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EU Solar Jobs Report 2023

Bridging the solar skills gap through quality and quantity

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SolarPower Europe

SolarPower Europe – Leading the Energy Transition

SolarPower Europe is a member-led association that aims to ensure that more energy is generated by solar than any other energy source by 2030.

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Please cite as: SolarPower Europe (2023): *EU Solar Jobs Report 2023 – Bridging the solar skills gap through quality and quantity.*

Published: September 2023.

ISBN: 9789464669084.

Thanks to our sponser members:

Design: Onehemisphere, Sweden. contact@onehemisphere.se

Front cover image: © Enel.

Executive summary

The solar photovoltaic (PV) energy sector in the EU is showing continuous growth. The year 2022 showed yet another record deployment level with 40.2 GW installed, helping the EU to work toward achieving its climate goals for 2030 and 2050. The demand for solar power systems in 2022 clearly underscored the urgent need among citizens to protect from soaring electricity and natural gas costs. Yet, an often underestimated and critical bottleneck emerging in various member states is the shortage of qualified installers.

While the growth of the sector is leading to a significant increase in job opportunities, Europe needs to attract and redirect workers in the industry to allow the sector to pursue its expansion. Therefore, this study aims to quantify both the direct and indirect employment generated by the European solar sector at present and provides projections until 2027. The research employs a hybrid methodology that takes into account the following stages of the PV value chain: Manufacturing, Deployment, Operations & Maintenance, and Decommissioning & Recycling.

In the year 2022, the EU solar industry provided employment for approximately 648,000 full-time equivalent positions (FTEs). This translates to a 39% growth from the number of solar jobs provided in 2021. Among the jobs created in 2022, 281,000 FTEs, which accounts for 43% of the total, were direct employment opportunities, while the remaining 367,000 were classified as indirect jobs. The majority of these positions (84%) were linked to activities related to the deployment of solar systems. Approximately 8% of the total jobs were associated with operation and maintenance, while manufacturing accounted for 7%, and decommissioning and recycling made a minor share of 1%. The year 2022 has also been pivotal since Operation & Maintenance Jobs are now surpassing the jobs created in the Manufacturing sector. This reflects the discrepancies between the installation rates of PV, and the slow expansion of a local supply chain.

Within the overall count of 48,200 generated by the manufacturing sector, inverter manufacturing accounts for 35,200 direct and indirect full-time equivalent positions (FTEs), representing 73% of the total manufacturing jobs. Module manufacturing and polysilicon production contribute to 15% and 10% of the total manufacturing jobs, respectively. In contrast, the EU's limited production capacity for ingots & wafers and cells results in the creation of less than 750 jobs in these specific activities.

Looking at Deployment and O&M activities, the vast majority of job creation occurs in the rooftop segment (which includes residential, commercial, and industrial segments). In the EU, rooftops-related jobs represented 73% of solar deployment workers, while utility covered the other 27%. 2022 also marks the first year in which rooftop-related jobs represent more than half the solar jobs in the 7 largest countries in terms of employment numbers. As in 2021, those countries include, Poland, Spain, Germany, the Netherlands, Italy, Greece and France.

The EU Solar Jobs Report offers a five-year projection for job growth in the European Union's solar sector, relying on the scenarios outlined in SolarPower Europe's Global Market Outlook 2023-2027, which was released in June. According to the Medium Scenario, sustained expansion could result in the creation of 1 million jobs already by 2025, and 1.2 million jobs by 2027. Our modelling also indicates than the expansion of manufacturing capacity in Europe following the European Industrial Solar Alliance (ESIA) could lead to 100,000 jobs by 2026, therefore improving energy security, while creating green and local jobs to many Europeans.

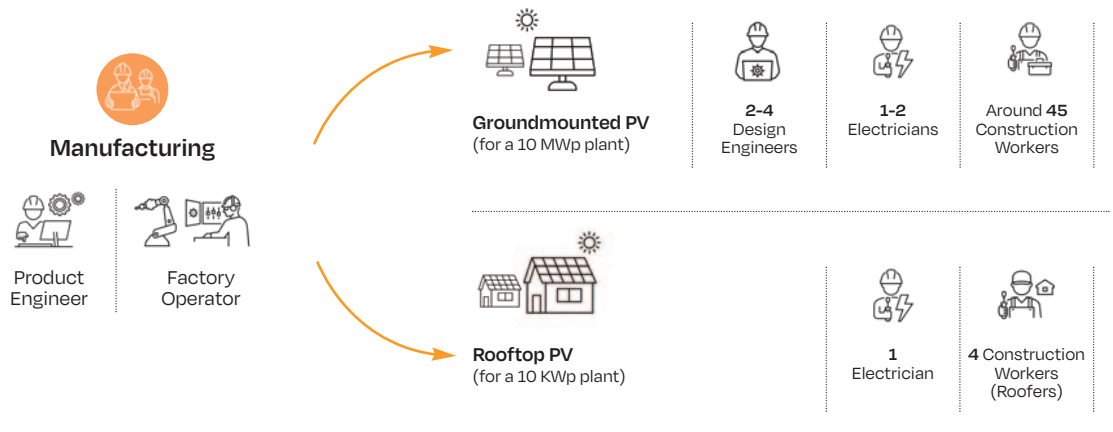
Policy recommendations

Please mind the (skills) gap

We lack workers in Europe... but which workers exactly?

The solar sector is about to create **over a million job opportunities** in just a few years. According to our analysis, sustained expansion of the PV sector in the EU could result in the creation of 1 million jobs already by 2025, and 1.2 million jobs by 2027. To understand the pace of expansion, at the end of 2022, 648,000 people were employed in the sector. In other words, jobs created by solar are basically going to double in just five years.

- Design engineers are particularly critical for the utility-scale segment. As in many industries, there is a fierce competition for engineering talents, while the proportion of STEM student, and the general European level in mathematics, decreases.[1]
- Electrical engineers are critical for the appropriate design and the safe grid connection of the solar system. They are a particular bottleneck for rooftop PV systems, as for each solar PV installation (as for every heat pump), one electrician is needed.
- Construction workers are the hands of the solar revolution. The rooftop PV market is impacted by a lack of roofers and construction workers. The utility-scale market could be significantly impacted by the lack of construction workers in charge of deploying the panels on the ground, especially with the impressive growth of the projects commissioning after 2022.



1 https://education.ec.europa.eu/sites/default/files/document-library-docs/pisa-2018-eu_1.pdf

Policy recommendations / continued

Bridge the gap

1. **Assess the lack of workers.** As mandated in REDIII, Member States must multiply efforts in identifying their gap in their workforce and skillsets. Currently, numbers for the lack of construction, roofing and electrical workers are incomplete and must be gathered by private initiatives. Governments should invest resources in this exercise, work on regular gathering of precise and regular information for each profession, and present it in a more harmonised manner, along with other Member States. This is necessary to establish a European plan of action on European skills, including for product engineers and factory workers in integrated module manufacturing and balance of system (BoS) products such as inverters.

2. **Communicate on green skills needs.** European education policies in Europe valuing service careers and theoretical occupations are having long-term consequences on our ability to carry out the energy transition. The result is a structural lack of technical workers. A fundamental shift in education systems is needed. Governments should better communicate on green job needs and training opportunities. More profoundly, manual careers need to be better valued among students and job seekers, as socially valued careers with perspective of development. The communication campaign shall not only address potential students or trainees, but also aim at mobilising the ecosystem of green skills that is too often unaware of the opportunities in the sectors and does not have access to the right resources: education professionals, public and private employment platforms, VET providers, local and regional authorities. Teaching at technical schools should be valued appropriately according to its strategic importance, bridges must be built between theoretical and technical education platforms as well, to enable the movement of students from university to VET/STEM, and apprenticeships should be valued in those various streams.

