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Mapping current and future workforce and skills requirements in Scotland's solar industry

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1 Executive summary

1.1 Aims

The aim of this study is to investigate the skills need of the solar industry in Scotland, based on a proposed ambition of 4 to 6 gigawatts (GW) installed solar capacity by 2030. These were addressed through a literature review, model development and stakeholder engagement. We also relied on the expertise of solar industry specialists in the study team.

1.2 Findings

The modelling was carried out assuming the delivery of 6 GW by 2030. This assumes a split between 3.5 GW ground-mounted, 1GW commercial rooftop and 1.5 GW domestic rooftop solar panels.

We developed a hypothetical deployment pathway that delivers 6 GW of solar power by 2030. On basis of this pathway, the workforce serving the solar industry will need to increase from approximately 800 in 2023 to an estimate of over 11,000 full time equivalent (FTEs) in 2030. Most of this growth is attributed to construction-related activities, especially for ground-mounted solar projects, as shown in Figure 1.

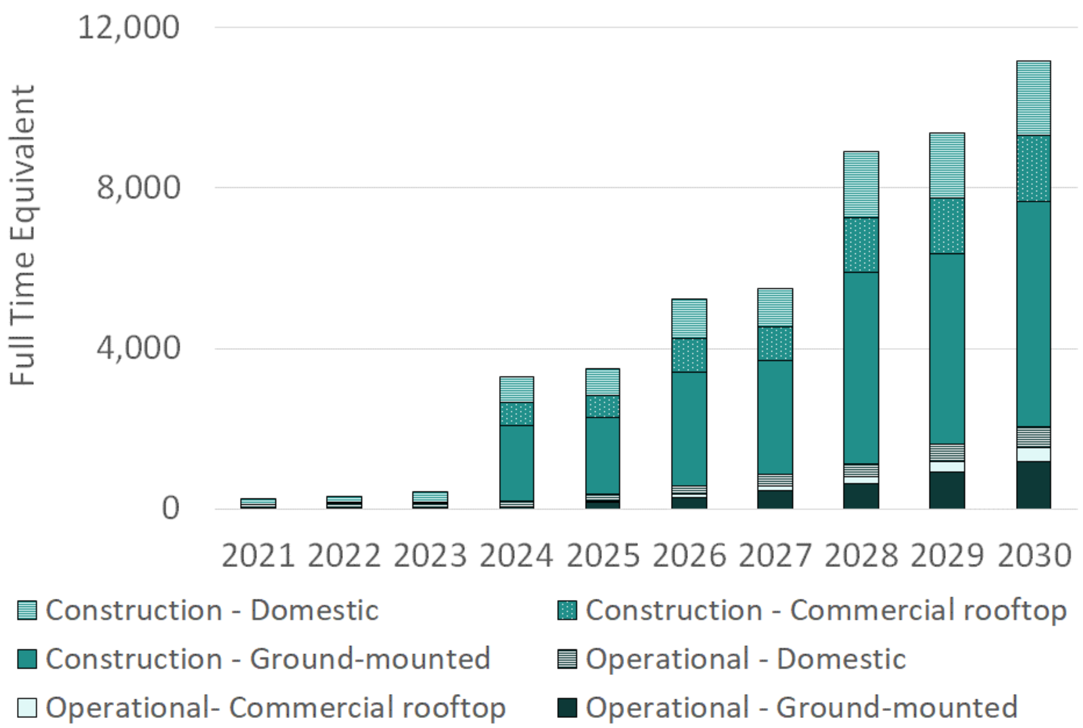

Figure 1. Workforce requirements to deliver 6 GW solar capacity in Scotland by 2030, in FTE. Based on hypothetical deployment pathway.

Overall, stakeholder engagement suggests that the people currently employed in the industry have the right skills, however, there is a significant shortage of skilled labour. Therefore, there is a need for more people to be recruited into the solar industry. The existing training provision, with some development and adaptation, can provide the necessary skills to those who do not have direct solar industry experience.

If skilled workforce shortages are not addressed, the potential impact on the ability to deliver 4 to 6 GW of solar capacity by 2030 could be significant, given the difference between current and required future workforce levels.

The expansion to around 11,000 FTEs by 2030 includes 9,100 FTEs for construction related activities, almost 82% of the new workforce required. These workforce requirements are relatively temporary. In contrast, approximately 2,000 FTEs will be required for operation and maintenance activities, which provide more lasting employment needs.

The highest levels of workforce requirements were identified in the following specialisms:

- electricians
- grid connection engineers
- high voltage technicians
- electrical engineers
- constructions workers, including:
    - civil contractors
    - general labourers / operators

- crane operators / lifting contractors
- roofers

Our research points to two pathways for achieving a suitable skillset for these specialisms: 1) upskilling in addition to general technical training through short courses or in-house training, or 2) adding PV-relevant modules to existing training courses.

In terms of geographic distribution, we base our estimates on the project pipeline data in the Renewable Energy Projects Database at the time of writing (December 2023). Our estimates suggest that the installation of **commercial rooftop** projects is, and will continue to be, concentrated in and around the main clusters of population in the central belt of Scotland, the Borders, Dumfries and Galloway, the east- and north-east of Scotland and in and around the Inverness area. The majority of the **ground-mounted** projects will be located in more rural and less densely populated regions of Scotland, particularly Aberdeenshire, Angus, Fife and Tayside, where there is availability of land at a size appropriate for these larger systems. The installation of ground-mounted systems is expected to require a partly mobile and partly fixed workforce. Reliable data relating to the future pipeline of **domestic rooftop** projects is not readily available.

1.3 Recommendations

Actions to address the skills shortages in Scotland will be essential for the success of Scotland's solar PV industry in its delivery of 6 GW installed capacity and for meeting broader renewable energy objectives. The development and delivery of these actions should be led by industry, but will require support from and collaboration with schools, colleges, universities, training providers and relevant public sector bodies.

We suggest the following actions to address the skills challenges highlighted:

- Developing strategies to promote the solar industry and attract new entrants. These should highlight its net zero and sustainability credentials and be designed for primary, secondary, further and higher education students, as well as individuals already in the workforce. These should clearly illustrate the wide range of potential career pathways for individuals at all levels of education.
- Putting in place initiatives to design and specify renewable energy and solar-specific course content. Potential options could include:
    - a dedicated apprenticeship in renewable energy
    - college and university courses (such as electrical engineering) and apprenticeships (such as electrician and construction) that provide the opportunity to specialise in renewable energy and/or solar PV system installation
    - extension of the vocational graduate apprenticeship scheme to cover a wider range of subjects, such as electrical engineering.

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2 Glossary / abbreviations table

AC	Alternating current
CAGR	Compound annual growth rate
DC	Direct current
DNO	Distribution network operator
FTE	Full time equivalent
GW	Gigawatt, a unit of power
GWO	Global Wind Organisation
HNC	Higher National Certificate
HND	Higher National Diploma
KW	Kilowatt, a unit of power
LCREE	Low carbon and renewable energy economy
MCS	Microgeneration Certification Scheme
MW	Megawatt, a unit of power
MWelec	Megawatts of electricity
PV	Photovoltaic
REPD	Renewable Energy Planning Database
SAP	Senior authorised person
SIC	Standard Industry Classification
TW	Terawatt, a unit of power
TWh	Terrawatt hour, a unit of energy

3 Introduction

3.1 Background

By late 2023, Scotland's solar energy capacity was recorded at approximately 600 megawatts (MW) consisting of domestic and commercial rooftop installations and a small number of ground-mounted installation[1].

In 2021 Solar Energy Scotland called upon the Scottish Government to commit to a minimum of 4 GW solar energy by 2030, with an ambition to reach 6 GW (Solar Energy UK, 2023). In October 2023, the Scottish Government publicly announced a proposal for a solar deployment ambition of 4-6 GW by 2030 (Scottish Parliament, 2023). A final decision on this proposed ambition will be made in the final solar vision, which is due to be published within the Energy Strategy and Just Transition Plan in summer 2024.

3.2 Purpose of this study

To deliver 4-6 GW of solar by 2030, ground-based solar farms and rooftop systems would have to be deployed at a scale that has never been attempted before in Scotland. A skilled workforce would play a crucial part in enabling this scale of activity and it is essential, therefore, that any skills gaps and/or shortages within the workforce are identified, so that skills providers and policymakers can develop actionable strategies to close these gaps. This study investigates the skills needs for the solar industry in Scotland, based on the proposed ambition to reach 4 to 6 GW installed solar capacity by 2030. The key objectives are to:

- Model the current and future workforce requirements in Scotland's solar industry assuming 6 GW installed capacity by 2030.
- Use these models to estimate the number of skilled workers required at each stage of the project lifecycle for the different types of project (ground-based and rooftop).
- Identify the geographical spread of the workforce, identifying where jobs will be located in Scotland.
- Assess the potential future demand for skills and identify any skills gaps.

3.3 Study methodology

The study relies on a literature review, insights from the experience of study team members and ITPEnergised in managing hundreds of solar projects, internal ITPEnergised interviews, study-specific modelling and stakeholder validation. Stakeholder engagement included interviews with ten stakeholders in the solar industry and a presentation at Solar Energy Scotland (the Solar Energy UK Scottish Working Group).

[1] This estimate comes from data extracted from the Renewable Energy Planning Database (REPD) (Department for Energy Security and Net Zero, 2023), which covers ground-based projects and commercial roof-top installations of 100 kilowatts (KW) and above, and the Microgeneration Certification Scheme installations database (Microgeneration Certification Scheme, 2023), which covers most domestic rooftop installations.

Section 4 provides an overview of the solar industry.

Section 5 details the solar project lifecycle, job roles and skills levels.

Section 6 quantifies the number and types of jobs required currently and to 2030.

Section 7 details the demand for skills, challenges and ways of addressing these challenges.

The report concludes with observations on future skills requirements and makes recommendations for actions required to address the skills challenges identified in sections 8 and 9.

4 Solar industry overview

4.1 Solar photovoltaic systems

The key components of a solar photovoltaic (PV) system are the solar panels that are constructed from layers of highly specialised semiconductor materials. When the sun shines on a solar panel, the energy causes electrons to be released from these materials and flow from one layer to another. When the layers are connected in an electrical circuit, electrons are 'pushed' towards the metal conducting elements (electrodes and wires) creating direct current electricity. This is known as the photovoltaic effect.

In addition to the solar panels themselves, other components in a typical PV system could include electrical connections, output power lines, inverters, mounting equipment, devices that manage the electricity exchange with batteries, batteries, meters, wiring, power processing and grounding equipment. The installation, commissioning, operation and maintenance of this equipment requires specialised skills.

4.2 Market overview

4.2.1. Global energy generation by solar photovoltaic

Globally, solar PV generation increased by a record 270 terrawatt hours (TWh), up 26%, in 2022, reaching almost 1,300 TWh. It demonstrated the largest absolute generation growth of all renewable technologies in 2022, surpassing wind (International Energy Agency, 2023).

A notable trend in the solar energy sector is the decreasing costs of PV systems. The prices for solar PV modules recently saw a dramatic decline, nearly halving year-on-year. This price decrease coincided with a substantial increase in manufacturing capacity, which reached three times the levels recorded in 2021.

Chinese companies have an almost complete monopoly over the global solar PV cell manufacturing industry, rendering the supply chain more prone to disruption. Overall, China is expected to maintain an 80-95% share in the global solar PV supply chain, as reported by the International Renewable Energy Agency (IRENA) in their Renewable Energy and Jobs Annual Review 2023 (IRENA, 2023).

