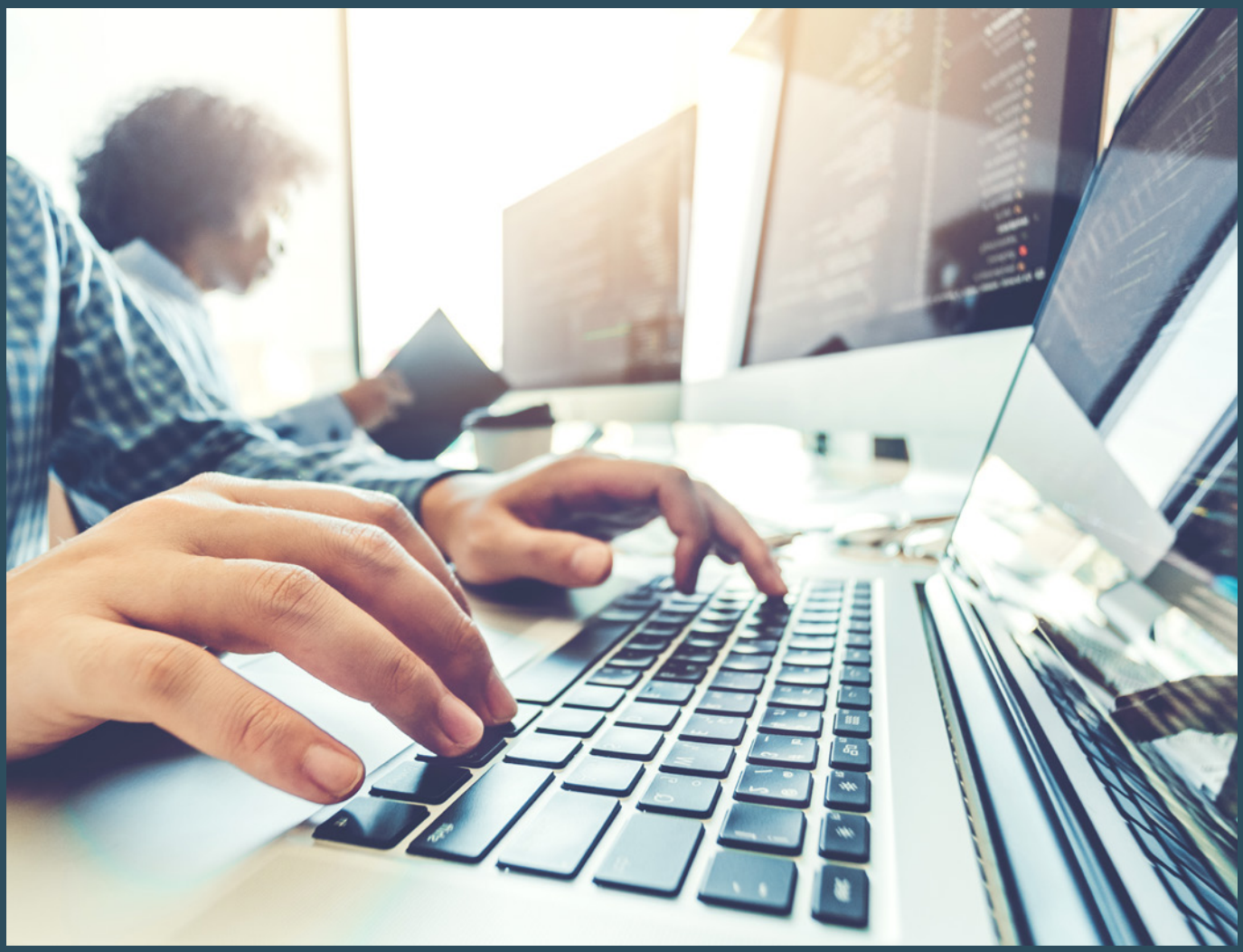
30 days
Median posting duration
33.5% above 40 days

Most popular skills

- Java (Programming Language)
- C++ (Programming Language)
- Computer Science
- Python (Programming Language)
- Software Engineering
- Communications
- C# (Programming Language)
- C (Programming Language)
- Software Development
- Agile Methodology

Most popular titles

- Software Engineers
- Software Developers
- Java Developers
- Embedded Software Engineers
- Java Engineers
- Graduate Engineers
- C++ Software Developers
- C++ Software Engineers
- C++ Developers
- Data Scientists



PHYSICS IN DEMAND

- **Recruitment demand for physics skills is growing faster than demand for the surrounding occupations – especially in Medical skills (perhaps driven by Covid) and Science skills.**
- **Job postings which are left online for longer are indicative of difficulties in finding the right talent – and these are especially associated with Science and Engineering skills.**
- **In June 2021, over 8,500 job ads were left online for significantly longer than average, with the largest number being Engineering roles, but significant numbers found too seeking Science skills in Digital or Business and Finance.**

Physics skills are needed in the labour market, both in physics-demanding roles and elsewhere. But many other skills are also needed: so the next question is whether physics skills demands are particularly acute, and are employers able to find the talent necessary to meet those demands? To find out, we need to look at the role of physics skills in driving growth for physics-demanding and related occupations, and to assess the impact of physics skills on how long employers have to wait to meet their needs.

Certainly many of the physics-demanding roles we have already explored are reported as being hard to recruit. Discussions with employers for this report generally reinforced that: especially for more senior, experienced positions – in advanced manufacturing, Rolls-Royce and Airbus Defence and Space both report difficulties recruiting for senior positions, and similarly Endomag found a much better response to more recent graduate recruitment. In civil engineering too, Buro Happold report a shortage of senior infrastructure engineers but no shortage of graduate candidates. In the South Wales compound semiconductor cluster, Chris Meadows at CSconnected reports ongoing work to improve the talent pool – planned and expected growth within the cluster could potentially exhaust the local supply of physics candidates and the region is investing in education and outreach programmes to widen potential recruitment..

At the more scientific end of the physics labour market, AWE have significant difficulties in recruiting for specialist fields such as optical physics. But looking further afield, in many cases physics is used as a recruitment strategy to deal with wide scarcities – there are significant demands for advanced scientific skills in data science and data engineering roles, but too few candidates. According to Laura Probert, previously Chief People Officer at a leading online gaming company, data science vacancies are hard to fill at all levels, and market rates are rising quickly with intense competition. Dr Carol Marsh MBE, Deputy Head of Electronics Engineering at Leonardo in Edinburgh, reports acute difficulty in finding candidates above graduate level - with recruitment becoming harder since Brexit, there is also substantial competition for candidates from venture capital-backed start-up firms offering higher salaries.

Skills shortage is not a universal experience, however. In civil engineering, Steve Morriss, President for Asia-Pacific and the Middle East at SNC Lavalin, reports that worldwide physics skills are generally available although there can be local constraints. Meanwhile for Christopher Dorman of Coherent, there is not generally a shortage of physics skills in the Scottish labour market, and the challenge is less about recruitment than the need to develop new recruits' engineering skills.