3. **Equip workers with solar knowledge.** Two major kinds of professionals are usually needed for rooftop solar installations: qualified electricians for the design, grid connection and supervision of projects, and construction workers (or more specifically roofers) for the mechanical work (installing mounting structures and modules). As the solar sector needs numerous capable hands to install a rising number of solar projects accelerating the training of both those professions to the craft of solar installation is key. When it comes to construction workers, more specialisation will lead to workers that are better equipped to carry out numerous installations while maintaining high levels of quality and safety, for what can be considered a new and rising sub-sector for them. On the electrician's side, apprentices should be encouraged to carry out solar PV training under the supervision of electricians, during their years of studies, to ensure they also have the necessary skills to work on residential, commercial and public roofs. Soon to be established Net-Zero Academies can help develop appropriate learning content for those skill needs, as well for skills in module and inverter manufacturing and engineering.

4. **Develop public and private retraining programmes, notably targeting just transition workers, and upskilling programmes – leveraging the Net-Zero Academies to develop training content.** A number of solar professions (such as solar construction worker or roofer) are accessible through retraining – and a number of workers had a past life before joining the industry. Lifelong training should be encouraged and facilitated for workers, particularly in transitioning industries. Appropriate programmes should be developed and incentivised to prioritise workforce reconversion in the jobs needed for the clean energy transition, and in particular in areas economically affected by the climate transition. In particular, private retraining actions can be supported by the public, through financing support or practical support. In addition, the solar industry is evolving fast. Solar panels are evolving, solar inverters are increasingly digitalised, and electric vehicles or heat pumps are coming with new opportunities for building-level connection. To keep up with the technology developments, electricians and installers must be able to access the right upskilling programmes, in close cooperation with manufacturers. The Net-Zero Industry Academies have a role to play there.

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5. **Skill-proof your energy policies.** Solar PV deployment in the next years will be heavily impacted by the availability of the right skills and workers to conduct the necessary works. Skill-proofing energy policies becomes more and more relevant to the energy transition. Integrated renovations of buildings can be promoted through smart subsidy schemes (for instance, in several countries, asbestos removal programmes are coupled with a subsidy for solar panel installations, coupling two roof works in one) or through improved access to information (for instance, several countries have tested information points offering citizens an early diagnosis of the potential for renovations, encouraging citizens to carry out coupled renovation works and HP / EV / PV installation). Planning and local authorities play a role, thinking building renovation and electrification together.

6. **Facilitate intra-EU movement of workers, by ensuring the mutual recognition of electrical skills and solar installation skills and facilitating the movement of solar workers[2] across borders in the framework of the Posted Workers legislation.** Governments must ensure the mutual recognition of qualifications for electricians and installers under the Services Directive and the Renewable Energy Directive. In the longer term an EU-wide certification standard for electricians should be developed, establishing a common nomenclature of electrical engineering skills and a common basis for skill requirements. The EU can also facilitate the posting of solar workers across countries, for instance by creating national enabling contact points. Those authorities should be aware of the political urgency of these procedures, and be tasked with accelerating them.

7. **Integrate the solar industry's needs into immigration policies.** Finally, the EU must support the growth of the solar sector by facilitating the entry of workers from third countries. Talent Partnerships and the EU Talent Pool, if applied with the right focus and resources, could steer legal migration to strategic sectors. Solar PV, as a key sector for Europe's geopolitical, economic, and environmental challenges, should be central to such mechanisms.

2 In this report, a "solar worker" is any person who spends more than 50% of their working hours on solar-related work.

1 Introduction & methodology

The climate and energy landscape surrounding this year's EU Solar Jobs Report has seen some changes compared to the previous year. The price of energy has come down in the first half of 2023, but next winter is just around the corner and the International Energy Agency (IEA) advised the European Union (EU) to add around 60 GW of solar power in 2023 to avoid gas shortages.

Based on our assessment from the Global Market Outlook for Solar Power 2023-2027, the EU's solar market is undergoing rapid growth. In 2022, the bloc added an impressive 40.2 GW of solar capacity, indicating a substantial 43% increase compared to the previous year. The expansion of solar PV is driven by its increasing adoption by households, businesses, and policymakers who recognise solar as a viable energy solution to attain long-term climate targets and to reduce the dependence on Russian fossil fuels. Projections indicate that the EU's solar market is likely to further increase to 53.8 GW in 2023 and reach a remarkable 97.8 GW by 2027 under a Medium Scenario.

Although challenges persist – such as grid congestion, timely availability of workers, and a stable permitting framework – the prospects for solar energy are promising, with positive market dynamics contributing to job creation across all segments of the value chain. Consequently, the main objective of this study is to showcase the current and future employment opportunities associated with the expansion of solar power in the EU. Our investigation is based on historical data and market scenarios presented in SolarPower Europe's Global Market Outlook 2023-2027.

1.1. Methodology

This study employs a hybrid approach to calculate full-time equivalent (FTE) jobs, drawing from methodologies previously used in solar and renewable energy job creation studies. The model estimates both direct and indirect solar FTEs generated annually in each EU member state, with a focus on four distinct stages of the value chain: (i) Manufacturing; (ii) Deployment; (iii) Operation & Maintenance (O&M); and (iv) Decommissioning & Recycling.

Direct jobs represent FTEs linked to core activities, such as manufacturing, deployment, O&M, and decommissioning & recycling. These are the result of expenditures made by producers/consumers due to final demand. On the other hand, indirect jobs stem from business-to-business purchases in the supply chain, which are considered intermediate transactions. They represent the activities in upstream industries that supply and support the core activities of solar PV. The spending of direct FTEs in intermediate sectors generates indirect FTEs in corresponding sectors.

The calculation of direct jobs in Manufacturing and Decommissioning & Recycling relies on employment factors, which specify the number of jobs created in manufacturing or end-of-life management for every 1 MW of solar capacity in a given country, with distinct values for each value chain segment. In contrast, the approach used for direct jobs in Deployment and O&M is a CAPEX-OPEX model. This model determines the aggregate labour cost as a share of total CAPEX (for deployment) or OPEX (for O&M) and divides it by the cost of labour per worker to obtain the number of jobs resulting from solar installations in a specific EU

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member state. Deployment jobs are based on the annually installed capacity, while O&M jobs are derived from the cumulative installed capacity.

Furthermore, in order to assess the indirect impacts of solar PV investments, the report employs an Input/Output table that encompasses all 27 EU member states and 63 sectors, covering a wide range of economic activities. The Input/Output table provides FTE multipliers, which enable the calculation of indirect jobs based on the direct jobs generated. Table 1 presents an overview of the methodology used in this process. All results are reported annually, reflecting the FTEs required to meet the corresponding year's demand.

TABLE 1 OVERVIEW OF METHODOLOGY

VALUE CHAIN STEP	METHODOLOGY FOR DIRECT JOBS		METHODOLOGY FOR TOTAL JOBS	
Manufacturing	Employment factors	Direct FTEs	Input/output (FTE multiplier)	Total FTEs
Deployment	CAPEX-OPEX model	Direct FTEs	Input/output (FTE multiplier)	Total FTEs
Operations & Maintenance	CAPEX-OPEX model	Direct FTEs	Input/output (FTE multiplier)	Total FTEs
Decommissioning & Recycling	Employment factors	Direct FTEs	Input/output (FTE multiplier)	Total FTEs

Table 2 provides an outline of the value chain activities considered in the study. FTEs associated with Deployment, O&M, and Decommissioning & Recycling are determined based on EU installed capacity scenarios. On the other hand, solar jobs related to Manufacturing are derived from EU production capacities for various value chain products, such as polysilicon, ingots/wafers, cells, modules, and inverters. A separate evaluation of job creation is performed for each of these products' manufacturing processes.

Regarding Deployment, the study evaluates both installation labour and soft labour, which includes engineering, procurement, customer acquisition, and permitting. Direct O&M jobs encompass activities like component and inverter replacement, as well as cleaning and repairs. Jobs in Decommissioning & Recycling pertain to the removal, collection, and treatment of end-of-life modules.