4.2.1. UK and Scottish market overview

In the UK, the cumulative installed capacity of solar PV reached nearly 16 GW at the end of 2023. In late 2023, Scotland's solar energy capacity was recorded at 600 MW, as noted previously (Department for Energy Security and Net Zero, 2023).

In addition to the installed capacity, there is, at the end of 2023, an estimated pipeline capacity of 1.74 GW, as shown in Table 1 (data extracted from the REPD database).

Development Status	Capacity (MW)
Planning application submitted (first application or revised)	727
No application required[2]	1.3
Awaiting construction	917
Under construction	99

Table 1: Pipeline of development projects in Scotland (REPD, December 2023)

The data above refers to commercial projects (ground mounted and rooftop) only, as such data is not collected for domestic rooftop installations.

The largest solar farm in Scotland, sited on land at the Errol Estate in Perthshire, came online in 2016 (Scotland Land & Estates, 2023). This 13 MW scheme, incorporating 55,000 solar panels, produces enough electricity to power 3,500 homes. The capacity of the other operational solar farms and commercial roof-top installations is 10 MW or less, with the majority being less than 1 MW.

Despite the reduction in PV system costs, coupled with the recent spike in energy prices in the UK, demand for domestic solar PV has not increased significantly, according to a stakeholder (industry association) contacted during this study. This is due to factors such as relatively high absolute costs and reduced grant availability.

In Scotland, solar value chains are primarily focused on the design, installation and maintenance aspects of solar PV systems. This focus aligns with the global trends in the solar market, with manufacturing centralised in China.

4.3 Solar industry context

Interviewees for this study have strongly emphasised the constraints they are facing with regards to obtaining a grid connection and to the processing of planning applications. Although this was not the focus of the study, it is an important contextual detail because bottlenecks in these allied sectors are likely to have a significant impact on how many projects progress through the pipeline. This, in turn, impacts the sector's demand for skilled workforce. Details are provided in Appendix B.

[2] REPD states that a project that does not require planning permission has been announced by the developer.

5 Solar project lifecycle, job roles and skills levels

5.1 Solar project lifecycle

A solar PV project lifecycle has five phases, as shown in Figure 2: equipment manufacture and distribution; project development; installation, commissioning and handover; operation and maintenance; and decommissioning. This has been developed based on the ITPEnergised experience of consulting and managing hundreds of projects for solar PV developers:

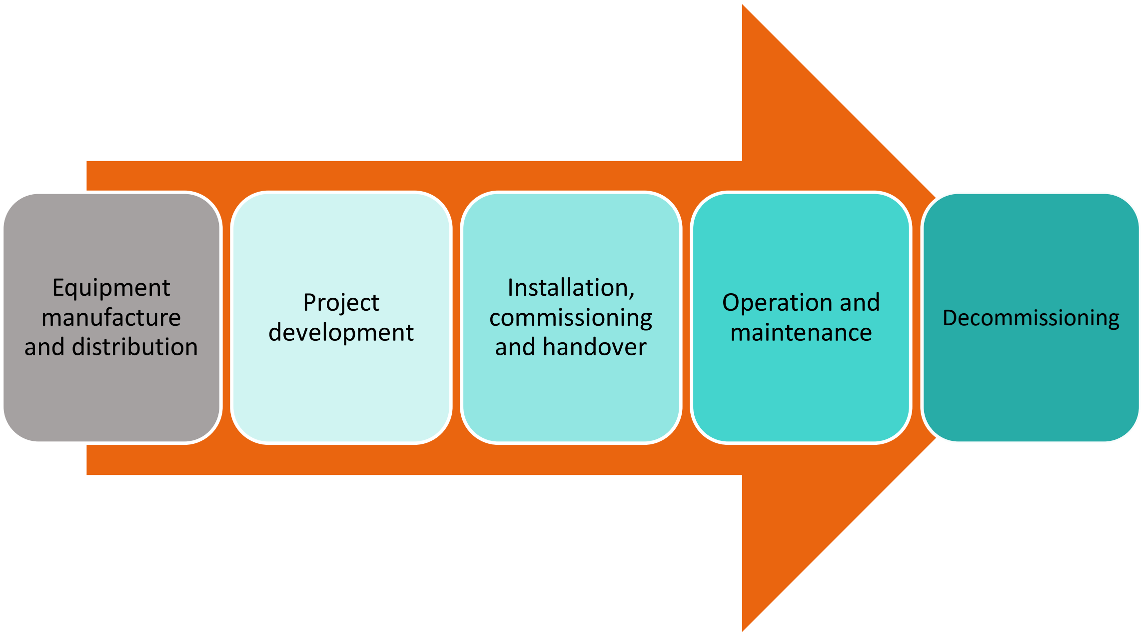

Figure 2: Solar project lifecycle

While the figure includes the first stage, equipment manufacture and distribution, this is shown for completeness only due to lack of PV manufacturing in Scotland, as discussed above.

With regards to decommissioning, this does not currently apply, since a typical solar installation has a design life of 25-30 years[3] and the solar industry in Scotland is not sufficiently mature to require skills for decommissioning. However, it is expected that some systems will be coming to end-of-life in the next ten years and decommissioning will become relevant in the timeframe to 2030. For example, the first domestic rooftop panels in the UK were installed in 1994 (Changeworks, 2024).

The project lifecycle covers both ground and rooftop solar projects, although, at a more detailed level there are some differences in the activities carried out at each stage of the lifecycle in a large ground-based project compared to a domestic rooftop. This, in turn, affects the timelines for initial feasibility and the project development stages of these project categories, as follows:

[3] PVs will continue to generate power after the 25-30 year lifetime duration, but performance and efficiency are likely to decline (M Sodhia, L Banaszeka, C Mageeb, M Rivero-Hude, 2022)

- Large ground mounted – two to three years depending on size and complexity[4].
- Commercial rooftop (average size of 50 KW) – three to six months depending on planning permission requirements[5].
- Domestic rooftop – three to six months depending on planning permission requirements[5].

5.2 Job roles and skills levels

The job roles required at different project stages depend on the project size and type. Not every type of project will require every job role and the scale of the project will have a significant influence on skills requirements.

The job roles and skills levels at each stage of the project lifecycle relevant to Scotland are considered below. These have been developed based on the expertise of IPTEnergised in delivering solar PV projects for clients[6]. Inputs and validation were also provided by stakeholders consulted during this study.

5.2.1. Project development

A wide range of job roles are required at the early stages of the project lifecycle, see table below. The breadth of specialisms required is an indicator of the importance of this stage of the process.

Job role	Skill level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Project manager	Variable	2	✓	✓	✓
Consultant - Site design and modelling	Degree	2	✓	✓	✓
Electrical engineer	Degree	5	✓	✓	✓
Consultant - Energy yield assessors and PV system specialists	Degree	2	✓		
Engineering procurement and construction contractor	Degree/Post-graduate	5	✓	✓	✓
Surveyor	Variable	2	✓	✓	✓
Environmental consultant – a range of roles*	Variable	2-4	✓		
Environmental consultant - Cultural heritage / archaeologists	Degree	4	✓	✓	

4 Information provided by ITPEnergised based on the company's experience of delivering large scale ground-mounted PV solar projects

5 Information provided by industry stakeholders involved in the installation of commercial and domestic rooftop projects consulted during this study

6 This includes the provision of environmental and energy consulting services; solar design services for both ground and roof mounted solar PV; yield assessments and due diligence services.

Job role	Skill level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Structural engineer	Degree/Post-graduate	3		✓	
Roofing contractor	Variable	1		✓	✓
Consultant - Transport	Variable	2	✓		
Civils contractor	Variable	2	✓		
Financial analyst	Degree	1	✓	✓	
Planning officer	Degree	4	✓	✓	✓
Consultant - Grid connection consultancy and application	Degree	2	✓	✓	✓
DNO case worker	Degree	4	✓		
Distribution network operator (DNO) Senior Authorised Person (SAPs)	Variable	7	✓	✓	
Legal	Degree	4	✓	✓	

*Different types of environmental consultants are required, including: ecological clerk of works, flood risk and drainage specialist, ornithologist, ecologist, hydro/hydrogeo/geologist/peat specialist, noise and vibration specialist, forester.

Table 2: Job roles at the project development stage of the solar project lifecycle

Ground mounted projects require the broadest range of job roles particularly where the potential environmental impacts of the project need to be considered. For rooftop projects, the services of a skilled structural engineer are crucial to ensure the structural integrity of the building remains intact following system installation. Project developers will, at this stage, commence engagement with the senior authorised person (SAP), a professional that is responsible for the safety of themselves and others working in high voltage areas at the relevant Distribution Network Operator (DNO). They will also engage with DNO engineers and case workers and with relevant planning authorities as required. At this stage, many of the of job roles require the achievement of tertiary education levels, as a minimum and / or a requisite number of years' experience.

5.2.1. Installation, commissioning and handover

The job roles for the installation, commissioning and handover of a solar project are more focused on construction, with less reliance of specialist consultants and engineers, see Table 3. For ground mounted projects, project management is a key role, typically delivered by an engineering, procurement and construction contractor, and some on-going oversight of potential environmental impacts by an environmental consultant may be required. As before, larger projects, both ground mounted and rooftop commercial, will require ongoing engagement with DNO staff and local authority planners as required. Rooftop projects, specifically, will require an experienced roofing contractor (e.g. slater / tiler). Smaller domestic installations can, typically, be completed by a roofer and an electrician, with limited input required from other job roles.

Job role	Skill/ certification level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Engineering procurement and construction contractor	Degree/post-graduate	5	✓	✓	✓
Civil engineer	Post-graduate	5	✓		
Civils contractor	Variable	2	✓		
Transport operative	Variable	5	✓		
Crane/lifting contractor	HNC/HND/GWO[7]	2	✓		
Labourer/operator (general)	Variable	1	✓	✓	✓
Back office support	Variable	1	✓	✓	✓
Health & safety officer	HNC/HND/GWO	3	✓	✓	✓
Electrician	Variable	2	✓	✓	✓
Electrical engineer	Degree	5	✓	✓	
Roofing contractor	Variable			✓	✓
Environmental consultant (general)	Variable	2	✓		
Grid connection installation	HNC/HND	5	✓	✓	✓
Distribution network operator (DNO) Senior Authorised Person (SAPs)	Variable	7	✓	✓	
Legal	Degree	4	✓	✓	

Table 3: Job roles at installation, commissioning and handover

5.2.1. Operation and maintenance

The emphasis of the job roles associated with this stage of the project lifecycle include, but is not limited to adjustments, repairs, replacements, cleaning and extension of equipment life. For larger ground-based projects this will, typically, be overseen by an asset manager and may require some input from engineering, procurement and construction contractors. Other contractors will be brought in as required. Generally, the main job roles across all three types of projects will be in the electrical field (electricians and high voltage technicians) and for rooftop projects, roofers will be required. At this stage, some of the job roles require the achievement of tertiary education levels, as a minimum and / or a requisite number of years' experience, see Table 4.