WHERE PHYSICS SKILLS DEMANDS ARE GROWING

We return here to using the interaction of physics-demanding and related occupation groups and the three physics skills groups, looking at the growth in relative demand in the most recent two years' worth of job postings to the period three years before.[20] For each occupation group, we measure the change in overall job postings (the vertical lines) and then the change for job postings with each of the three skills groups.[21]

The largest swings in demand are all related to Medical skills: for Scientist, Health, Business and Finance, Public and Regulatory and Digital occupational groups; this is doubtless driven by the support for higher levels of demand during the pandemic, especially in 2020. Perhaps more interesting is that Science skills have also shown faster growth – in Business and Finance, Construction, Public and Regulatory, Engineer, Health and Scientist occupation groups. The addition of Science physics skills in these settings seems to be becoming more popular, suggesting an increasing presence in labour market demand.

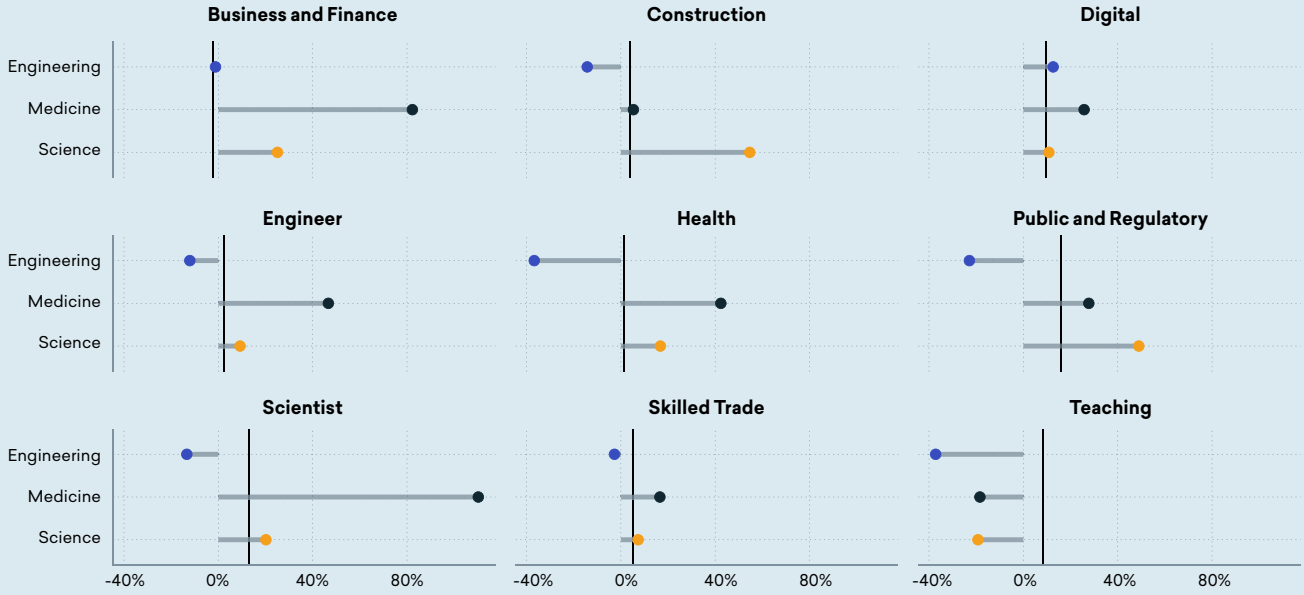
[20] Specifically, we look at Aug 2016-Jul 2018 and Aug 2019-Jul 2021. Because of the Covid-19-driven dip in the middle of this latter period, we measure the growth in the share of total postings rather than the volume.

[21] Missing items had fewer than 100 job postings in either period.

Figure 5.1

Physics science skills growth in demand in business, construction regulation

Strong growth in medical requirements – may reflect better performance during pandemic



Data: Emsi Burning Glass Job Postings Analytics

percentage growth in share of recruitment, 16-18 to 19-21 >
vertical lines are growth for all postings in the occupation group

Analysis of growth by volume is distorted since 2020 by the consequences of the Covid-19 pandemic. But analysis of growth by volume between 2016 and 2019 is instructive: across all occupation and skills combinations, 21 per cent growth (slightly slower than overall recruitment growth of 25 per cent). The largest growth by volume was predictably in Engineering roles for Engineering skills and Teaching roles for Science skills, but also there were Digital roles with Science skills (moving from 7,261 postings to 10,554 postings, 45 per cent) and Business and Finance with Science skills (7,463 postings to 10,145 postings, 36 per cent).

MEASURING SKILLS SHORTAGE BY POSTING DURATION

Typically, measurement of skills shortage is confined to large-scale survey work, which can make it difficult to evaluate highly specific skill areas.[22] In this report, we use online job adverts to identify where employers are finding it hard to fill vacancies. In Emsi Burning Glass job posting data, we measure the date each job advert was first seen online, and the date it was last online; the gap between the two points is the posting duration.

The majority of postings are online for around one month. The top quartile of posting durations starts around the 40-day mark; at this point employers are consciously leaving postings open for longer.[23] For this reason, we use the share of postings with duration over 40 days as an indicator of skills shortage.[24] Again, as well as measuring at the occupation group level (vertical lines), we measure with the addition of each skill group.

[22] The authoritative survey source is the Employer Skills Survey, but it is only produced biennially, and published sometime after. The latest release is Mark Winterbotham et al (2020). Employer Skills Survey 2019. Research Report. Department for Education.