TABLE 2 SCOPE OF SOLAR PV CHAIN FOR CALCULATION OF DIRECT FTES

CATEGORY	CATEGORY SECTION	CATEGORY BREAKDOWN
Manufacturing	Polysilicon	Polysilicon Manufacturing
	Ingot/wafer	Ingot/wafer Manufacturing
	Cells	Cell Manufacturing
	Modules	Modules Assembly
	Inverter	Inverter Manufacturing
Deployment	Installation Labour	Mechanical
		Electrical
	Soft Labour	Procurement
		Engineering
		Customer Acquisition
		Permitting
Operation & Maintenance	Operation & Maintenance Labour	Components replacement
		Inverter replacement
		Cleaning
		Reparations
Decommissioning & Recycling	Decommissioning	Removal of Modules
	Recycling	Collection of waste
		Treatment of waste

1.2. Manufacturing scenarios

EU manufacturing capacities through 2027 are evaluated on three different scenarios:

- A **Low Scenario**, in which EU production capacity remains limited, only existing companies expand their production and announced projects are not fully realised;
- A **Medium Scenario**, in which most of the current companies' announcements are realised;
- A **High Scenario**, in which the production increase in order to reach the 30 GW target by 2030 set by the European Solar PV Industry Alliance (ESIA).

A specific description of the scenario for each of the value chain's segment is presented in table 3.

TABLE 3 EU MANUFACTURING SCENARIOS DESCRIPTION

SEGMENT	LOW SCENARIO	MODERATE SCENARIO	HIGH SCENARIO (ESIA)
Polysilicon	Solar polysilicon manufacturing is decreasing as the production is focusing on semi-conductor segment.	Polysilicon manufacturing increases marginally following large PV market growth, but production focuses on semi-conductor segment.	Polysilicon manufacturing increase and serves both the domestic solar PV market and exports.
Ingots & Wafers	European Ingot production does not expand. Wafer production expands marginally.	Domestic ingot & wafer production increases marginally but cannot serve the full domestic cell production.	Domestic ingot and wafer production is established at a combined 20 GW level to serve the domestic cell industry.
Cells	The current plans for expansion of cell factories are realised, sometimes with a delay, but no other develop.	Most serious cell factory plans announced in 2020/2022 complete financing and open factories.	The EU industry manages to redevelop a 30 GW cell production capacity by 2027.
Modules	The current plans for expansion of module factories are realised, sometimes with a delay, but some smaller manufacturers cannot face the higher competition and go bankrupt.	Certified and planned expansion come online, existing module manufacturing expend their capacity.	Certified and planned expansion come online, existing module manufacturing expend their capacity, all prospect projects come online.
Inverters	Inverter manufacturing in Europe decreases slightly as it cannot compete with foreign production's prices.	Inverter manufacturing in Europe grows and serves both the domestic market and exports.	Inverter manufacturing in Europe grows and serves both the domestic market and exports.

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1.3. Changes from EU Solar Job Report 2022

In the current edition of this study, a different approach has been used to calculate the job creation in the Decommissioning & Recycling segment. After reviewing the model results with industry evidence, an update of the waste generation model was carried out. This revision significantly reduced the share of Decommissioning & Recycling jobs compared to last year's figures; however, the change in the overall number of jobs is negligible and has been counterbalanced by the increase in the other segments.

We have also reviewed and updated manufacturing capacities across all value chain segments, incorporating information from public company announcements and insights provided by our members.

Finally, we have updated labour costs and CAPEX values with the latest available publications, wherever possible, to ensure the most accurate and up-to-date data is considered in our analysis.

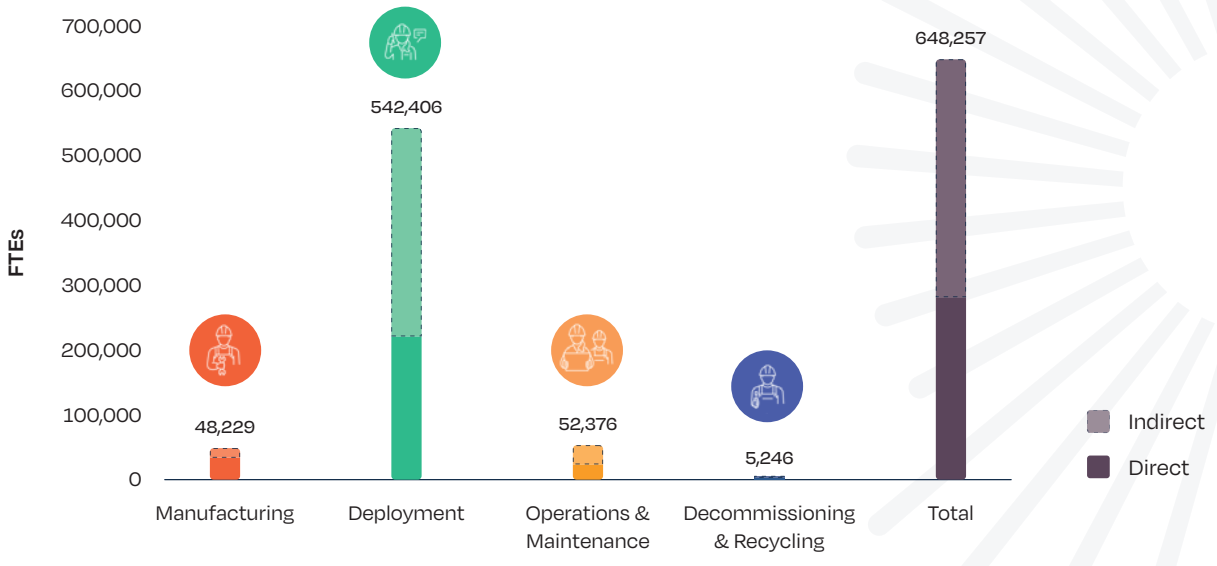
2 EU solar jobs

2.1. Update 2022

In our report from last year, we forecasted an increase in the count of EU solar jobs between 2021 and 2022, but at a slower pace than the growth we observed from 2020 to 2021. It turns out that, as often in the solar industry, the reality outpaced all expectations. The sector grew at a 39% growth rate in 2022 and surpassed the remarkable 30% growth rate observed in 2021. As of 2022, the solar sector has employed 648,000 FTEs in the European Union. Among these, 281,000 FTEs, accounting for 43% of the total, are direct jobs, while the remaining 367,000 FTEs (57%) represent indirect jobs (Figure 1).

The majority of jobs within the solar industry are linked to the deployment phase, amounting to 542,000 FTEs, which constitutes 84% of the total jobs (see Figure 2). The year 2022 was also pivotal as Operation and Maintenance activities generated more jobs than Manufacturing activities for the first time, with 8.1% and 7.4% share respectively, translating the fast increase of the total installed solar PV capacity, and the rather small uptake of manufacturing capacity is the EU. Finally, Decommissioning & Recycling jobs remain a minor component, making up only 0.8% of the total jobs.

FIGURE 1 EU-27 SOLAR JOB MARKET IN 2022



The prevalence of Deployment jobs over the Operation & Maintenance segment is due to the fact that installing solar panels on rooftops and fields demands a substantial workforce, but, once installed, they require minimal physical maintenance and less workers.

Similar to the situation in 2021, Decommissioning & Recycling FTEs constitute the smallest portion of the total FTEs, as solar PV waste streams remain limited in volume and are expected to remain so for the foreseeable future. It is anticipated that solar PV waste streams will only become significant from 2030 onwards when the first wave of larger installed systems in Europe reaches the end of their operational lifetime.