[7] HNC: Higher National Certificate, HND: Higher National Diploma, GWO: Global Wind Organisation

Job role	Skill/ certification level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Engineering procurement and construction contractor	Degree/post-graduate	5	✓		
Back office support	Variable	1	✓	✓	✓
Electrician	Variable	2	✓	✓	✓
Roofing contractor	Variable	1		✓	✓
Civils contractor	Variable	2	✓	✓	
Asset manager	Degree	2	✓	✓	
Crane/lifting contractor	HNC/HND/GWO	2	✓		
Health & safety officer	HNC/HND/GWO	3	✓	✓	✓
High voltage technician	Variable	5	✓	✓	
Logistics manager	Variable	1	✓	✓	
IT manager	Post-graduate	2	✓	✓	
Legal	Degree	4	✓	✓	

Table 4: Job roles for operation and maintenance

5.2.1. Decommissioning

As discussed above, the solar industry in Scotland is not sufficiently mature for projects to have reached end of life. The job roles and skills levels required for each type of project in Table 5 are, therefore, based on expert judgement.

Job role	Skill/ certification level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Civils contractor	Variable	2	✓		
Crane/lifting contractor	HNC/HND/GWO	2	✓		
Grid connection installation	HNC/HND	5	✓	✓	✓
Transport operative	Variable	5	✓		
Back office support	Variable	1	✓	✓	✓
Health & safety officer	HNC/HND/GWO	3	✓	✓	✓
Environmental consultant (general)	Variable	2	✓		
Civil engineer	Post-graduate	5	✓		

Job role	Skill/ certification level	Experience (Years)	Ground mounted	Rooftop commercial	Rooftop domestic
Electrical engineer	Degree	5	✓		
Electrician	Variable	2	✓	✓	✓
Labourer/operator (general)	Variable	1		✓	✓
Roofing contractor	Variable	1		✓	✓
Engineering procurement and construction contractor	Degree/post-graduate	5	✓	✓	✓
Legal	Degree	4	✓	✓	

Table 5: Job roles at the decommissioning (end of life) stage of the solar project lifecycle

We note that legal skills may be required at all stages of project lifecycle, most typically for ground-based projects and for larger rooftop projects. This will be to satisfy the requirements for contract negotiations, land purchase, regulatory compliance, and other related legal matters.

6 Current and future jobs

6.1 Current and future jobs numbers by category

The current number of FTE in Scottish solar sector was 800 with the same value reported in LCREE for 2021 and 2022.

To estimate job numbers and roles for 2024-2030 we developed two modelling approaches:

- a top-down model which uses the data on the total employment in the solar sector in 2021 and the installed solar capacity in 2021, and
- a bottom-up model uses IPTEnergised simulated projects (ground-mounted, 50 MW; commercial rooftop, 1 MW; domestic rooftop, 4 KW) and their corresponding FTE requirements.

The top-down model is based on recorded historic data and is aligned with analysis for other renewables sectors. The bottom-up model allows sufficient granularity to generate predictions regarding detailed job roles, information for which is not available in the top-down modelling.

The modelling structure is presented in Figure 3.

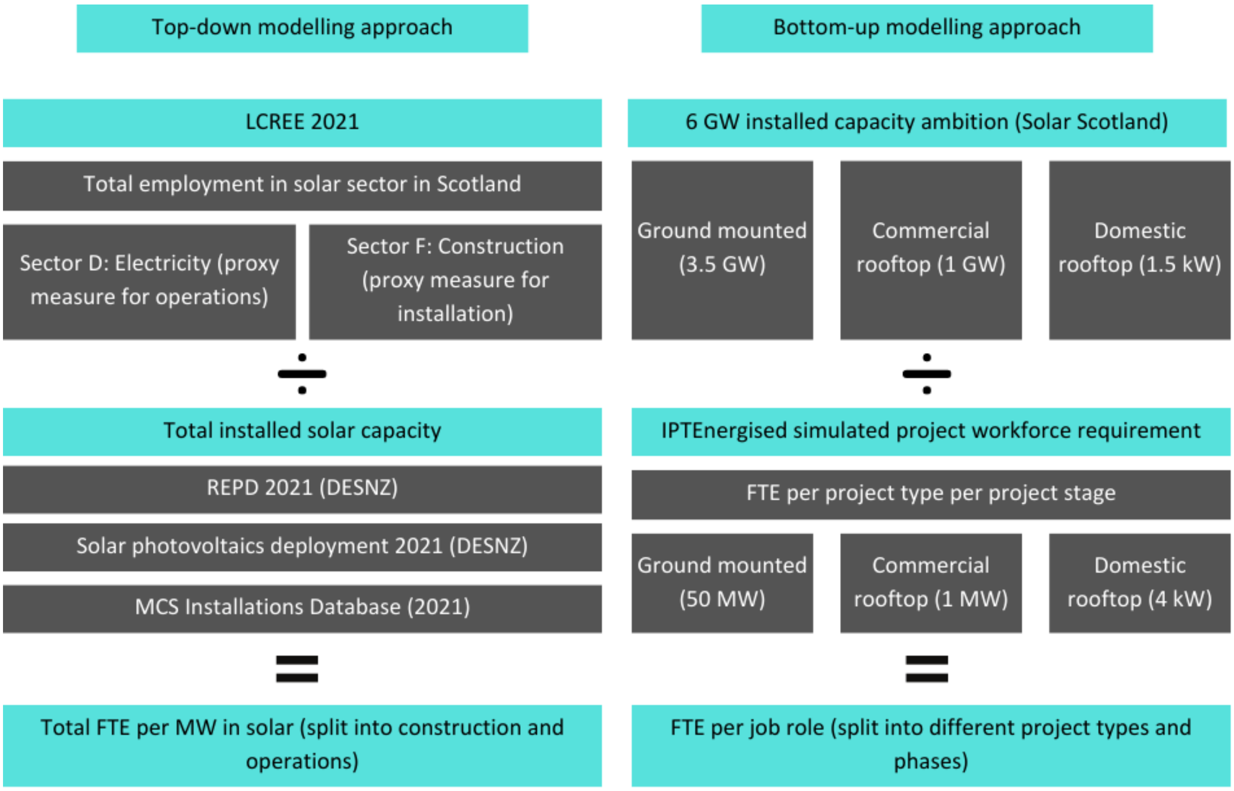

Figure 3: Overview of the data sources, assumptions, and simulations used in the top-down and bottom-up modelling approaches.

The bottom-up model is based on a typical solar project lifecycle, associated job roles and skills levels and a hypothetical solar deployment pathway scenario for Scotland that has been developed for this project. It has not been possible to create an evidence-based deployment scenario as the pipeline of projects that would be required to achieve the proposed ambition of 4-6 GW installed capacity by 2030 does not yet exist. The FTE requirements over the period 2024 – 2030 are dependent on this hypothetical capacity deployment pathway. They could look different under a different capacity deployment scenario.

The initial outputs of the two types of modelling, including assumptions about the deployment pathway, were validated by industry and other stakeholders through interviews and a presentation of the draft study findings at a meeting of the Solar Energy Scotland (the Solar Energy UK Scottish Working Group).

Further details on modelling methodology and data sources are included in Appendix C.

Figure 4 provides an annual overview of the projected FTE requirements by project phase and project type to 2030, on basis of our top-down modelling. Both, construction and O&M activities are predicted to increase steadily throughout this timeframe.

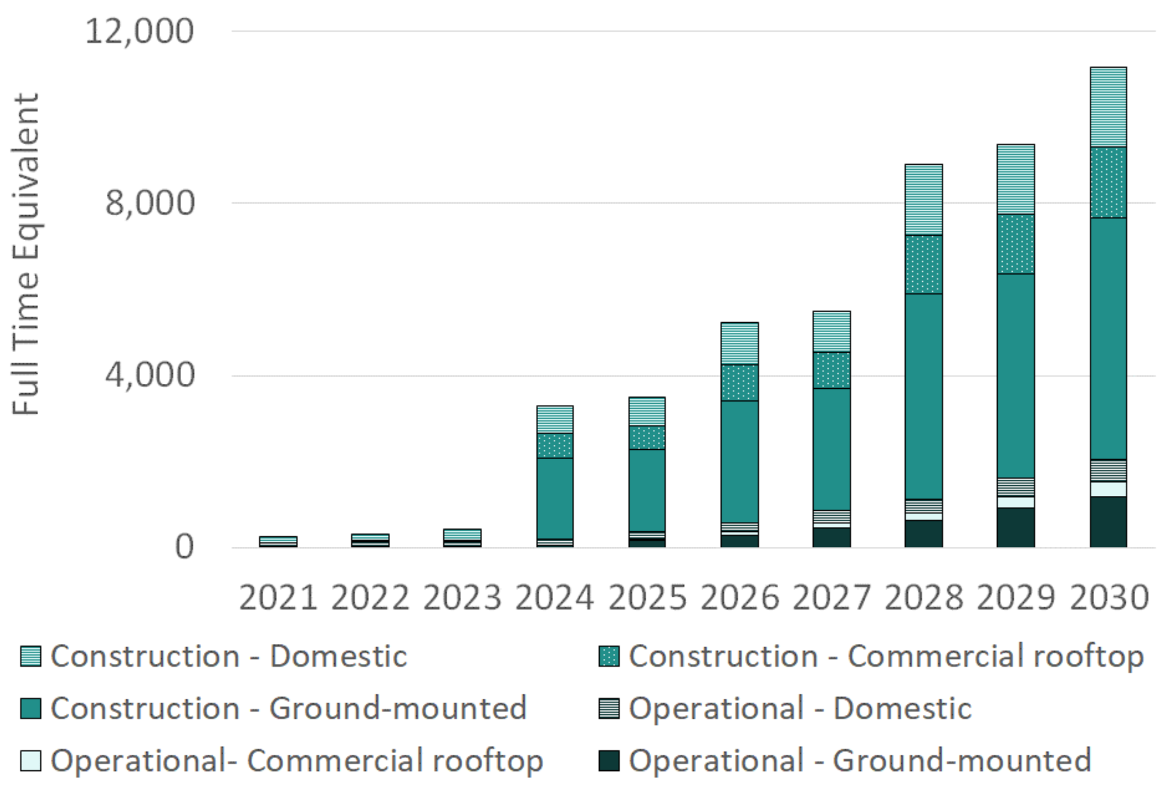

Figure 4: Annual FTE requirements in construction and operation of solar projects, by project type

Our modelling shows demand increasing from an estimated 3,291 FTEs in 2024 to an estimated 11,150 FTE in 2030. The highest workforce demand is expected in construction, particularly for ground-mounted projects. These jobs will be a combination of permanent and temporary roles that will exist for the duration of a project.

O&M jobs will be sustained over a period of time, with staff based on site or in close proximity. A number of the construction jobs will also be permanent, albeit mobile, i.e. involving teams of construction workers moving from site to site.

Further information on how these figures have been estimated is provided in Appendix C.

Using the bottom-up modelling approach, the Table 6 shows the estimated total number of FTEs created each year and the average number of FTEs per year over the seven-year period.