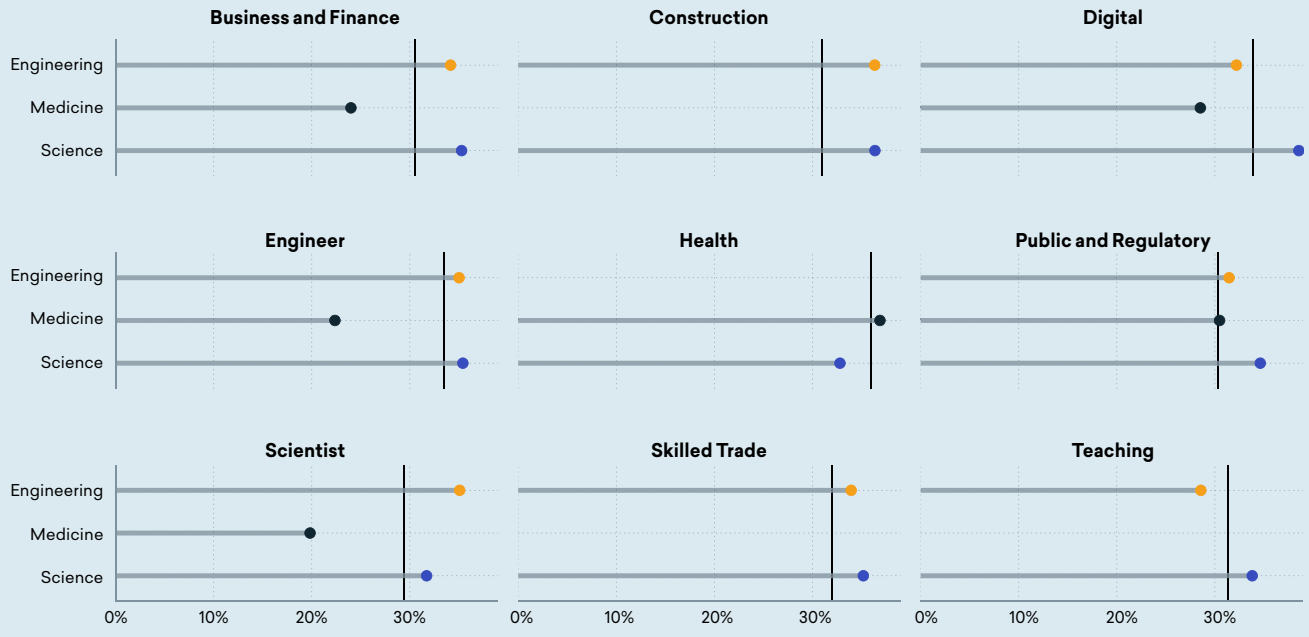
[23] Postings with durations longer than 90 days are excluded as they can reflect other strategies, such as standing job adverts. The top quartiles for each of the nine occupation groups here started between 38 and 42 days, so the 40-day benchmark was used as a common standard.

[24] It is an indicator, not a metric; employers may have other reasons for moving slowly on advertising besides skills shortage.

Figure 5.2

High duration postings suggest difficulties in finding science and engineering skills

High duration postings as share of all postings 2019-2021



Data: Emsi Burning Glass Job Postings Analytics

percentage of postings with high duration online > vertical lines are growth for all postings in the occupation group

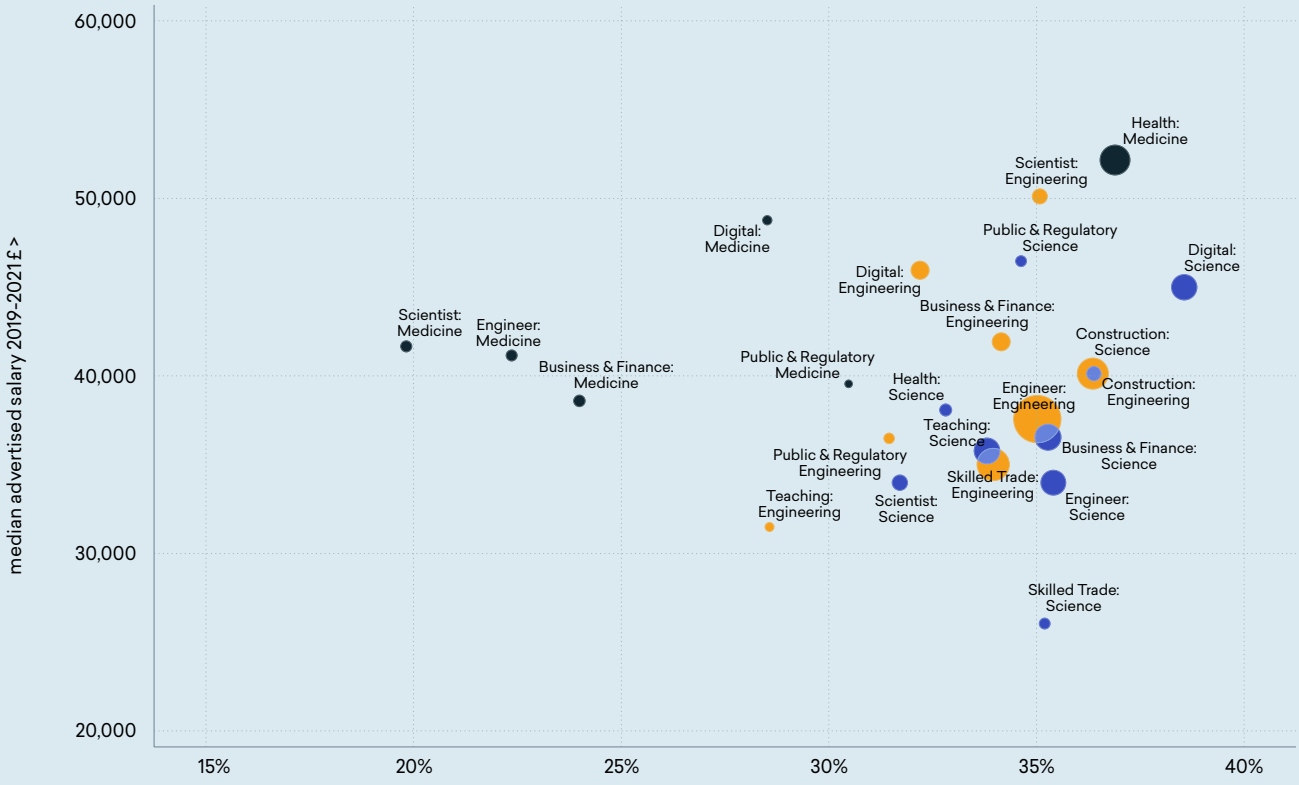
We see that the addition of Science and Engineering skills associates with greater prevalence of high-duration postings in Business and Finance, Construction, Engineer, Scientist and Skilled Trades roles. Teaching, Digital and Public and Regulatory roles also have greater prevalence of high-duration postings with the addition of Science skills. Despite their recent growth in importance, Health skills do not seem to have this effect; there is only a marginal increase even for Health vacancies, where Medicine skills needs are heavily concentrated.

Pay can be another indicator – although sometimes trailing – of skills shortage. Using the prevalence of high duration postings as the skills shortage metric, we can see that some but not all are in the highly-paid category: Medicine skills in Health occupations, Engineering skills for Scientists, and Science skills for Digital all fit this category – but the greater number of high duration postings are much more middling in pay terms compared to the range of physics-demanding job adverts. As noted, pay can be a trailing indicator and if difficulties in finding necessary talent persist, then that will lead to pressure to increase advertised salary offers; comparing 2019-2021 advertised salaries with those for 2016-2018 shows that for example Science physics skills in Construction have seen median advertised salaries increase by 20 per cent; Science physics skills in Health roles by 15 per cent, and Science physics skills in Digital by 12 per cent, compared to 5 per cent across all job postings.

Figure 5.3

High salaries tied to high demand in digital, health, science roles – but not always

Median advertised salary and high duration density, 2019-2021 (size indicates volume)



Data: Emsi Burning Glass Job Postings Analytics

MEASURING THE LEVEL OF HIGH DURATION POSTINGS

In June 2021, there were 8,542 unique active postings with high duration spread across our nine occupation groups and three skills groups; in practice, these postings have a median duration of over 50 days, suggesting that employers hold out their adverts for nearly 3 weeks longer than typical postings. Reflecting their large number, more than half of these were seeking Engineering physics skills, and most of those were to be used in Engineering and Construction roles.