The FTE figure for a specific year represents a snapshot of the number of workers employed by the industry in that specific year. Deployment jobs are directly tied to the amount of solar capacity installed each year and, therefore, depend on the annual market size. Thanks to the sustained growth of the EU solar market in recent years, Deployment jobs have experienced substantial growth. The EU market rose from 19.9 GW in 2020 to 40.1 GW in 2022, exhibiting a 42% compound annual growth rate (CAGR) over the last three years, which has consequently led to a somewhat proportional increase in jobs related to solar deployment.

On the contrary, O&M jobs rely on the cumulative installed solar capacity. As it grew larger, the total fleet of installed capacity is less influenced by yearly new additions. Throughout 2020-2022, the European Union's solar fleet has increased from 139 GW to 208 GW, demonstrating a CAGR of 22%.

Manufacturing roles within the EU's solar sector are intricately tied to the production capacities spanning member states. Notably, the EU's industry holds substantial manufacturing capabilities at specific stages of the value chain, primarily for polysilicon and inverters. On the contrary, the production of modules currently remains small at the global scale and there is a notable deficiency in production capacity for ingots/wafers and cells, an issue the industry is actively working to rectify.

In terms of employment, inverter manufacturing takes the lead, contributing significantly to EU solar manufacturing jobs – approximately 35,000 jobs in total, encompassing both direct and indirect roles. This accounts for 73% of the overall FTE positions within manufacturing (Figure 3). This result aligns with the widespread presence of inverter companies across Europe, including numerous global market players.

FIGURE 2 EU-27 TOTAL SOLAR JOBS BREAKDOWN IN 2022

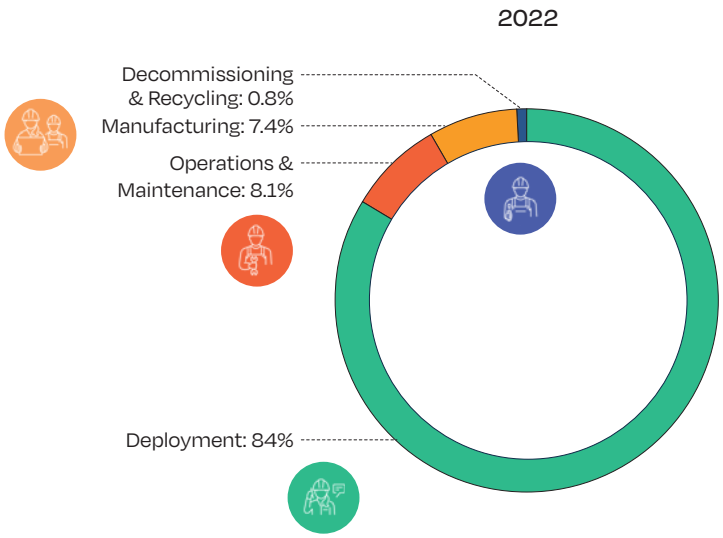
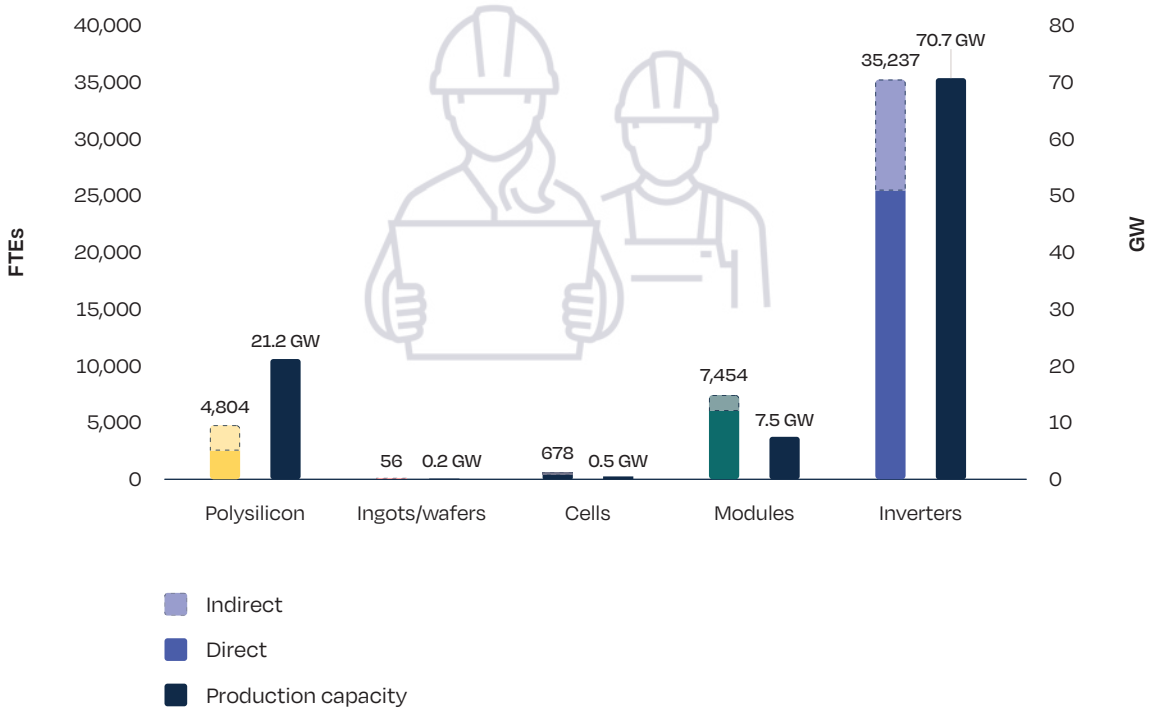
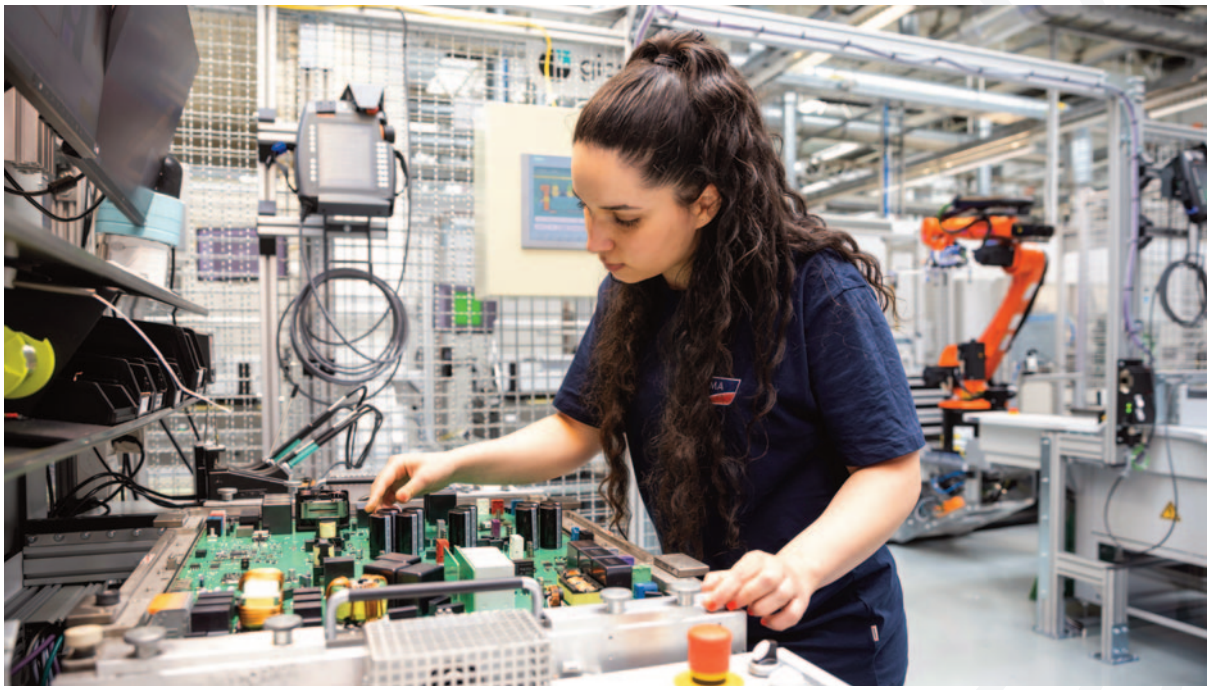


FIGURE 3 EU-27 SOLAR MANUFACTURING JOBS AND PRODUCTION CAPACITY IN 2022





SolarPower Europe

#SolarWorks PLATFORM

There's a career for everyone in solar

Find solar talent, trainings & jobs on the #SolarWorks Platform >

The solar sector is booming, and we cannot let the shortage of skilled workers hold us back from driving the energy transition. To address this challenge, SolarPower Europe has developed the #SolarWorks Platform, a one-stop-shop for future solar workers and recruiters, matching applicants to relevant roles or training programmes.