Job Roles (combined)	2024	2025	2026	2027	2028	2029	2030	Average FTE/year
Civils contractor	61	132	213	321	449	623	776	368
Electrician	144	166	249	282	436	492	589	337
Grid connection & installation specialist	136	136	204	204	340	340	394	251
Labourer /operators (general)	132	132	198	198	330	330	383	243

Job Roles (combined)	2024	2025	2026	2027	2028	2029	2030	Average FTE/year
Health & safety officer	88	107	164	193	295	344	418	230
Crane/lifting contractor	24	72	120	192	266	386	496	222
HV technician	22	70	118	191	263	384	494	220
Roofing contractor	114	119	173	180	286	298	342	216
Logistics manager	18	58	99	159	220	320	412	184
EPC contractor	101	111	151	170	249	259	229	181
Back office support	35	48	73	93	136	168	206	108
Asset manager	10	32	55	88	122	177	228	102
Electrical engineer	46	49	69	74	115	117	118	84
Civil engineer	36	36	54	54	90	90	106	67
IT manager	6	20	33	54	74	109	140	62
Surveyor	34	37	51	56	85	87	83	62
Project manager	33	35	49	54	82	84	79	59
Consultant - Site design and modelling	32	34	47	52	78	80	75	57
Consultant - Grid connection consult./application	29	30	43	45	72	73	76	53
DNO/TO Senior Authorised Person (SAPs)	21	22	31	33	52	53	55	38
Environmental consultant (general)	19	19	29	29	48	48	57	35
Planning officers	16	18	23	27	38	40	33	28
Transport operative	10	10	14	14	24	24	28	18
Financial analyst	6	8	9	12	14	16	7	10
Structural engineer	5	5	8	8	14	14	16	10
Consultant - Energy yield & PV system specialists	6	8	8	13	13	15	0	9
Environmental consultant - ECoW	6	8	8	13	13	15	0	9
DNO case worker	4	6	6	10	10	12	0	7
Consultant - Landscape & visual consultant	3	3	4	4	7	7	8	5
Consultant - Transport	3	4	4	6	6	7	0	4
Cultural heritage / archaeologist	3	4	4	6	6	7	0	4
Environmental consultant* - specialised	18	24	24	36	36	42	0	24
Total FTE per annum	1219	1563	2337	2875	4273	5065	5848	

Table 6: Yearly cumulative FTEs by job role for all project types. Colour coding: green represents a relatively lower FTE demand; red represents a relatively higher FTE demand
*Environmental consultant specialisms include ecologist, flood risk and drainage, forester, hydro / hydro-geo/peat specialism, noise and vibration specialists and ornithologists.

The estimates above are subject to change as the industry experiences ongoing activities in, for example, standardisation of the application process and the rapid changes in policy and consenting processes, as highlighted during discussions with Solar Energy UK.

This modelling approach shows demand increasing from an estimated 1,219 FTEs in 2024 to an estimated 5,848 FTE in 2030.

The average number of FTEs created at the feasibility and constructions stages, over the period 2024 -2030, is estimated at around 1,900. Some of these jobs will be permanent but many will be temporary, mainly appearing during peak construction times. The average number of FTEs created at the O&M stage, over the same period is estimated at around 1,400. Most of these jobs are likely to be sustained beyond 2030.

There will be a particularly high demand for electrical specialists such as electricians, energy yield assessors and grid connection engineers, as these skills are also sought after in other areas of the energy industry. Additionally, the need for construction workers, including civil contractors, general labourers, and operators, will grow quickly to support the building of solar projects.

A detailed breakdown of the estimated job roles by project type and by stage in the project lifecycle is provided in Appendix D.

The FTE job numbers from the top-down model are consistently higher than those from the bottom-up model, although both show similar growth trends. The numbers from the top-down model could, therefore, be interpreted as the upper limit and those from the bottom-up model as the lower limit.

Details of the number of FTE for each job role to deliver 4 GW installed capacity are provided in Appendix C. For this scenario, a further breakdown of jobs into project lifecycle stages was not undertaken, as the 4 GW scenario has not been broken down into ground-mounted, commercial rooftop, and domestic rooftop projects in the way it has for the 6 GW ambition.

6.1.1. Limitations and uncertainties

Results should be interpreted with consideration of the model's core assumptions, limitations and broader uncertainties in the industry.

The presented models are built on the assumption of workforce intensity per MW installed solar capacity (FTE/MW). This ratio is calculated from LCREE 2021 employment data and a combination of data sources indicating the installed capacity in 2021 (the full methodology is described in the Appendix C). All models assume that the 6 GW installed capacity will be met in 2030.

Mode limitations include the following:

- There are uncertainties associated with the underlying LCREE data, particularly for smaller sectors such as solar PV, where estimates are subject to volatility. Additionally, LCREE estimates are survey-based and gather information from a sample rather than the whole population, meaning that they are subject to sampling uncertainty.

- The top-down model is based on 2021 workforce requirements per MW to estimate future workforce needs. This was the most up to date dataset available at the time this work was undertaken. This approach does not account for potential shifts in workforce efficiency, automation, or technological breakthroughs that could impact the industry.
- The bottom-up model forecasts FTE with total forecasted FTE numbers broken down into specific job roles, acknowledging the short lifespan of some solar projects, especially commercial (< 1 year) and domestic PV (< 1 week) rooftop projects. Although the model normalises the transient jobs in terms of project duration and installed capacity, it is important to recognise that not all FTEs projected by the model will be sustained in the long-term.
- Some jobs will be realised before the start of construction, e.g. those in planning stages of a project, might be realised a year before the construction work. This is particularly relevant for ground-mounted projects. In the absence of information on how quickly different types of projects will move through the planning pipeline, we have assumed in the bottom-up model that FTEs for ground-mounted feasibility stages are created one year before the construction stage. It was not possible to do this for the top-down modelling as the underlying data is not broken down in sufficient detail.

Lastly, the model data should be interpreted in the context of broader developments and uncertainties in the sector that affect the project pipeline.

6.2 Predicting the geographical distribution of solar skills demand

Revisiting the REPD, we analysed the pipeline of solar projects awaiting construction and in planning.[8] This determines the geographical distribution of projects and, therefore, the location of the demand for skills, see Figure 5.

[8] This includes projects for which the planning application was originally rejected and an appeal subsequently lodged

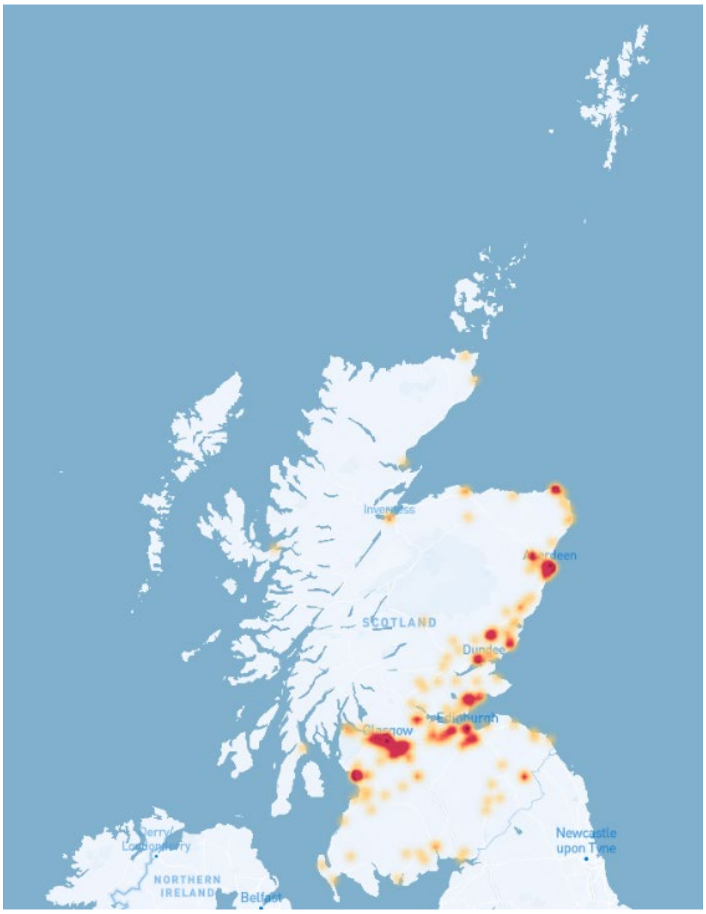

Figure 5: Heat map of solar projects awaiting construction and in planning.

Colour coding: yellow represents a relatively lower concentration of project numbers and red represents a relatively higher concentration of project numbers.

The REPD does not include pipeline data for **domestic solar installations**. It can be assumed, however, that the majority of domestic installations will be concentrated in the main population centres across the central belt of Scotland, the Borders, Dumfries and Galloway, the East and North East of Scotland and around the Inverness area. This is largely in line with the REPD data in the figure above.

Domestic rooftop installations are expected to require a workforce that is anchored in a particular geographical location, for both construction and O&M project phases, with companies delivering services to local customers. As noted above, this will be concentrated in and around the main clusters of population.

On basis of the current experience in the sector, we expect that construction, installation and commissioning of larger **ground-mounted and commercial rooftop systems** will require teams of workers moving from site to site around the country. These types of installations may require dedicated O&M staff but numbers are likely to be small, as described previously. The number of ground mounted systems under construction, awaiting construction or for which planning has been submitted is shown in the following figure (analysis of the REPD database – December 2023 data). The figures in brackets indicate the installed capacity in MW.

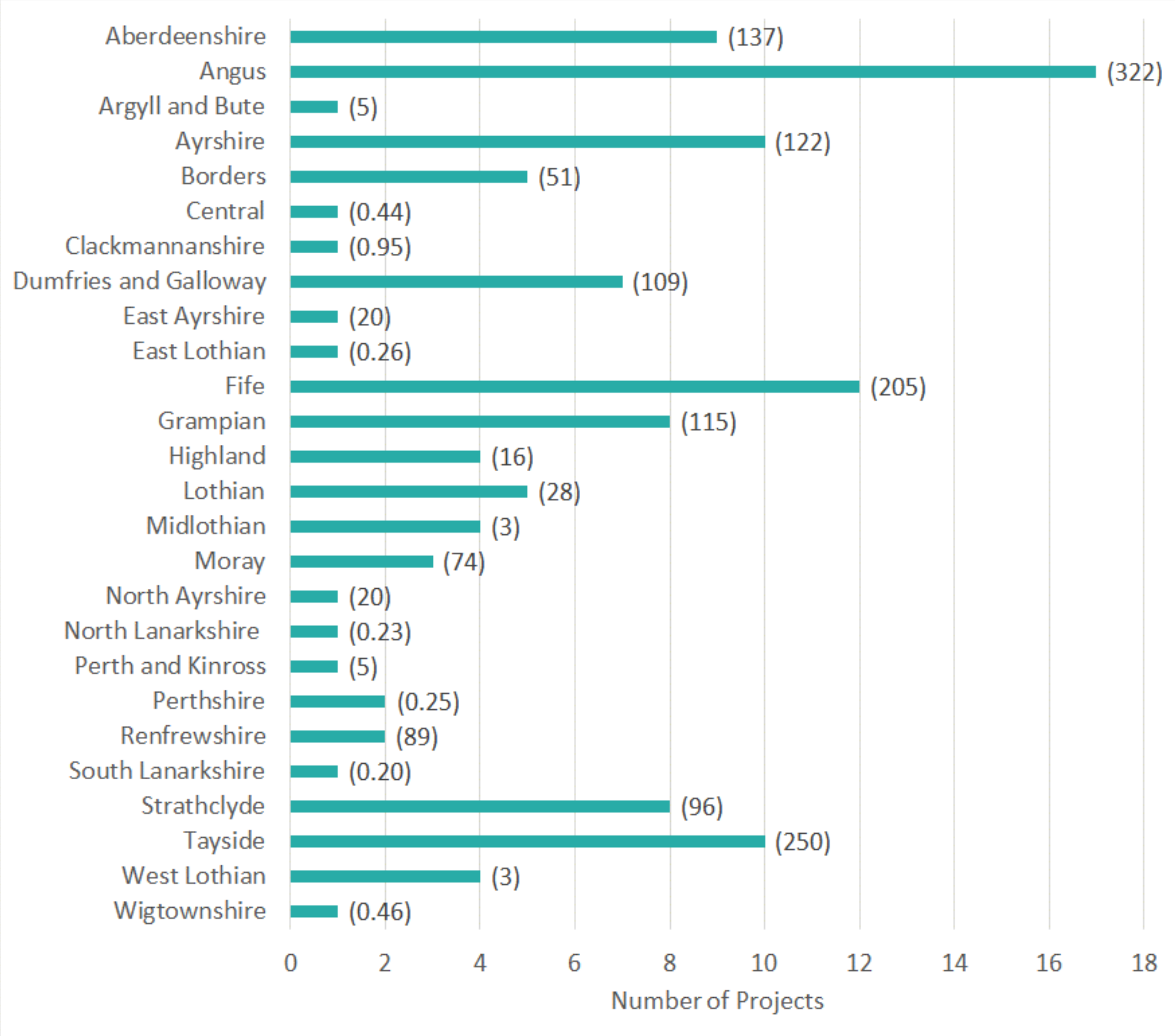

Figure 6: Number (and MW of installed capacity) of ground mounted systems under construction, awaiting construction or for which planning has been submitted, by council area.