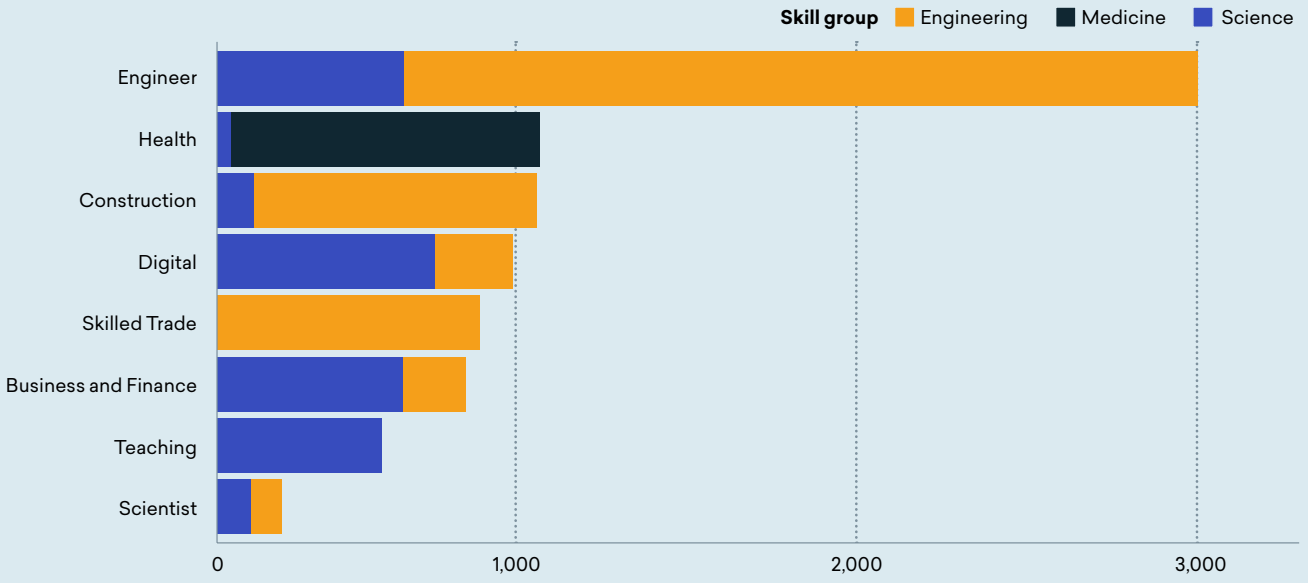
But that is far from the whole story. 2,831 of these high duration postings were looking for Science physics skills – and most of these were not for Scientist roles. In fact, the largest categories of high duration postings seeking Science skills were for Digital (717 postings), Engineer (641 postings) and Business and Finance (614 postings) roles, which shows the increasing demand, hard to meet, for physics skills outside of the scientific space, and often in high-value, high-skill demand fields. The timeseries chart suggests the level of high duration postings has been relatively stable over time, aside from a reduction during the fall in labour market demand early in the Covid-19 pandemic. Science and Medicine skills have risen faster in high duration posting volumes during the recovery since that time, with Medicine up 50 per cent and Science up 10 per cent compared to February 2020, and Engineering down 24 per cent.

Employers are taking steps to tackle the weaknesses of skills supply. Many of the employers we spoke to invest in apprenticeships and PhD places to develop the future workforce – for AWE this is especially important because its role constrains recruitment to UK nationals, and as some of the specialist university courses it has in the past relied on for new recruitment have disappeared, it has had to take steps to ensure supply. At the highest skill levels, Paul Dowling of Mindstream AI finds that relatively few academics are willing and sufficiently entrepreneurial to make the move to industry – collaborations with academic institutions help, but Mindstream also host summer camps and accelerators to create opportunities. Many employers in more traditional physics-demanding settings – advanced manufacturing, civil engineering – report there is increasing competition from financial and professional services employers for the available physics workforce.

Figure 5.4

Physics skills in related roles drive over 8,800 high duration job postings

One recent month's data – June 2021 – shows the key role played by all three skill groups in making roles hard to fill



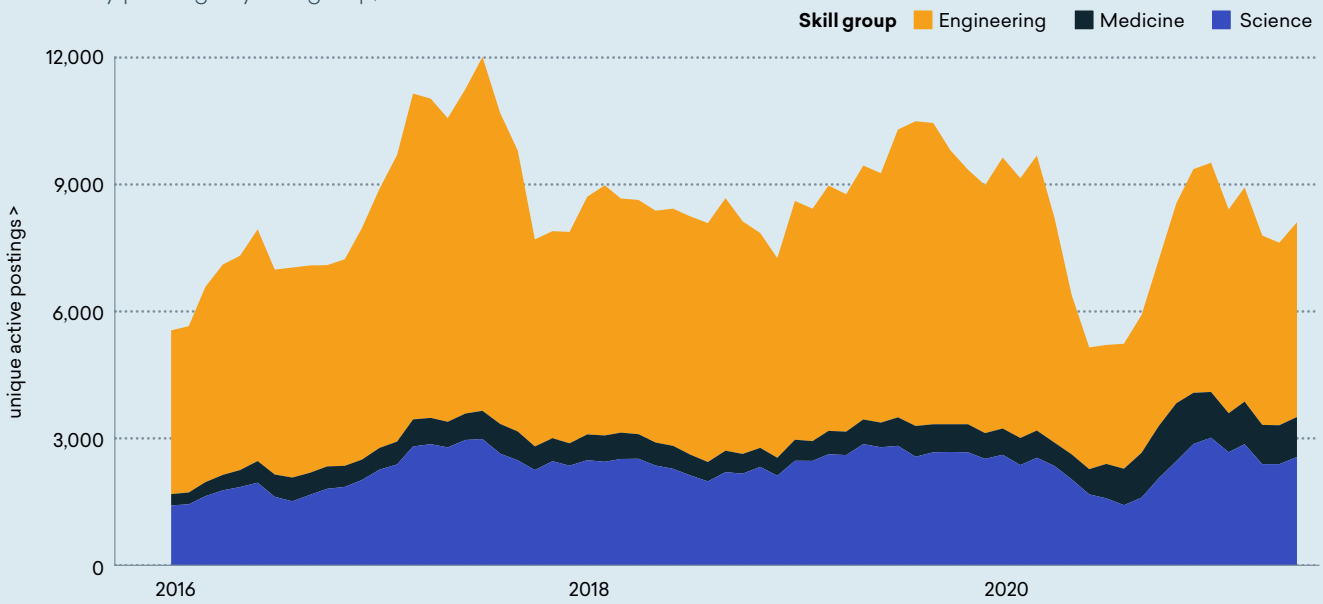
Data: Emsi Burning Glass Job Postings Analytics

unique active postings with high duration >

Figure 5.5

COVID took off the pressure, but high duration postings close to pre-pandemic levels