Is your organisation often looking for new solar talent? Then it's time to join upload your job openings to the #SolarWorks Platform – the jobsite for the solar sector, connecting job seekers to solar companies & trainings, all based on their skills. Registrations are free for solar companies, job seekers, education and training providers. Solar companies in Europe and beyond are welcome to create their company profile and upload their latest open vacancies. The website is available in Dutch, French, German, Spanish, Italian & Polish.

There are already more than 100 companies offering all kinds of jobs on the platform. By adding your open vacancies, your job ads will reach many job seekers thanks to targeted advertising, helping you find the best person for the job. Do you offer trainings relevant for solar jobs? Then be sure to create another profile as educational partner and add your training programmes.

Follow the #SolarWorks social media channels to stay up to date with the platform, and see how we promote vacancies to job seekers across Europe, while creating awareness about what working in the solar sector is like.

There's a job for everyone in solar - let's get to work!

Follow **#SolarWorks** on social media for regular updates:

news letter

Questions or suggestions for this jobs platform? Feel free to reach out to SolarPower Europe's Sien Van de Wiele, leading the #SolarWorks Platform & Communications.

Register now for the #SolarWorksFair

The #SolarWorksFair is an online jobs fair, hosted on a digital platform, that enables job seekers and companies to instantly connect in a hassle-free way. It is a place for companies from the entire solar value chain to showcase their brand and attract new recruits. For jobs seekers, the #SolarWorksFair offers the opportunity to connect with talent recruiters and educators to better understand the wide variety of jobs in the solar sector. Moreover, job seekers can get insight into skills that are needed and advice on education and training options to enter the rapidly growing solar market in Europe & beyond.

Registrations are free for solar companies, job seekers, education and training providers. Learn more about the upcoming #SolarWorksFair **here**.

Our 'Solar Jobs' guide presents a comprehensive list of roles in the industry and the skills required to fill them, to those interested in joining the solar industry and the fight against climate change. The guide encapsulates the combined experience of over 30 professionals in hiring manager positions from across the solar sector.

It provides an overview of the jobs available throughout the solar value chain, from manufacturing to operational, and financial roles; the skills needed to do these roles; and what qualifications are in-demand. It also contains a section outlining the soft skills required across all of these roles, in an effort to demystify job adverts and give concrete pointers on how to get involved in solar. Whether you are looking for your first job or changing industry, this guide contains the fundamental information for a successful career in solar.

Are you looking for a job? Is your company often looking for new solar talent? Do you offer education or training opportunities that can help people reskill to find a job in the sector?

This guide is part of SolarPower Europe's overall objective to recruit talented and committed people into the industry.

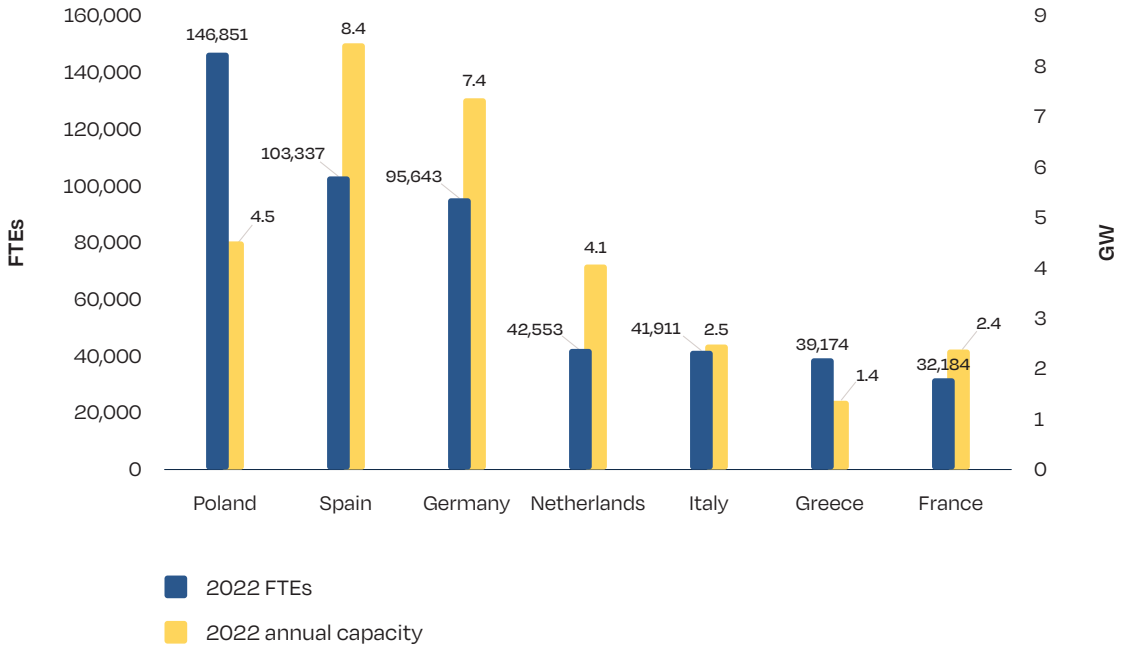
Download the Solar Jobs Guide.
https://www.solarpowereurope.org/insights/thematic-reports/solar-power-europe-s-solar-jobs-guide

Module production and polysilicon production also make substantial contributions, representing 16% and 10% respectively, equivalent to 7,400 and 4,800 jobs. Given the current limitations in production capacity for ingots, wafers and cells within the EU, these activities collectively generate fewer than 750 jobs, accounting for a combined 2% share. The lower FTEs number in cell manufacturing in 2022 compared to 2021 is only temporary, and is explained by factories that have temporarily paused their production in 2022 in order to ramp up their capacities.

The level of job intensity differs across various manufacturing processes. Cell and module production exhibit higher job intensity, while inverter and ingot/wafer production show lower levels, and polysilicon production has the lowest level of job intensity. Consequently, this disparity elucidates why polysilicon production, despite its current higher production output compared to inverters and modules, yields a smaller number of direct jobs.

Looking at country-specific employment figures, Poland remained the primary contributor to solar job creation within the European Union in 2022, generating approximately 147,000 solar-related positions, constituting a substantial 23% share (Figure 4). Several methodological reasons explain the dominance of Poland in solar job creation. Firstly, the deployment jobs are obtained by dividing the total cost of work related to PV installation by the labour cost in the construction sector. The Polish sector exhibits salaries in the low range of European salaries, therefore the ratio results in a higher number of workers. Furthermore, no other large European PV markets are as much skewed towards residential PV than Poland and these smaller rooftop systems entail more job opportunities compared to larger PV systems in the commercial and industrial or utility-scale segments. Finally, the input/output matrix yields high FTE multipliers for Poland compared to other large European PV markets. In terms of direct FTEs only, Poland falls just behind Germany, and just before Spain, while the amount of indirect jobs created by Polish solar jobs is higher than in any other country.