This demonstrates that many of these projects will be located in more rural and less densely populated regions of Scotland where there is availability of land at a size appropriate for larger ground mounted systems. The solar potential of an area is also likely to be an important factor, with the East and South West of Scotland tending to have higher levels of solar potential (Global Solar Atlas, 2024). The projects that will be required to achieve 4-6 GW installed capacity do not yet exist, so it can only be assumed, at this stage, that future projects will be deployed in a similar manner in less densely populated regions.

For many of the development activities at the start of the solar PV project lifecycle, location may not be a concern, as much of this work will be desk-based and can be done from anywhere in the country and, possibly, not even in Scotland.

7 Solar industry skills demand

7.1 Skills challenges

To further clarify the job roles and skills that will be in demand as the industry evolves, we engaged with stakeholders as described in the sections above. One of the strongest messages from stakeholder consultations is that there are **significant skills shortages at every level and across each stage of the solar project lifecycle**. This was highlighted by nine of the ten stakeholders that provided input and was confirmed by members of Solar Energy Scotland when the initial report findings were presented to them. This is not, however, specific to the solar industry and is being experienced by numerous industry sectors across the UK that rely on engineers and tradespeople. One industry stakeholder noted "there are simply not enough people going into engineering[9]."

This is leading to widespread problems for companies in attracting and, importantly, retaining staff. Competition for staff is increasing and this, in turn, is driving up costs. The "brain drain" to the south-east of England was also cited by one company stakeholder as a contributing factor with people being attracted by higher salaries and a wider range of job opportunities. This was also validated by members of Solar Energy Scotland at the meeting in Glasgow in March 2024.

Some of the main skills shortages highlighted include electricians, engineers (electrical, structural and civil), roofers, ground-workers and, in general, construction workers. Six of the ten stakeholders consulted highlighted these specific disciplines. This is discussed in more detail in the context of the solar PV project lifecycle below.

7.1.1. Engineering skills

At the first stage of the lifecycle, project development, there is a requirement for engineers and designers that specialise in solar PV systems. Some stakeholders indicated that these are niche roles and many of the relevant degree courses (such as electrical engineering, civil and structural engineering, and architecture), college courses and apprenticeships (electricians and construction) are quite general. This means that people are coming into the industry with good, general, technical skills but do need to undergo further upskilling to meet specific requirements for solar projects. One interviewee said that "the vocational Graduate Apprenticeship Scheme needs to be broadened to include electrical engineering as the current scheme does not support it…we are crying out for this."

Some companies in the sector (including all five of the company stakeholders consulted) are, therefore, developing these skills in-house either through on-the-job training or, in some cases, by setting up their own skills academies. Extending or modifying existing

[9] Technical skills shortages are long-standing issues, with a shortfall of over 173,000 workers identified in science, technology, engineering and maths disciplines in 2021 (Engineering and Technology, 2023).

university courses and apprenticeships to allow some degree of specialisation in renewable energy technologies, including solar, could go some way to addressing this issue. There is also a strong demand for project managers as their skills are very transferable across all renewable energy sectors, not just solar. This was highlighted by one industry association stakeholder that represents companies across the renewable energy sector.

There were no specific skills shortages highlighted in relation to the construction, installation and operation of large ground-mounted solar projects other than the more general UK wide shortages of engineers and tradespeople. Large ground-mounted solar projects are often undertaken by engineering, procurement and construction companies specialising in this type of work. As the number of such projects in the UK, and especially Scotland, is low, the associated workforce tends to be mobile, moving from site to site.

7.1.1. Roofer skills

For both domestic and rooftop projects the chronic shortage of roofers, especially slaters and tilers, both of which are required for solar PV installation, was highlighted by more than 50% of industry stakeholders as well as an industry association consulted during this study. Furthermore, the average age of a competent roofer is over 50 with 60% of the workforce expected to retire in the next five years[10]. There are not enough people coming into the industry to cover these losses so skills shortages are expected to deteriorate. Roofing skills are, however, essential to undertake an appropriate survey, assess what is possible and install the correct brackets, fixings and panels. One industry association stakeholder commented that diversifying into the installation of solar PV would seem like a logical move for many companies but workforce shortages mean that companies are already overbooked, so the appetite for new opportunities is often limited.

7.1.1. Electrician skills

The other key trade required for rooftop projects is electricians and, again, skills shortages were highlighted by over 50% of the stakeholders consulted. Careful consideration needs to be given, however, when discussing skills, particularly with respect to the installation of solar PV systems in new build properties (domestic or commercial) versus retrofit. At a general level, the electrical skills for both are the same. New build projects, whether housing or commercial, tend to be managed by a lead contractor or project manager that co-ordinates and oversees all activities, including electrical work. This lead contractor should ensure that all construction workers on site have the appropriate level of training and skills required. Retrofitted systems, especially domestic, often will not be project managed and electricians, therefore, need to coordinate with other trades (e.g. roofers) and have overall responsibility for the correct and, more importantly, safe installation and operation of the system. Three company stakeholders and one industry association indicated that this is where some problems can arise, especially if electricians are not trained to appropriate standards and there is little or no oversight of the work they are doing.

[10] Information provided during an interview with an industry association stakeholder consulted as part of this study.

Fitting of solar systems, especially in a domestic situation, is not regulated and there is no requirement for engineers or trades to achieve a specified level of training or recognised certification with stakeholders commenting that: "anyone can do it and this leads to quality problems" and that "there is no definition of what a competent installer should be able to do."

The Microgeneration Certification Scheme (MCS) aims to address some of these issues by working with industry to define, maintain and improve standards for low carbon energy technologies, including solar PV, as well as provide a database of certified contractors. Companies can obtain certification by meeting certain standards which demonstrate their competency but there is no obligation for them to do this.

7.1.2. Planning and distribution network operator skills

Skills shortages in allied sectors (see Appendix B for details) were also cited by three company stakeholders, two industry association stakeholders and during the Solar Energy Scotland meeting as causing issues, which will become more severe as the number, scale and complexity of projects increases. Key job roles for which there are already widespread shortages include DNO engineers and local authority planners. A report published in 2020 (Scottish Renewables, 2020) highlighted that the number of planners employed by councils across Scotland fell by 20% between 2011 and 2020. This shortage of planners, and the resulting delays to the progression of projects that this causes was also highlighted by five of the ten stakeholders consulted, both company and industry association. Furthermore, one company stakeholder and two industry association stakeholders cited the significant shortage of DNO engineers with the required level of competency in solar PV as a major issue, particularly in Scotland where renewable energy generation is much more strongly focused on onshore and offshore wind and hydropower. Skills and competencies have, therefore, developed accordingly.

7.2 International solar industry skills strategy development

For the solar PV industry, skills demand is affected by structure of the global supply chain as well as the cross-sectoral nature of installation and maintenance requirements. In 2023, it was estimated that global solar PV employment involved nearly 4.9 million jobs (IRENA, 2023), and almost 40% of workers along the solar PV supply chain require formal training (e.g. electrical engineers and technicians), while 60% require minimal formal training (IRENA, 2021). There is a significant overlap in the skills needed with existing job roles not only across the energy sector, but also in petrochemicals, manufacturing, construction, and other sectors.

The following provides a brief overview of some of the strategies put in place internationally to support the development of the skills in the solar industry.

7.2.1. USA

The USA's Solar Energy Technologies Office accelerates the advancement and deployment of solar technology to support "an equitable transition to a decarbonised economy" (US

Office of Energy Efficiency and Renewable Energy, 2023). It funds solar energy research and development efforts in seven main categories, one of which is solar workforce development. According to the Solar Energy Technologies Office, the US solar workforce will need to grow from approximately 250,000 workers in 2021 to between 500,000 and 1,500,000 workers by 2035. As a result, the Office is funding a range of workforce development initiatives including online and in-person training and education programs, work-based learning opportunities, such as internships and apprenticeships, collegiate competitions, certification programs, and support services such as career counselling, mentorship, and job readiness.

To address the critical need for high-quality and locally accessible training for solar installation, the U.S. Department of Energy established the Solar Training Network (US Office of Energy Efficiency and Renewable Energy, Solar Training Network, 2023). It brings together solar industry representatives, workforce development subject matter experts, diversity group leaders, and other key industry stakeholders to develop and deliver the specialised training needed to meet the demand for skilled workers.

7.2.2. European Union

In May 2022, the European Commission proposed a new strategy, REPowerEU (European Commission, 2023), in response to the energy market disruption caused by Russia's invasion of Ukraine. This includes a target to more than double solar PV capacity to reach 600 GW by 2030, up from 160 GW in 2021. One of its components, the European Solar Rooftop initiative, sets a legal obligation to install solar panels on new buildings, as well as public buildings. Under more ambitious targets of 750 GW and 1 terawatt installed capacity, that Solar Power Europe (Solar Power Europe, 2022) is advocating, solar energy employment could exceed 1 million jobs (457,000 direct + 576,000 indirect) and 1.5 million jobs respectively, as shown in Figure 7.

Figure 7: Solar sector jobs in 2030 to achieve EU installed capacity targets. Adapted from Solar Power Europe 2022

The EU is promoting employment in the solar industry through initiatives such as the Solar Works platform (Solar Power Europe, Solar Works Platform, 2023) which is a combined jobs board and course advertisement resource for those looking to enter the industry. The electrical skills sector is closely collaborating with developments in solar energy as the key element in the solar deployment value chain.

7.2.3. UK and Scotland

The UK British Energy Security Strategy outlines an ambition to increase the solar capacity in the UK from the current 16 GW to 70 GW by 2035 (House of Commons Library, 2023). To develop and drive forward a plan to achieve this target, a government-industry Solar Task Force has been set up. It has established four topic-specific sub-groups, one of which is focused on skills (Solar Energy UK, 2023). This will focus on the development and delivery of the skills and training needed in the solar industry in the short- and long-term.