> 40-day postings by skill group, 2016-2021



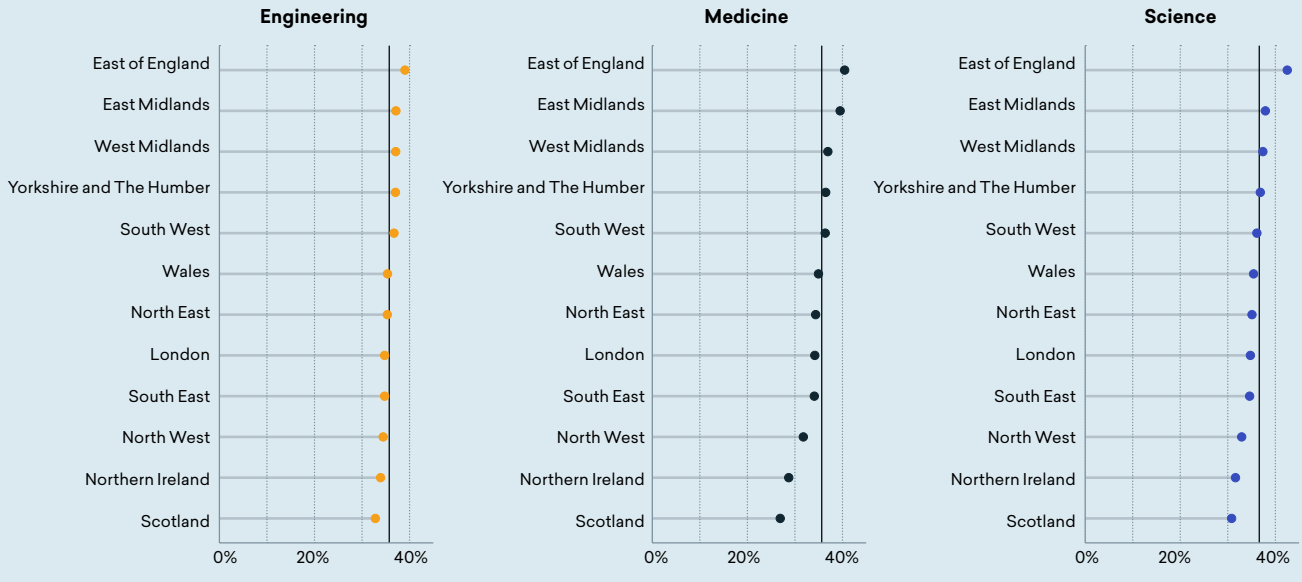
Data: Emsi Burning Glass Job Postings Analytics

We can use the same indicators to explore how the recruitment experience varies by region and country (see Figure 5.6). Here we look at all postings across the occupation groups with one of the three skill groups, comparing them to the UK and Ireland-wide benchmark for the share of postings over 40 days' duration. The common thread is that the East of England has the highest shares of high duration postings in all skills groups, rising to 42 per cent of postings seeking Science skills. Scotland meanwhile has consistently the lowest share of high duration postings – other places are more varied; for example, the East Midlands scores second-highest for Engineering skill demands, and Wales for Medicine skill demands, and London for Science skill demands, but on other skills these places are placed much lower.

Figure 5.6

East of England leads on high duration job postings across Engineering, Medicine and Science skills

Skills shortage indicators by region and country, 2019-2021



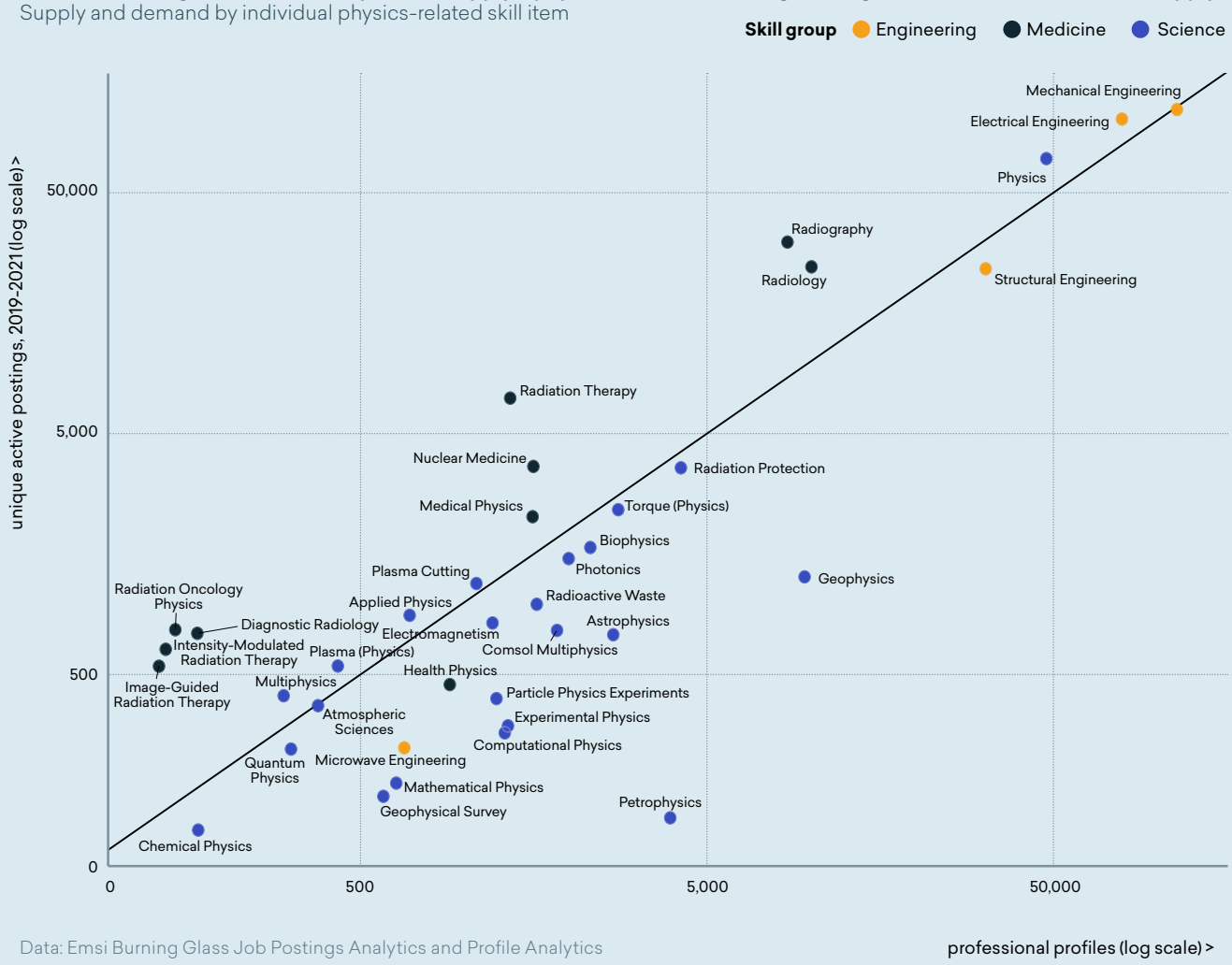
Data: Emsi Burning Glass Job Postings Analytics

SKILLS-SPECIFIC SUPPLY AND DEMAND

We can also look at the specific skills in our skills groups, and compare the level of supply and demand, by combining the volumes sought in job postings with the volumes of professionals claiming each skill in Profile Analytics, a database of over 14 million individual worker profiles (see Appendix for more detail). We can see a range of skills which have greater levels of demand than supply – including Physics itself, but also Electrical Engineering and a range of skills in the Medicine group.