FIGURE 4 EU-27 TOP 7 FTE COUNTRIES AND ANNUAL INSTALLED SOLAR PV CAPACITY 2022

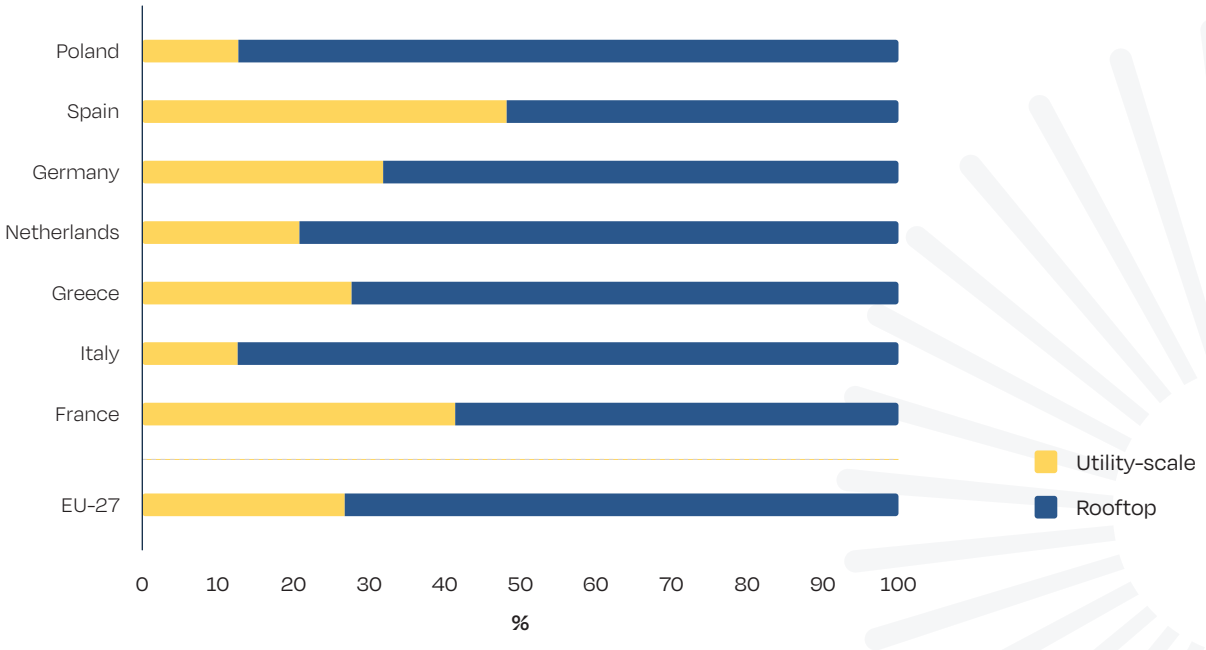


Predictably, most of Europe's largest PV markets, including Spain, Germany, the Netherlands and Italy all rank within the top 7 contributors, generating 103,000; 96,000; 43,000; 42,000 FTEs respectively.

Across the EU member states making the most substantial contributions to solar job creation, a notable proportion of employment originates from the rooftop segment (Figure 5). Poland's advantageous framework for residential systems has led to over 87% of jobs being created in this segment. Similarly, other significant GW-scale PV markets like Italy and the Netherlands also heavily rely on rooftop jobs, constituting 87% and 79% of their total share. In Spain, the proportion of individuals employed in rooftop systems witnessed a remarkable rise, climbing from 28% in 2020 to 44% in 2021 and ultimately reaching 52% in 2022. This marks the first occasion when rooftop installations have accounted for more than half of all jobs in Spain. Consequently, all of the leading seven markets now boast a share of rooftop-related employment exceeding 50%. In Germany, 68% of FTEs stems from the rooftop segment as well, while the ratio is 59% in France.

Across the EU-27 member states, job growth in the solar industry remains significantly skewed toward rooftop PV systems. Nevertheless, despite the rapid increase in rooftop installations as a response to the ongoing Ukrainian conflict, the percentage of solar jobs related to rooftop installations declined from 76% in 2021 to 73% in 2022. This shift mirrors a slight rise in the portion of utility-scale projects within the annual solar installation, which inched up from 39% of the total annual capacity installed in 2021 to 40% in 2022.

FIGURE 5 EU-27 TOP 7 FTE COUNTRIES – ROOFTOP VS. UTILITY-SCALE JOBS BREAKDOWN 2022

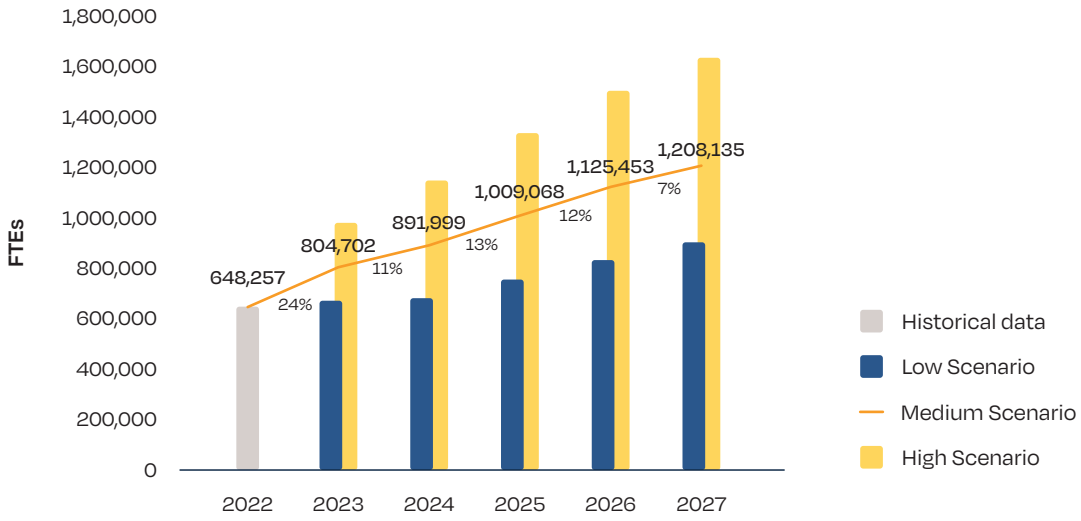


2.2. Prospects 2023-2027

A notable upswing in the number of EU solar jobs is anticipated for 2023. Given the significant reliance of solar job figures on yearly PV installations, the projected 34% expansion in the EU solar market for 2023 is poised to yield positive implications for job creation. Our projections for solar jobs envisaged annual growth of 24%, resulting in 805,000 full-time equivalent positions (FTEs) within the Medium Scenario's projection of 53.8 GW capacity additions (Figure 6). Yet, should our more ambitious 65.6 GW High Scenario materialise, a remarkable 64% year-on-year market growth in 2023 would result in a 52% growth in solar jobs, reaching 983,000.

Based on our Medium Scenario, this trajectory of growth leads to 1 million jobs already by 2025 – an impressive 56% surge compared to 2022 levels. However, a heightened policy ambition, propelling increased solar deployment and enhanced energy self-sufficiency, coupled with the establishment of larger manufacturing capacities across the EU, could propel solar job figures beyond the 1.3 million FTE mark in 2025, as outlined in the High Scenario. This achievement would signify an extraordinary 107% growth from 2022. Looking at 2027, solar jobs could reach 1.2 million under our Medium Scenario (+86% from 2022), and up to 1.6 million following the high scenario (+153%) On the contrary, our unlikely Low Scenario envisions constrained market growth coupled with prolonged dependence on global solar supply chains, resulting in a more limited increase in solar jobs. In this scenario, job figures would reach 903,000 FTEs per year by 2027, reflecting a 39% growth from the 2022 figures.