7.3 Options for closing any current or future skills gaps

The general consensus amongst the stakeholders consulted as part of the study was that, in future, the types of skills required will remain much as they are now as the solar PV project lifecycle will, largely, remain the same. The consensus is that the current setup needs to be scaled up. A key message from all stakeholders is that more people with relevant and transferrable skills will need to be attracted into the industry at all levels and across the various job roles. It is likely that many of these individuals will require retraining or upskilling to meet the specific requirements of the solar industry. Given the growth of the sector that will be required to achieve 6 GW of installed capacity and the small size of many of the companies operating in the solar PV industry, especially domestic solar PV, some external support may be required.

Stakeholders indicated, however, that the construction industry, of which the installation of solar PV is considered to be part, is very traditional, conservative and male dominated. It is not considered to be an attractive career option for many people, especially women, despite a number of stakeholders indicating that there should be more focus on attracting women into the industry. Therefore, greater effort is needed to encourage a younger and more diverse workforce to enter the sector. These will be people coming through further and higher education systems via apprenticeships, or certificate, diploma and degree programmes. These individuals will be critical three to four years from now when installation activity will need to ramp up quickly to achieve 6 GW installed capacity. For those entering technical roles, there will be a need to ensure that existing training, apprenticeships and degree programmes are tailored, or new programmes created as appropriate, to meet the needs of the solar PV industry now and in the future. There is a need, therefore, for concerted action to increase the visibility of the sector to individuals in secondary, further and higher education. These are the people that could address potential workforce shortfalls towards the end of this decade and into the 2030s. This may require a more strategic and co-ordinated approach with industry, training providers, schools and relevant government bodies working in partnership to develop interventions to meet the forecast numbers of skilled workers.

In parallel, raising the awareness of the broad range of career opportunities, directly or indirectly associated with the solar PV sector, would be beneficial as an additional means of attracting more people, and especially young people, into the industry. A good example is the Solar Career Map developed by the USA's Interstate Renewable Energy Council (Interstate Renewable Energy Council, 2024) which covers the broad spectrum of job roles, potential salaries and routes to career progression.

As has been highlighted previously, the UK as a whole, is suffering from engineering related skills shortages and the skills that are in demand in the solar PV sector will also be in demand from other parts of the renewable energy industry and other industries. Many of the stakeholders interviewed during this study indicated skills for solar PV cannot, therefore, be considered in isolation and that a more strategic action is required to understand the number of jobs roles that will be required to meet the targets and ambitions of relevant industries (e.g. installed capacity ambition in renewable energy and house-building targets in construction) and identify those for which there will be competing demands. This would provide a baseline on which future skills development interventions could build.

8 Conclusions

Based on the evidence gathered during this study, there are significant skilled workforce shortages in Scotland's solar industry. This applies to all project lifecycle stages. The workforce currently employed in the industry has adequate skills, according to our stakeholder engagement, however, the number of people working in the industry will need to increase rapidly for the deployment of 4 to 6 GW installed capacity aspirations.

If this shortage is not resolved, the impact on the ability to achieve this installed capacity will be significant. This will be further exacerbated by increasing competition for a pool of skilled workforce that is already insufficient to meet demand from both the solar industry and other parts of the renewable energy sector as well as industry sectors, such as construction.

Specific project findings include:

- Delivering 6 GW of solar PV by 2030 could result in the number of jobs expanding from approximately 800 FTE in 2022 (LCREE data) to a maximum of just over 11,000 FTE in 2030. This includes 9,100 FTE for construction related activities, almost 82% of the workforce. Many of these jobs will be temporary and mobile, mainly appearing during peak construction times.
- Operations and maintenance jobs will increase from an estimated 184 FTE in 2024 to an estimated 2,000 FTE in 2030. These job roles are more likely to be permanent and sustained in the following years.
- The pipeline of projects to achieve 6 GW installed capacity does not yet exist, so is it not possible to state definitively the geographical locations that will have the highest additional skills demand. Based on an analysis of the current ground-mounted and commercial rooftop project pipeline (REPD 2023), Aberdeenshire, Angus, Fife and Tayside are the local authorities with the highest expected MW of installed capacity, 54% of the total, and, therefore, will be the areas with the highest demand for construction FTEs and, subsequently, for operations and maintenance FTEs.
- The growth in the number of domestic rooftop installations that will be required to meet the 1.5 GW installed capacity aspiration for this type of projects by 2030 is more likely to result in a construction, installation and maintenance workforce that is anchored in a particular geographical location, with companies delivering services to local customers. This will be concentrated in and around the main clusters of population in Scotland.
- As these skills are also sought after in other parts of the energy and other industries, there will be a particularly high demand for:
    - electrical specialists like electricians: 589 FTE by 2030
    - grid connection engineers: 394 FTE by 2030
    - high voltage technicians: 494 by 2030
    - electrical engineers: 132 FTE by 2030.
- The need for the following job roles will increase quickly to support the build of larger solar projects:
    - construction workers, including civil contractors: 791 FTE by 2030
    - general labourers and operators: 383 FTE by 2030,
    - crane operators and lifting contractors: 496 FTE by 2030 and
    - roofing contractors: 342 FTE by 2030.

These are also skills that are readily transferable to and in demand from other parts of the renewable energy sector, as well as the construction sector.

- Existing skills shortages in 'allied sectors' such as energy system operation, DNOs and local authority planning are causing delays to the planning, approval and construction of solar projects. A combined average of 73 FTE of these allied sector job roles will be required each year to enable solar PV project developments.

9 Recommendations

Actions to address skills shortages in Scotland will be essential for the success of Scotland's solar PV industry in its aspiration to achieve 6 GW of installed capacity, as well as for the achievement of Scotland's broader renewable energy objectives. The development and delivery of these actions should be led by industry, but will require support from and collaboration with schools, colleges, universities, training providers and relevant public sector bodies.

Based on the evidence gathered during this study the suggested actions to address skills challenges include:

- Develop strategies to raise awareness and promote the solar PV industry to attract new entrants. These should highlight the sector's net zero and sustainability credentials and be designed for primary, secondary, further and higher education students, as well as individuals already in the workforce. These should clearly illustrate the wide range of potential career pathways for individuals at all levels of education, recognising that younger generations, in particular, are far more mobile in the workforce.
- Build on the work that is already being done by, for example, the Solar Task Force skills working group, to design and specify renewable energy and specific solar PV course content. Potential options identified during this study could include:
    - a dedicated apprenticeship in renewable energy
    - college and university courses such as electrical engineering and apprenticeships, such as electrician and construction, with opportunities to specialise in renewable energy and solar PV system installation.
    - extension of the vocational graduate apprenticeship scheme to cover a wider range of subjects, such as electrical engineering.

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11 Appendix / Appendices

11.1 Appendix A – Stakeholder consultation process

In total, ten stakeholders were consulted as part of this study to obtain their insights on current workforce needs and how they might change in the future. The organisations that provided input are shown in the table below.

Interviewee	Category
Emtec Energy	Company
Forster Group	Company
NFRC Scotland	Industry Association
RES Group	Company
Savills Energy	Company
Scottish Renewables	Industry Association
SELECT	Industry Association
Solar Energy UK	Industry Association
Gensource	Company
InnoSol	Company

Table 7: Stakeholders consulted as part of the study

The interview structure approved by the project steering group and used to guide the stakeholder discussions, is as follows:

- Lifecycle of a solar installation project: could you talk us through the typical lifecycle of a solar installation project and the key workforce needs at each stage?
- Project-specific workforce requirements: for your current and upcoming projects, what specific job roles and skills levels are a priority for you?
- Workforce composition and numbers: what does the workforce composition look like in terms of job roles and numbers for a typical solar project (rooftop installation versus ground-based project)?
- Skill level assessment: how are the skill levels required for various job roles assessed for each installation or project?
- Skills gaps: are there any skills shortages or gaps being faced by the industry currently? If yes, in which job categories and which geographic areas
- In-house training: What, if any, training is provided in-house, including existing apprenticeship programmes
- Attracting and retaining talent: if you are an employer, do you experience recruitment difficulties for any specific roles?
- Future demand for skills: what skills will be required to achieve the proposed ambition of 4-6 GW of solar capacity by 2030 and what is the likely demand for these skills (i.e. to what size will the workforce grow)? Do you predict any changes in a typical lifecycle of a solar project that would require new/different skills?

- New skills: are there any challenges or changes in the solar industry that are creating demand for new skills or new job roles?
- Competition for skills: is there competition for skills from other industries or from other parts of the UK / Europe? Is the solar industry in Scotland attracting skills from elsewhere? Are there any synergies between the workforce in solar and other sectors (e.g., electrical)?
- Skills development and training: Are universities, colleges and vocational training institutes delivering skills development and training required by the industry? What role can they play in addressing any skill gaps identified?

In addition, the draft findings of this study were presented to members of Solar Energy Scotland, the Scottish working group of Solar Energy UK, at a meeting held in Glasgow in March 2024. At this meeting, further insight into skills requirements now and in the future were provided with additional written feedback provided by email.

11.2 Appendix B – Solar Industry Context

This section explores policies and skills demands in allied sectors that will influence the development of the Scottish solar industry.

11.2.1. Electricity System Operation

Electricity system operation (ESO) in the UK is undergoing rapid change as it responds to an exponential increase in pressures associated with planning and operating the UK's gas and electricity networks as the number and complexity of electricity projects increases. Anecdotal evidence suggests that the waiting time for renewable energy projects to be connected to the grid is, currently, extending into the late 2030s(Local Government Association, 2023).

Seven of the nine individual stakeholders contacted during this study highlighted that the delays to grid connection is the main bottleneck in the industry and is the one issue that is most likely to impact on the deployment of solar PV. Without a strong pipeline of projects progressing through planning and onto construction and operation, jobs will not be created.

In 2020, the National Grid estimated that across their activities, the future energy workforce requirements to 2050 will include approximately 400,000 FTE, of which 260,000 will be an additional demand (i.e. an increase in the overall workforce requirements) and 140,000 will be replacing those leaving the workforce, for example, by retiring (National Grid, 2020). Of these jobs, 48,700 will be based in Scotland. The report highlights the appetite for data, digital, and engineering skills (at technician and graduate levels). Very little has been reported, however, on the upstream skills requirements, including preparation of the regulatory documentation (e.g., Data Registration Code), review of the documentation, environmental skills and competencies, and other enablers of project compliance. Stakeholders consulted during this study, however, have highlighted the challenges being faced by companies across the renewables energy sector, not just solar PV, due to staff shortages at the National Grid and other distribution network operators. One company stakeholder commented "the biggest barrier is the grid."

11.2.2. Consenting bodies

Electricity generation with a capacity exceeding 50 MW must be submitted to the Scottish Government's Energy Consents Unit for consideration by Scottish Ministers. Those below 50 MW are authorised by the local planning authority (Scottish Government, 2023).

The REPD database (data extracted for December 2023) shows that there were only four project applications made to the Energy Consents Unit, two of which have been granted planning permission and are awaiting construction. The remaining two are still awaiting planning permission. This means that the bulk of applications must go through local planning authorities and, as far back as 2020, Scottish Renewables was highlighting a renewable energy planning 'log jam' that could jeopardise Scotland's net zero targets. This issue was detailed in a report (Scottish Renewables, 2020) that concluded this issue was, in part, due to the increasing number of planning applications being submitted at the same time as a fall in the number of planners employed by councils across Scotland – 20% between 2011 and 2020 - when this Scottish Renewables report was published. Many of the stakeholders consulted during this study also highlighted this as an issue. Quotes from the interviewees include: "local authority planners are totally stretched," and "it can take two to three months to get a response from planning and then another two to three months to get a building warrant. This has a major impact on workflows." Councils are also known to struggle with hiring and retention of staff (The MJ, 2023).