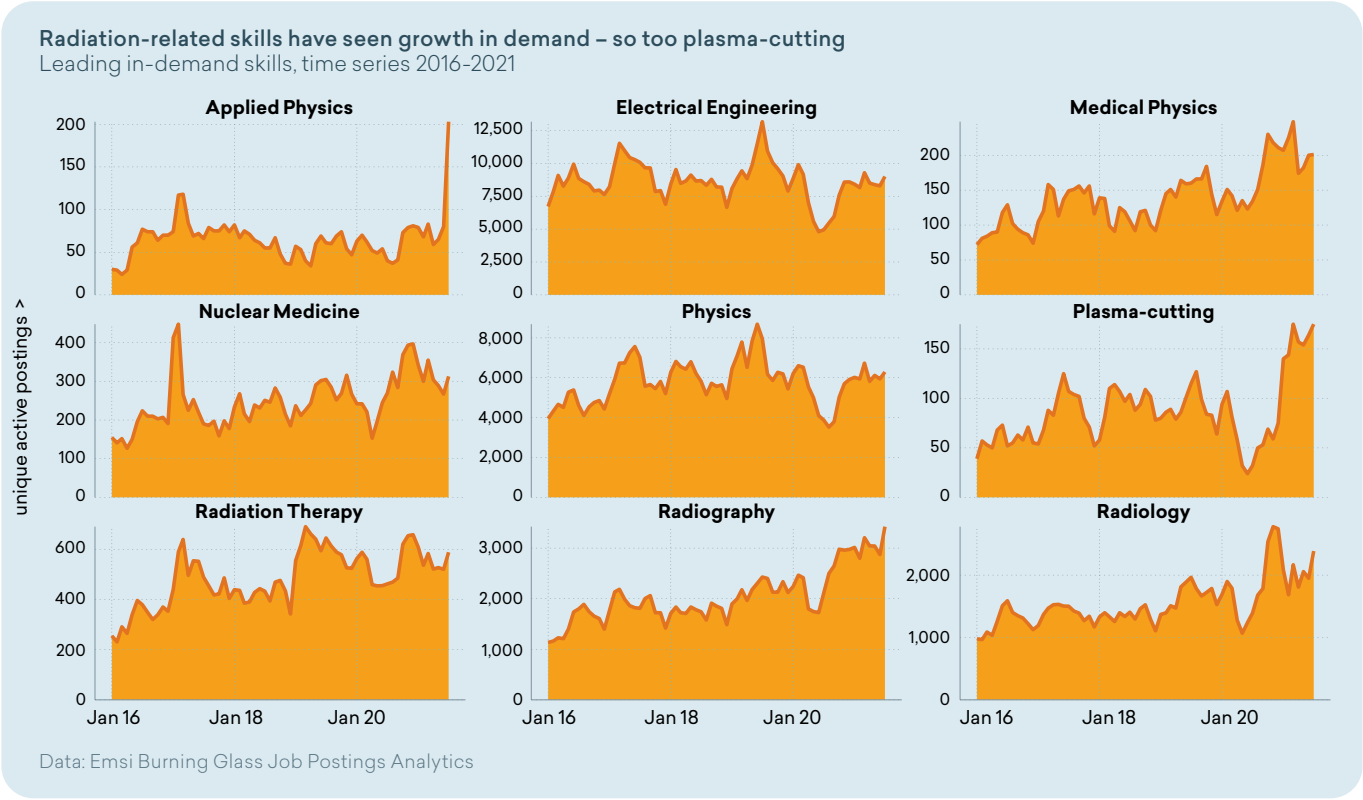
Figure 5.7

Medical skills high in demand compared to supply – physics and electrical engineering also see more demand than supply
Supply and demand by individual physics-related skill item



Data: Emsi Burning Glass Job Postings Analytics and Profile Analytics

Figure 5.8



Taking a selection of 10 skills with a gap of demand over supply, we can see that Medicine skills have generally shown more positive trends over time, while Science and Engineering skills are more stable in demand. Analysis of the composition of postings by skill shows that, in line with our high duration analysis at the group level, Medicine skills – although typically attracting higher advertised salaries – have relatively fewer high duration postings, around a quarter, compared to the third seen for Physics and Electrical Engineering. Analysis of titles and skills points to the high degree of crossover expected across Medicine skills but a more interesting mix elsewhere: Physics driven by Teachers but also Data Scientists; Electrical Engineering by Engineer roles and Multi-Skilled Operators; Applied Physics split between Design Engineers, Systems Engineers and Physicists.

MEETING DEMAND

The analysis here suggests that there is – aside from a brief hiatus driven by the collapse in demand during the Covid-19 pandemic – a sustained volume of high duration postings, primarily associated with Science and Engineering skills. High duration postings are indicative of difficulties in hiring, and many (but not all) of the combinations of roles and skills see high and rising pay levels. The demand is strong for Science skills, but is not primarily found within the scientific sector: it is in Digital, Business and Finance and Engineering roles that the largest numbers are found, suggesting it is in the application of Physics skills in solving technological and commercial problems which is where the need is most acute.