FIGURE 6 EU-27 SOLAR PV FTE SCENARIOS 2023-2027

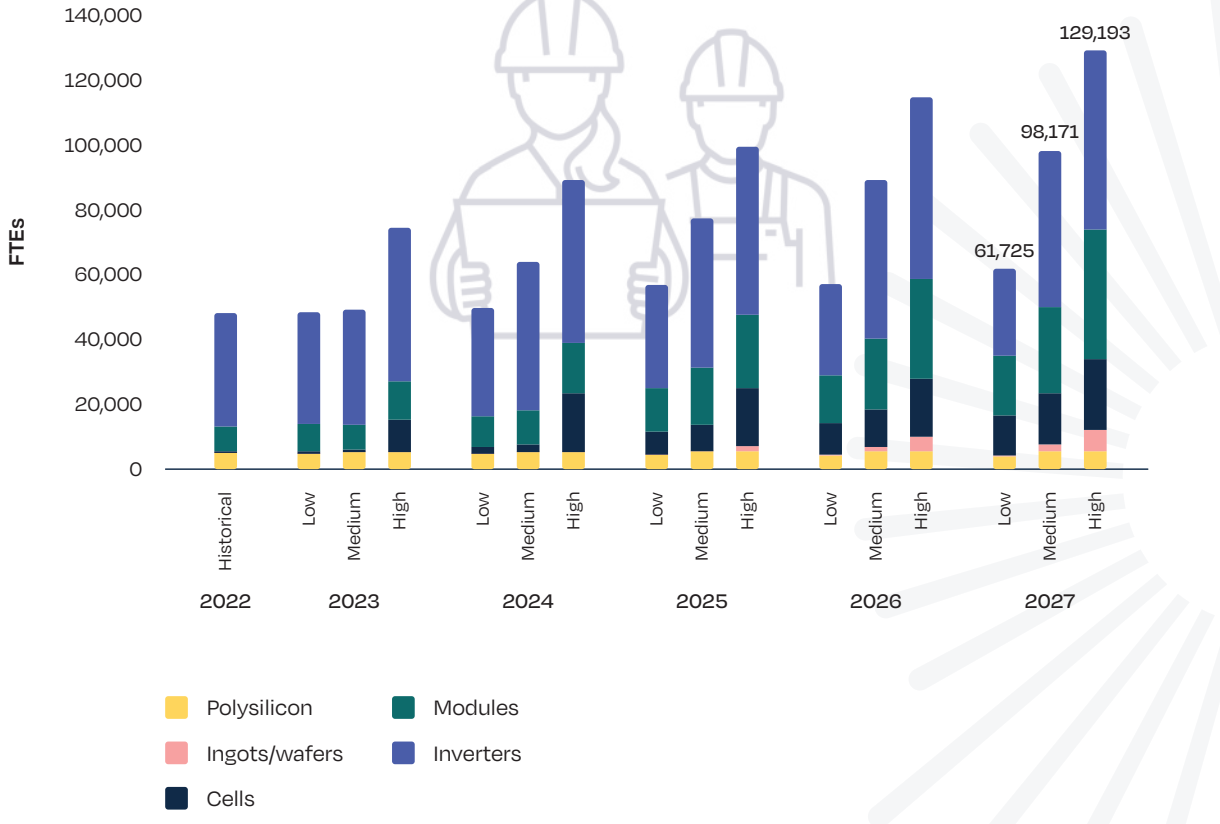


Examining the **manufacturing** sector, the forthcoming five years will see the extent of job creation closely tied to the effectiveness of the recently established EU Solar PV Industry Alliance (ESIA), which aims to reach a minimum of 30 GW of solar manufacturing capacity from polysilicon-to-module within Europe by 2030.

Under our Medium Scenario, in which the ESIA targets are only partially realised (see methodology in section 1.2), EU manufacturing jobs are projected to reach 49,000 FTEs in 2023, and further rise to 98,000 units by 2027, reflecting a substantial 100% increase compared to 2022 (Figure 7). Conversely, within a low-ambition scenario characterized by limited growth in EU production capacity, manufacturing jobs would reach 62,000 FTEs by 2027, resulting in a 29% growth compared to 2022. However, with strong political backing for establishing a robust manufacturing base within the EU and reducing reliance on supply chains from third countries, domestic solar manufacturing jobs could soar to as high as 129,000 units in 2027, indicating a remarkable 169% increase from 2022.

Such growth would encompass all value chain segments, even those presently contributing minimally to EU employment. Anticipations within the High Scenario for 2027 include 6,700 jobs arising from wafer and ingot production combined and 21,800 jobs stemming from cell production. EU manufacturing expansion under a Medium Scenario would also entail an increase in module manufacturing jobs from 7,400 to 26,500 FTEs by 2027, while inverter manufacturing jobs would rise from 35,200 to 48,100 within the same period.

FIGURE 7 EU-27 SOLAR MANUFACTURING JOBS SCENARIOS 2023-2027



The variance in manufacturing capacities among the three scenarios is already quite high even in the short term, as several companies have set interim targets by 2025 as part of larger plans towards 2030. However, the implementation of plans for new production facilities will require some time to come to fruition. Rapid establishment of large manufacturing capacities within a short timeframe is unlikely due to the current modest starting levels across various segments of the value chain, particularly in ingots and wafers. The differentiation becomes increasingly noticeable toward the later years of the observed period. Because the decisions made today necessitate significant planning, financing, and construction of manufacturing plants, their effects will only become apparent several years down the line. Starting from 2026 in the High Scenario, the number of manufacturing jobs crosses the symbolic 100,000 landmark. This reminds that developing a domestic solar PV industry is not only a matter of energy security and diversification of supply chains, it also has beneficial trickle-down effect with the creation of numerous clean and local jobs.

The various activities encompassing procurement, construction, installation, and other parts of PV system deployment are projected to yield 684,000 job opportunities in 2023, indicating a 26% increase from the preceding year (Figure 8). Extending the analysis beyond, Deployment jobs are poised for sustained expansion, reaching a total of 970,000 FTEs by 2027 under our Medium Scenario. Given their susceptibility to the oscillations within the annual EU solar market, Deployment jobs could potentially range from a lower estimate of 724,000 to a higher estimate of 1.3 million by the year 2027.