The REPD database (December 2023) includes information relating to when planning applications are submitted and, subsequently, when planning permission is granted. For commercial rooftop projects the data shows that this ranges from four weeks to seven months with the majority being in the range two to three months, which reflects the comments made by stakeholders.

In Scotland, the installation of rooftop projects can be done under permitted development if they meet a set of rules covering minor modifications or improvements made to the outside of homes and commercial buildings. The Scottish Government has produced guidelines (Scottish Government, 2021) on householder permitted development rights and what can be built without submitting a planning application. Any domestic installations that do not meet these rules will require planning permission.

On March 28th 2024 a statutory instrument was put before the Scottish Parliament announcing new measures to help simplify the planning rules (Solar Energy UK, 2024). Amongst the most significant changes are:

- A proposal to remove the current 50 kW limit for permitted development on rooftop solar installations. Currently, any rooftop solar PV installation of 50 kW (approx. 220m^2) or greater, must be subject to a full planning application.
- Solar PV installation in conservation areas can be a permitted development under certain circumstances, such as not on primary elevations or facing roads.
- Flat roof solar PV systems can be installed under permitted development provided they do not protrude more than one meter from the roof surface.

These changes are considered to be a significant step forward, streamlining the processes and making it easier to design and install solar PV systems.

11.3 Appendix C – Modelling methodology

11.3.1. Background

The top-down model was built using LCREE Survey estimates for the UK between 2014 and 2021 (Office for National Statistics, 2021) that provides FTE job estimates per country and per Standard Industry Classification (SIC) code in relation to the solar sector. Therefore, the solar employment in SIC D: Electricity, gas, steam and air conditioning supply was used as a proxy measure for the number of FTEs in solar project operation and installation in Scotland and SIC F: Construction to estimate the number of FTEs in construction. It is noted that SIC codes are not broken down at a Scotland level so it was assumed that the UK breakdown applies to Scotland. Using the REPD 2021, the capacity (MWelec) in construction and in operation in the solar sector for ground-mounted and commercial rooftop projects was calculated. The datasets describing the sector's activity in 2021 were used as these were the most recent available at the time of the preparation of this report (LCREE 2022 was released in March 2024), and to allow the comparability with the parallel study focusing on the economic activity and skills requirements of the onshore wind sector (ClimateXChange, 2024). The overview of the data sources and outputs of the models are presented in the main body of the report.

The cumulative MWelec of domestic rooftop projects was estimated using the solar PV deployment database(Department for Energy Security and Net Zero, 2023) and the MCS installations database. These official data sources then yielded the core assumptions of FTE/MWelec in construction and FTE/MWelec in the operation of solar energy projects.

We used REPD data (ground-mounted and commercial rooftop) and MSC data (domestic rooftop) to estimate installed solar capacity in 2021-2023 and the assumption that 6 GW total installed capacity will be met in 2030. The capacity increase between 2023 and 2030 was proportionately divided into three fractions as follows:

- 20% in 2025-2026
- 30% in 2027-2028
- 50% in 2028-2030.

This forecast served as a hypothetical deployment pipeline as the project pipeline to achieve 6 GW of installed capacity does not yet exist. Subsequently, the FTE requirements over the period 2024 – 2030 are entirely dependent on this hypothetical capacity deployment pathway. They could look differently under a different capacity deployment scenario. To note, the prediction for installed capacity in 2024 is based on the sum of already operational projects and projects in construction in 2023.

We used the 2019-2023 REPD data as the industry's past performance measure and the 6 GW as the assumed capacity in 2030. This was broken down as follows: 3.5 GW ground-mounted, 1.5 GW domestic rooftop, and 1 GW from commercial rooftop. In consultation with technical experts from ITPEnergised, a possible scenario for the installed capacity increase was predicted. The overall workforce requirements in construction and operation of solar projects were then calculated on an annual basis.

For the bottom-up modelling we used the in-house expertise of IPTEnergised and input provided by stakeholders to develop a jobs matrix that describes the stages of a typical solar project across the three project types (ground-mounted, commercial rooftop and domestic rooftop) in terms of FTE requirements. We then modelled how workforce requirements in each job role could increase in the context of the forecasted installed capacity.

11.3.2. Top-down modelling of solar capacity increase and total FTE forecast

The assumptions to top down modelling are presented in Figure 8 and described in section 11.3.1.

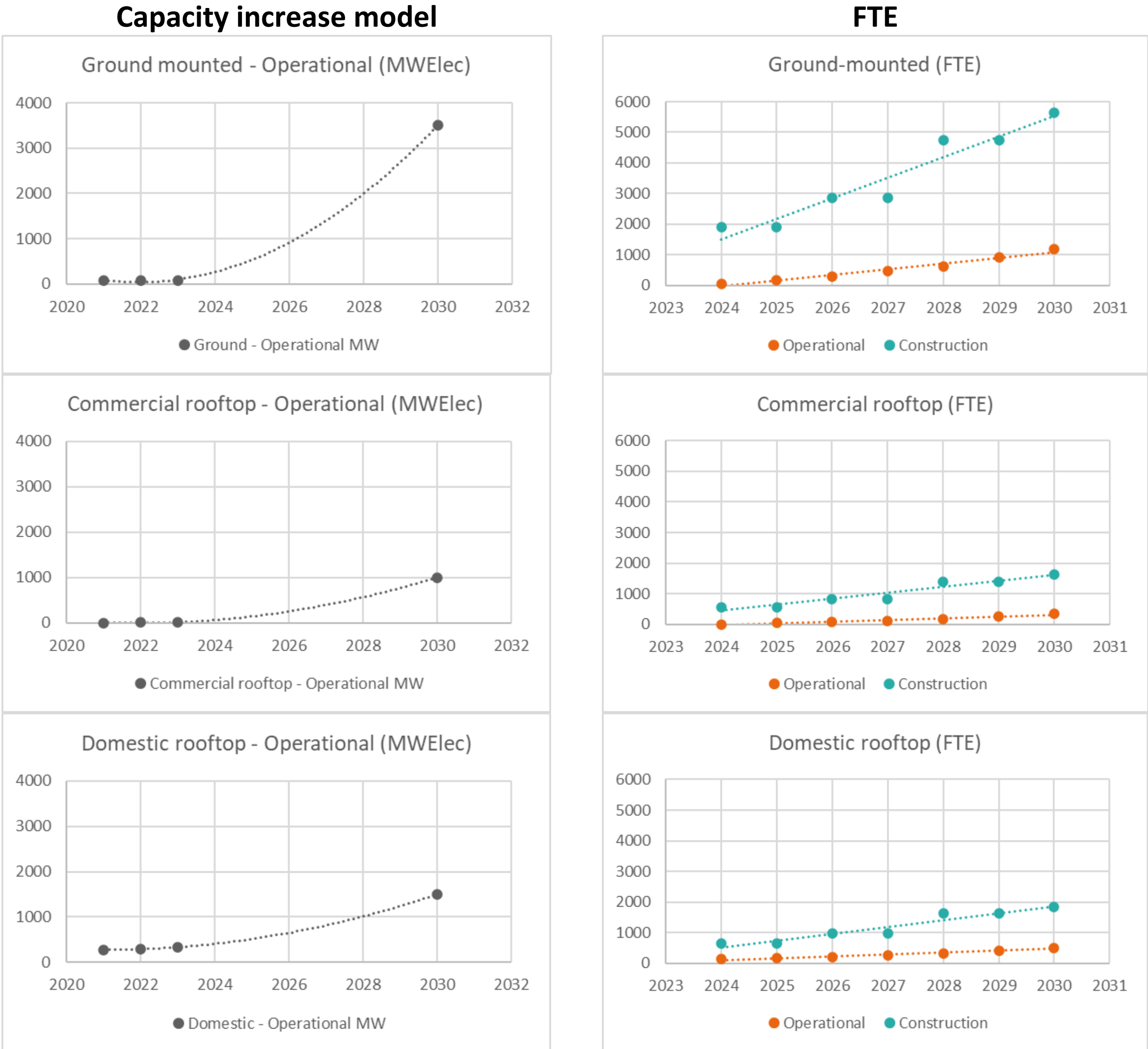

Figure 8: 6 GW installed capacity - top-down modelling of MWelec installed capacity increase and the possible FTE requirements in ground-mounted, commercial rooftop, and domestic rooftop solar projects split by construction and operation

11.3.3. Bottom-up modelling of job roles and total FTE demands

As indicated previously, conventional bottom-up modelling for the economic activity forecast in the sector is not feasible due to the fact that the projects that will enable a 6 GW deployment are not yet in the development pipeline. As a result, a typical solar project and its workforce requirements have been simulated, based on the following assumptions:

Type of solar panel	Size	Project duration
Ground mounted	50 MW	24 months
Commercial rooftop	1 MW	8 months
Domestic rooftop	4 kW	3 months

Using the in-house expertise of IPTEnergised, an established project developer, the job roles required for each project type and at each project stage of the project lifecycle were defined and an estimate made of the FTE for each job role by project type. The number of projects necessary to achieve the 3.5 GW ground-mounted, 1.5 GW domestic rooftop and 1 GW commercial rooftop capacities were calculated and the number of FTEs multiplied accordingly. In the absence of robust information on how quickly different types of projects will move through the planning pipeline, we have assumed that FTEs for ground-mounted feasibility stages are created one year before the construction stage.

Where possible, the job roles and FTE calculations were validated during the stakeholder interview process. In this way, heat maps have been created that illustrate potential workforce requirements across different project types and stages. The heatmap for 6 GW installed capacity is shown in the main body of the report. The heatmap for the 4 GW installed capacity is shown below.

Combined	2024	2025	2026	2027	2028	2029	2030
Legal	70	110	176	237	349	450	566
Civils contractor	40	86	141	210	299	414	527
Electrician	96	111	166	188	291	328	392
Grid connection installation	91	91	136	136	227	227	263
Labourer/Operators (general)	88	88	132	132	220	220	255
Health & safety officer	59	72	109	128	197	229	279
Crane/lifting contractor	16	48	80	128	177	257	330
HV Technician	14	47	79	127	175	256	329
Roofing Contractor	76	79	115	120	191	199	228
Logistics manager	12	39	66	106	146	214	275
EPC contractor	65	65	98	99	164	165	190
Back office support	23	32	49	62	91	112	137
Asset Manager	7	21	36	59	81	118	152
Electrical engineer	30	30	46	46	76	76	88
Civil engineer	24	24	36	36	60	60	71
IT manager	4	13	22	36	50	72	93
Surveyor	22	22	34	34	56	56	65
Project manager	22	22	32	32	54	54	62

Combined	2024	2025	2026	2027	2028	2029	2030
Consultant - Site Design and Modelling	21	21	31	31	52	52	59
Consultant - Grid connection consult./application	19	19	29	29	48	48	55
DNO/TO Senior Authorised Person (SAPs)	14	14	21	21	34	34	41
Environmental consultant (general)	13	13	19	19	32	32	38
Planning Officers	10	10	15	15	25	25	29
Transport operative	6	6	10	10	16	16	19
Financial Analyst	4	4	6	6	9	9	11
Structural Engineer	4	4	5	5	9	9	11
Consultant - Energy Yield Assessors and PVSyst specialists	3	3	5	5	8	8	9
Environmental consultant - ECoW	3	3	5	5	8	8	9
DNO case worker	3	3	4	4	6	6	8
Consultant - Landscape & Visual Consultant	2	2	3	3	5	5	5
Consultant - Transport	2	2	2	2	4	4	5
Environmental consultant - Cultural Heritage/Archaeologists	2	2	2	2	4	4	5
Environmental consultant - Ecologist	2	2	2	2	4	4	5
Environmental Consultant - Flood risk and drainage	2	2	2	2	4	4	5
Environmental consultant - Forester	2	2	2	2	4	4	5
Environmental consultant - Hydro/Hydrogeo/Peat	2	2	2	2	4	4	5
Environmental consultant - Noise & Vibration	2	2	2	2	4	4	5
Environmental consultant - Ornithologist	2	2	2	2	4	4	5

Table 8: Total workforce requirements – 4 GW capacity

The full selection of heat maps by project type can be found in Appendix D. This is for 6 GW installed capacity only. As the 4 GW capacity has not been broken down by ground-mounted, commercial rooftop and domestic rooftop in the same way as the 6 GW capacity, it was not possible to undertake the same level of modelling and analysis, including modelling of one-year lag time between the realisation of FTEs associated with ground-mounted feasibility and construction stages.