Table 5.1

Group	Unique active postings	Median advertised salary (£)	Median posting duration (days)	% postings >40 day duration	% postings > £50k advertised salary
Radiation Therapy	17,033	38,112	26	23.4	23.5
Medical Physics	4,937	38,112	25	20.8	22.8
Nuclear Medicine	8,528	37,568	28	25.6	28.0
Radiology	55,026	37,088	26	23.2	30.9
Radiography	68,665	36,832	30	31.1	27.9
Applied Physics	2,160	36,544	30	32.1	22.0
Physics	191,666	35,040	30	32.9	19.7
Electrical Engineering	285,996	35,008	30	33.0	16.4
Plasma Cutting	2,917	24,896	30	29.7	1.6

Table 5.2

Group	Job title	Skill
Physics	Science Teachers Physics Teachers Data Scientists	Chemistry Biology Computer Science
Electrical Engineering	Electrical Engineers Multi-Skilled Operators Electrical Maintenance Engineers	Programmable Logic Controllers Building Services Engineering Electrical Wiring
Radiology	Radiographers Consultant Radiologists Staff Nurses	Magnetic Resonance Imaging Interventional Radiology Ultrasound
Radiography	Radiographers Dental Nurses Diagnostic Radiographers	Magnetic Resonance Imaging Mammography Ultrasound
Radiation Therapy	Radiographers Radiation Therapists Dosimetrists	Chemotherapy Oncology Cancer
Nuclear Medicine	Nuclear Medicine Technologists Radiographers Imaging Field Service Engineers	Positron Emission Tomography Magnetic Resonance Imaging Ultrasound
Medical Physics	Clinical Scientists Cardiac Electrophysiologists Radiation Therapists	Brachytherapy Biomedical Engineering Healthcare Scientists
Plasma Cutting	Mig Welders/Fabricators MIG Welders Welders	Metal Inert Gas (MIG) Welding Welding Fabrication
Applied Physics	Electronic Design Engineers Physicists Systems Engineers	Optics Electronics Electronic Engineering

CONCLUSION

- **Physics skill needs are substantial and growing, and hard to fill – meeting those needs is an important challenge to sustain future economic growth.**
- **Preparing the workforce takes place from school and upward, and will involve adapting to new aspects of science while retaining a strong base in fundamental physics.**
- **Physics-trained workers can access an increasing range of opportunities but need additional skills – some about application, especially in the digital domain, but also a base of transferable skills – to be fully successful.**

Physics' importance as a science should make it no surprise that it is also important across many parts of the economy. Throughout this report, physics has been found to have a wide variety of applications in the workplace, moving well beyond its explicit role as a scientific discipline into many established and new applications. Physics plays a vital role in the skills mix of all nations and regions and many industries – from nuclear energy to major project construction and more besides.

The demand for physics is high – 1 in 20 jobs on a relatively strict, occupation-based measure – and growing. The opportunity to look, using online job adverts, at the demand for physics skills shows that employer needs go wider and deeper than the occupational analysis suggests – with a high value placed on physics skills far beyond its traditional settings. These demands take place on different levels; the presence of physics in construction and production industries means many physics-demanding roles are middle and lower-skill.

That skill mix is changing gradually over time, with a drift towards the higher-skilled categories. We see this at the occupational level, with the fastest growth among scientists, but we can also see it in the spread of physics skills demand outside of traditionally physics-demanding roles: it is at high-skill levels that we see physics needs among data scientists and software engineers. But at present we know that a small majority of physics-related roles – around half of those at the occupation level – do not need Bachelor's degree level qualifications, and that while the largest part of growth is at higher qualification levels, there remain substantial opportunities for physics at middle-skill levels, typically requiring intermediate qualifications like Apprenticeships or A-levels, Highers or Leaving Certificates.

As the analysis of transferable skills shows, physics skills are never the whole story on what is necessary for a career. The employer discussions we had for this report underlined this most of all: there is a need to help take the foundation of scientific physics knowledge and add the wider skills which will make it ready for the workplace. Many of the employers we spoke to emphasised their wish to see greater understanding among those coming from physics education of the wider context in which physics is used in the economy.

Analysis of skills clusters highlights that physics' spread throughout the economy continues to add new dimensions of opportunity for those with physics skills. The clear presence of roles such as data scientist, software engineer, computer scientist and quantitative analyst show that physics knowledge brings skills which are highly valued in the labour market in meeting some of the biggest commercial and technological challenges faced by employers.

Again, employer discussion helps to flesh out how this can be taken forward. First, technology development is creating new demands for the application of physics which need to be reflected within education and training programmes today. Our discussions highlighted photonics engineering, quantum technologies, nuclear fusion and transport electrification as areas where demand will be increasing in future.

Second, and in some ways most pressing is that there are large unmet demands in exploiting Big Data and other digital technologies, but while physics-trained professionals are often well placed to help with these challenges, they need other skills. Chiming with our findings from the skills cluster analysis, the employers we spoke to highlighted the need to complement physics skills in this way – as Richard Bray of Appleyard Lees says, matching physics skills with knowledge of computer science is "gold dust" in today's labour market.

It's perhaps not surprising then that the physics-demanding job vacancies that seem to be the hardest to fill – those which employers advertise longest – include many roles in digital, business and finance and engineering fields. Roles which demand physics knowledge are more likely to be advertised for longer, and also show signs of high and rising pay compared to others within their occupational categories. But the fact that many are found in labour markets which require physics as part of a wider skill set reinforces the story from our discussions with employers: physics skills are of high value, and rising in value, but they need other skills and knowledge to realise that value.

In sum, physics skills needs are large and growing across the UK and Ireland. A substantial number of roles at any one time – nearly 9,000 active vacancies at the time of writing, having quickly recovered to pre-Covid-19 levels – seem to persist in being hard to fill, with likely knock-on consequences for hiring organisations in being less able to deliver on their plans. Economic change – new methods and materials for sustainable construction, Big Data in analytical work – favour those with knowledge of physics, and those trends are not going to go away. While evidence suggests that the scientific demand for physics skills is growing over time,[25] it seems likely that the wider labour market demand we have explored here may be growing more quickly – suggesting that the labour market for physics skills seems likely to tighten as time goes on.

PHYSICS IS VALUABLE AT MANY SKILL LEVELS

As a science, the idea of physics in the workplace is difficult to detach from the idea of workers with many qualifications solving extremely complex, frontier problems. But an understanding of physics as it is applied in the workplace means around half of physics-demanding roles are in occupations which require intermediate level qualifications. The importance of physics in construction, manufacturing and infrastructure means there are many roles where the bulk of the work relies on applied understandings of physics knowledge, but the typical qualification level is in the low or middle-range of skills. As we have seen in this report, looking at physics-demanding roles, the majority do not require a degree of any sort.

For education, there is a need for institutions at all levels to recognise that physics is valuable for many different types of careers. At school age, providing a good education in physics will be useful to far more than those who will go on to study the subject at university – it prepares pupils for practical work with valuable job opportunities, regardless of whether further study is right for everybody.

For government, physics is an important part of the skills mix for a wide range of workers, and a foundation knowledge of the science is important for all – labour market demands for physics skills aren't confined to those at the frontier of the science, and education policy and funding decisions should reflect that.

PHYSICS CONTINUES TO EVOLVE – WITH DEMANDS FOR NEW SPECIALISMS ALONGSIDE GENERAL SKILLS

The range of skills sought by employers in the labour market, and the testimony of employers we have talked to for this report, point to labour market demand for physics skills continuing to evolve with the science. Employers we spoke to pointed to the need for investment in education in new frontiers for physics. At the same time, some employers pointed to the need to balance increasing specialisation with robust fundamental physics knowledge.

For employers, if the frontiers of physics skills demand are to be met by education, there will be a need to invest time and resource to share knowledge about the latest developments in physics-related engineering at work with those instructing new students.

For education, be active in seeking out opportunities to work with leading physics employers to develop education in new engineering disciplines which can bring together high-quality physics education with exposure to the latest technologies as they will be used in business.

[25] Jeisson Cardenas Rubio and Terence Hogarth (2022). The R&D Pipeline. BEIS Research Paper No 2021/22. Department for Business, Energy and Industrial Strategy.

PHYSICS SKILLS ARE IN HIGH DEMAND – ESPECIALLY OUTSIDE OF "PHYSICS JOBS"

We have seen that while physics-demanding roles are growing in line with the wider labour market, there are increasing demands to add physics skills in other roles not traditionally associated with the science, for example in digital and business and finance domains. The analytical rigour associated with physics gives physics-trained professionals competitive advantages in taking on these roles, distilling their complex problems and identifying how to solve them. The evidence presented in this report suggests that significant number of physics-demanding vacancies – especially in these new roles – are hard to fill for employers, with significant potential for impact on business and economic performance.

For employers, recognise that physics-trained workers are an increasingly scarce asset given the range of demands within the labour market, and invest in the pipeline through education to recruitment to ensure the stability and growth of that supply.

For education, there is a need to recognise that while many of those learning physics may not end up in physics-specific roles, that doesn't mean that they won't be using physics skills as a critical part of their work: physics skills have wide application.

PHYSICS SKILLS OFFER SOME OF THEIR GREATEST VALUE IN CONCERT WITH OTHER SKILLS

If physics skills have value far beyond physics-specific roles, the corollary is that they do so in concert with other skills. A highly trained physicist may be able to contribute to engineering a new bridge or producing a new machine learning model, but making these contributions requires them to pair their physics skills with other skills. As we have seen in this report, some of the greatest concentrations of skills shortage are in these intersections between physics and different domains.

The skills clusters set out in this report summarise the way that employers increasingly see these skills marrying up: drawn together from a range of online job adverts, they demonstrate the emergent physics-demanding roles which have a key role in employer demand. Discussions with employers for this report really emphasised that the need for physicists in digital and especially data science roles is already present, and growing fast: but also that while physicists are prized for their skills, they need knowledge of computer science, specific technologies and the working world in order to be ready to meet those employer needs.

For education, the skills clusters represent important intelligence on the potential career paths open to physics students today and the required complementary skills, and can inform curriculum design, especially to combine physics education with training in economically vital applications – and the labour market need for that is pressing.

For employers, the skills clusters can provide a benchmark for thinking about skill development of new employees, to grow new talent – many skills are best honed in the workplace, especially for more advanced roles. While education has a part to play, employers can also act to bridge the gap between physics education and how those skills are used at work.

PHYSICS SKILLS NEED TRANSFERABLE SKILLS TO BE USED EFFECTIVELY AT WORK

One specific dimension which becomes clear is that in all work settings, physics skills need to be matched with a wider range of transferable skills – from communication to innovation to research – to be applied successfully in the workplace. Again, employer discussions heavily reinforced this: physics skills are valuable, but the challenge is to prepare those with physics skills to apply them at work. The particular mix of soft skills varies between roles and sectors, as demonstrated in chapter 4 of this report, but the need to be able to communicate, collaborate and create are continuing themes across the different occupation groups.

For education, developing physics skills in isolation of wider employability and the skills to support it will limit career opportunities – embedding practical experiences testing these skills within physics education is an important part of making students readier for the workplace. One proposal from an employer during our discussions for this report was that more exposure to general essay-writing would encourage physics students to become used to expressing their ideas.

APPENDIX: DATA AND METHODS

Emsi Burning Glass provides the richest and most comprehensive set of labour market analytics available. Our data sets range from enriched versions of the traditional, survey-based labour market intelligence produced by the Office for National Statistics in the UK – or the Central Statistical Office in Ireland – to big data approaches, mining employers' online job adverts to understand what they are seeking.

LABOUR MARKET INTELLIGENCE

For the UK, Emsi Burning Glass maintains and refreshes biannually comprehensive estimates of jobs by occupation (down to 4-digit unit groups on the Standard Occupation Classification (SOC 2010)) and industry (to 4-digit classes on the Standard Industry Classification (SIC 2007)), down to LAU1 geography and dating back to 2003. These are based on the integration of a range of UK government sources including ONS Business Register and Employment Survey, the Labour Force Survey, the Workforce Jobs Survey, DEFRA statistics and others. Integration includes fitting processes to ensure consistency across levels of hierarchy and occupation, industry and geographic dimensions, and smoothing to remove outliers. Earnings estimates are sourced from the ONS Annual Survey of Hours and Earnings, down to the SOC unit group level with missing cases imputed where necessary.

For Ireland, a dataset was produced using similar methods to allow for comparison, drawing together data from the CSO Quarterly Labour Force Survey and Census (2011 and 2016). Using the number of primary and secondary jobs measures from QLFS allowed for the closest alignment with the workplace-based jobs measures used in UK BRES. Occupational data are already coded (with exceptions) to UK SOC 2010 and industry data to NACE v2, which has the same basis as SIC 2007. The resulting dataset includes estimates of occupation unit groups from 2010 to 2020 and industry divisions from 2003 to 2020, down to the NUTS2 level.

JOB POSTING ANALYTICS

Emsi Burning Glass scrapes thousands of job boards every day to assemble the near-universe of online employer job adverts. The raw adverts are then subject to robust deduplication techniques and then enriched to classify them according to job title, SOC occupation, location, skills, advertised salary (where available) and more. Every posting is identified by its date of first appearance and last appearance, to allow for measurement of its time online.

Job titles are parsed using the Emsi Title library of over 70,000 identified titles, and skills using the Emsi Skills library of over 30,000 individual items of skills, knowledge and ability – both of these libraries are open for all to use, and are in continuing revision. As of writing, Emsi Burning Glass' Job Posting Analytics database has over 50 million unique job adverts dating back to 2016.

PROFILE ANALYTICS

As a supply-side complement to the big data demand-side intelligence our Job Posting Analytics provides, Emsi Burning Glass also maintains an analytical database of worker profiles gathered from a range of public and opt-in online sources. With over 14 million individual profiles in the database, Profile Analytics are enriched in a similar way to Job Posting Analytics, with SOC, Emsi Skills and Emsi Titles used to identify the kinds of jobs and capabilities claimed for each profile.

Emsi Burning Glass is the world's leading authority on job skills, workforce talent, and labour market dynamics.

With engineers and data specialists collecting and analysing data from thousands of job boards, company websites, online resumes, employee profiles, and traditional government sources, the company produces the most comprehensive and up-to-date picture of the labour market available. Organisations across the globe use Emsi Burning Glass market research, analytical software, and data expertise to better understand their own workforce and identify skilled and diverse talent for future growth.

Headquartered in Boston, Massachusetts, and Moscow, Idaho, Emsi Burning Glass is active in more than 30 countries and has offices in the United Kingdom, Italy, New Zealand, and India.

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