11.3.4. Top-down and bottom-up model convergence

Two modelling approaches were developed that sought to:

- Predict the total annual FTE that could enable the delivery of 6 GW solar installed capacity in the timeframe 2024 - 2030.
- Estimate the job roles and their FTE requirements on annual basis.

The FTE job numbers calculated using the top-down modelling approach are consistently higher that the FTE job numbers calculated using the bottom-up modelling approach, although both show similar growth trends. The numbers from the top-down model could, therefore, be interpreted as the upper limit and those from the bottom-up model as the lower limit.

The breakdown into annual FTEs is shown in the figure below.

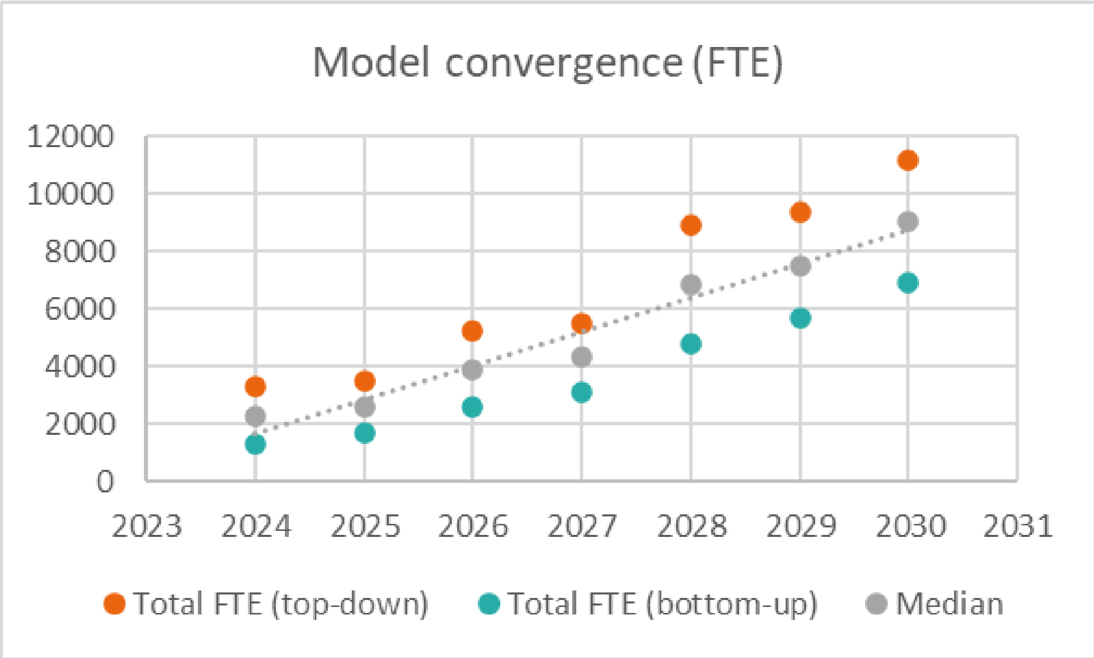

Figure 9: Workforce Requirements – Comparing the Two Modelling Approaches (FTE)

11.4 Appendix D – Workforce requirements by project type and at each stage of the project lifecycle

The following heatmaps show the number and types of jobs required annually to 2030, broken down by project type and at each stage of the project lifecycle. Decommissioning has not been included as solar systems have not yet reached this stage of the lifecycle in Scotland and it is not, therefore, possible to estimate job numbers with any certainty. As noted above, this is only possible for 6 GW capacity as the 4 GW capacity has not been broken down into the different project types.

11.4.1. Ground mounted projects – 6 GW installed capacity

Job role	2024	2025	2026	2027	2028	2029	2030
Ground mounted, feasibility stage							
Project manager	6	8	8	13	13	15	0
Consultant - Site Design and Modelling	6	8	8	13	13	15	0
Electrical engineer	6	8	8	13	13	15	0
Consultant - Energy Yield Assessors and PVSyst specialists	6	8	8	13	13	15	0
EPC contractor	22	32	32	51	51	60	0
Surveyor	6	8	8	13	13	15	0

Job role	2024	2025	2026	2027	2028	2029	2030
Environmental consultant - ECoW	6	8	8	13	13	15	0
Environmental Consultant - Flood risk and drainage	3	4	4	6	6	7	0
Environmental consultant - Ornithologist	3	4	4	6	6	7	0
Environmental consultant - Ecologist	3	4	4	6	6	7	0
Environmental consultant - Hydro/Hydrogeo/Peat	3	4	4	6	6	7	0
Environmental consultant - Noise & Vibration	3	4	4	6	6	7	0
Environmental consultant - Cultural Heritage/Archaeologists	3	4	4	6	6	7	0
Environmental consultant - Forester	3	4	4	6	6	7	0
Consultant - Transport	3	4	4	6	6	7	0
Civils contractor	6	8	8	13	13	15	0
Financial Analyst	4	5	5	9	9	10	0
Planning Officers	4	6	6	10	10	11	0
Consultant - Grid connection consultancy and application	2	3	3	5	5	6	0
DNO case worker	4	6	6	10	10	12	0
DNO/TO Senior Authorised Person (SAPs)	2	3	3	5	5	6	0
Legal	30	43	43	68	68	80	0
Ground mounted, construction							
EPC contractor	4	4	6	6	10	10	11
Civil engineer	36	36	54	54	90	90	106
Civils contractor	24	24	36	36	60	60	71
Transport operative	10	10	14	14	24	24	28
Crane/lifting contractor	2	2	3	3	5	5	6

Job role	2024	2025	2026	2027	2028	2029	2030
Back office support	1	1	1	1	2	2	3
Health & safety officer	48	48	72	72	120	120	142
Electrician	10	10	14	14	24	24	28
Electrical engineer	2	2	2	2	4	4	5
Environmental consultant (general)	19	19	29	29	48	48	57
Grid connection installation	4	4	6	6	10	10	11
DNO/TO Senior Authorised Person (SAPs)	7	7	11	11	18	18	21
Legal	12	12	18	18	30	30	35
Ground mounted, operational							
EPC contractor	0	1	1	2	2	3	4
Back office support	5	16	27	43	59	87	111
Electrician	8	25	42	68	93	136	175
Civils contractor	31	99	168	271	373	544	700
Asset Manager	10	32	53	86	119	173	223
Crane/lifting contractor	22	70	118	189	261	381	490
Health & safety officer	8	25	42	68	93	136	175
HV Technician	22	70	118	189	261	381	490
Logistics manager	18	58	98	158	218	318	408
IT manager	6	19	33	53	73	106	136
Legal	27	87	147	237	327	476	613

Table 9: Ground mounted projects – 6 GW installed capacity scenario, FTE requirements by job role

Job role	2024	2025	2026	2027	2028	2029	2030
Commercial rooftop, feasibility							
Project manager	4	4	6	6	10	10	12
Consultant - Site Design and Modelling	3	3	4	4	7	7	8
Electrical engineer	5	5	8	8	14	14	16
EPC contractor	4	4	6	6	10	10	12
Surveyor	5	5	8	8	14	14	16
Structural Engineer	5	5	8	8	14	14	16
Roofing Contractor	5	5	8	8	14	14	16
Consultant - Landscape & Visual Consultant	3	3	4	4	7	7	8
Financial Analyst	2	2	4	4	6	6	7
Planning Officers	2	2	3	3	5	5	6
Consultant - Grid connection consultant /application	3	3	5	5	8	8	10
DNO/TO Senior Authorised Person (SAPs)	3	3	5	5	8	8	10
Legal	33	33	49	49	82	82	97
Commercial rooftop, construction							
EPC contractor	4	4	6	6	10	10	12
Labourer/Operators (general)	62	62	93	93	155	155	183
Back office support	3	3	4	4	7	7	8
Health & safety officer	3	3	4	4	7	7	8
Electrician	41	41	62	62	103	103	122
Electrical engineer	10	10	15	15	26	26	31
Grid connection installation	62	62	93	93	155	155	183
DNO/TO Senior Authorised Person (SAPs)	8	8	12	12	21	21	24
Legal	7	7	10	10	17	17	20
Commercial rooftop, operations							
Back-office support	0	0	0	1	1	1	2
Electrician	0	0	1	1	2	3	4
Civils contractor	0	1	1	2	3	4	6
Asset Manager	0	1	1	2	3	4	6

Job role	2024	2025	2026	2027	2028	2029	2030
Health & safety officer	0	0	0	1	1	1	2
HV Technician	0	0	1	1	2	3	4
Logistics manager	0	0	1	1	2	3	4
IT manager	0	0	1	1	2	3	4
Legal	0	1	2	3	4	6	8

Table 2: Commercial rooftop projects – 6 GW installed capacity scenario, FTE requirements by job role

11.4.2. Domestic rooftop projects – 6 GW capacity

Job role	2024	2025	2026	2027	2028	2029	2030
Domestic rooftop, feasibility							
Project manager	23	23	35	35	59	59	66
Consultant - Site Design and Modelling	23	23	35	35	59	59	66
Electrical engineer	23	23	35	35	59	59	66
EPC contractor	31	31	47	47	78	78	89
Surveyor	23	23	35	35	59	59	66
Roofing Contractor	23	23	35	35	59	59	66
Planning Officers	9	9	14	14	23	23	27
Consultant - Grid connection consult./application	23	23	35	35	59	59	66
Domestic rooftop, construction							
EPC contractor	35	35	53	53	88	88	100
Back office support	20	20	30	30	50	50	57
Health & safety officer	23	23	35	35	59	59	66
Electrician	70	70	105	105	176	176	199
Roofing Contractor	70	70	105	105	176	176	199
Labourer/Operators (general)	70	70	105	105	176	176	199
Grid connection installation	70	70	105	105	176	176	199
Domestic rooftop, operational							
Back office support	6	8	10	13	16	21	25
Electrician	15	20	25	32	39	50	60

Job role	2024	2025	2026	2027	2028	2029	2030
Health & safety officer	6	8	10	13	16	21	25
Roofing Contractor	15	20	25	32	39	50	60

Table 11: Domestic rooftop projects – 6 GW installed capacity scenario, FTE requirements by job role

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