FIGURE 8 EU-27 SOLAR DEPLOYMENT JOBS SCENARIOS 2023-2027

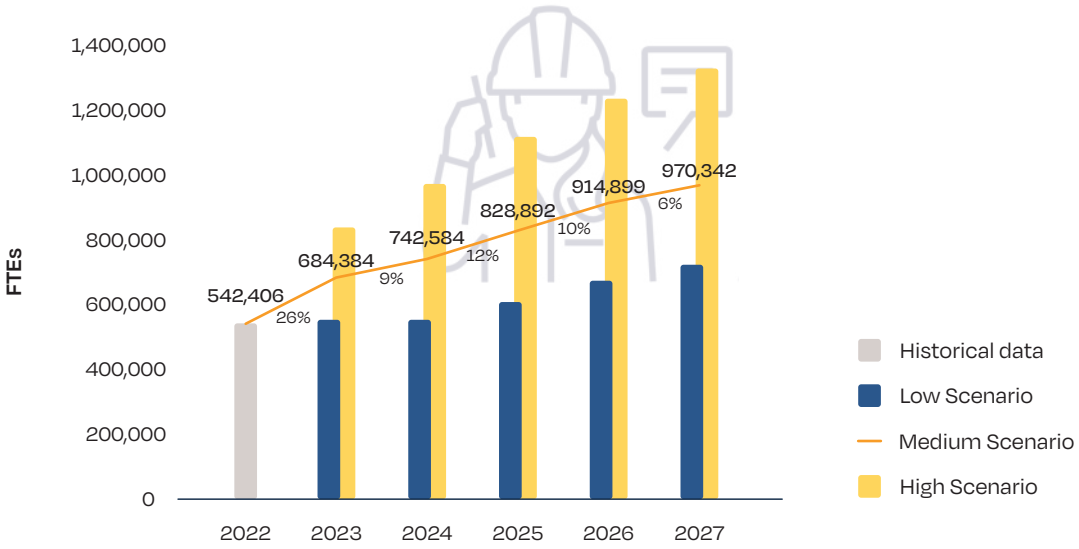
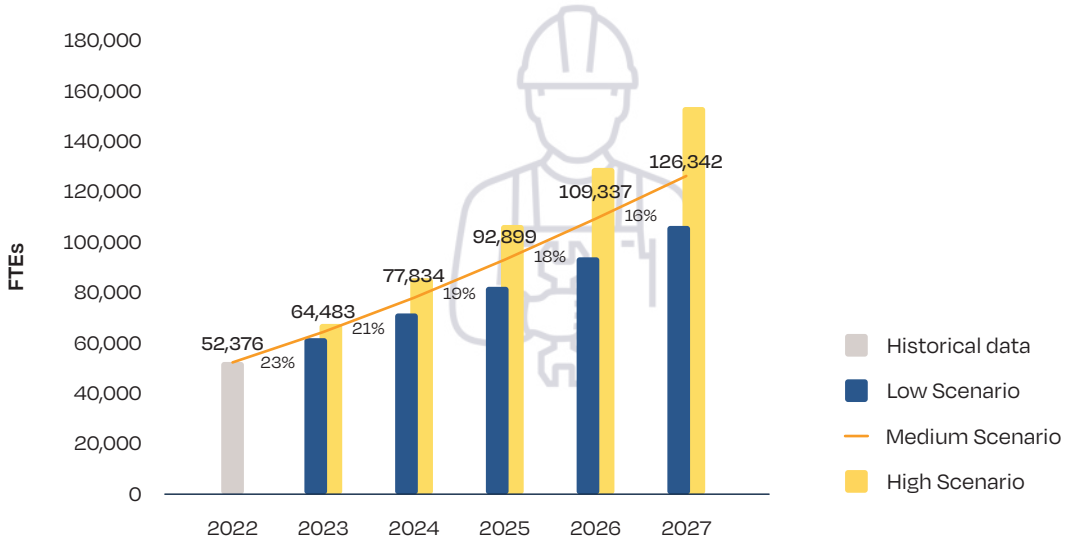


FIGURE 9 EU-27 SOLAR O&M JOBS SCENARIOS 2023-2027



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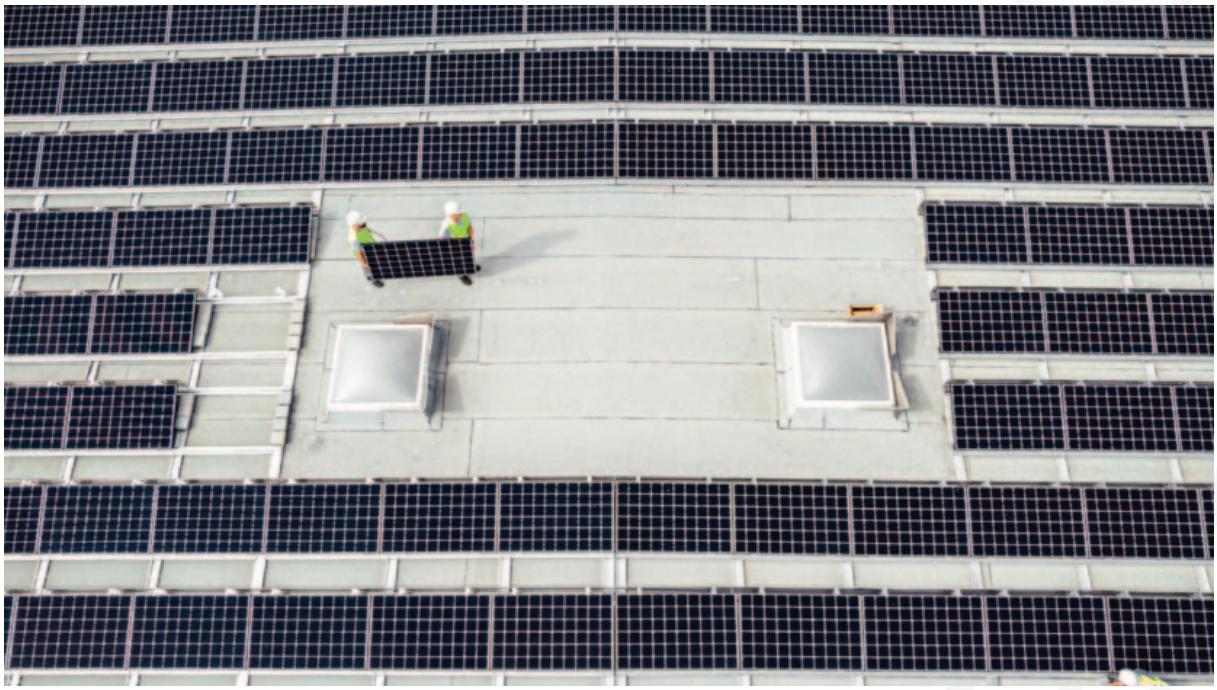
Unlike Deployment jobs, which are influenced by the annual oscillations of the PV market and consequently subject to year-to-year changes, O&M roles are linked to the overall operational capacity of solar installations and display a heightened level of predictability. These positions are anticipated to undergo steady double-digit growth from 2023 to 2027, characterised by minimal fluctuations. The workforce of 52,400 FTEs engaged in solar O&M in 2022 is forecasted to witness a 23% rise, reaching 64,000 FTEs in 2023, followed by a subsequent increase to 126,000 positions by 2027 (Figure 9).



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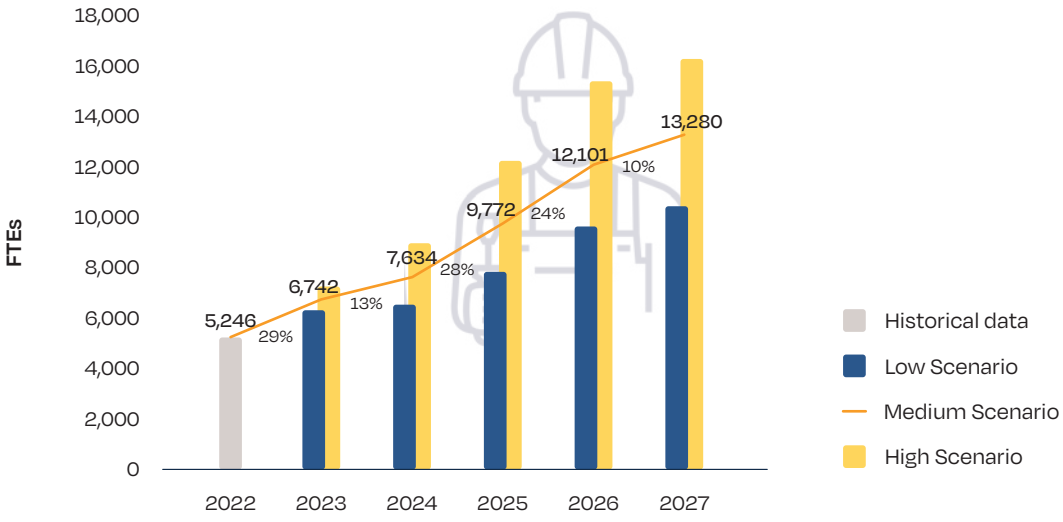
Employment opportunities originating from the Decommissioning & Recycling sector are still minor in comparison to the overall solar jobs landscape. This is due to the fact that a large amount of PV started to be deployed in the early 2000s, and with a product lifetime of 30 years or more, only a very small portion of current installed modules are already reaching the end of their operational life. The current waste streams generated are coming from modules that have been damaged during transportation and installation, early failures during the first years of operation, or the repowering of older products being replaced with newer and more efficient models. However, this employment trend is poised to change considerably in the medium to long term, as an increasing number of PV systems will inevitably reach the end of their operational lifespans.

In 2022, jobs stemming from this segment remain limited, with about 5,200 FTEs, yet the short to medium term projections indicate significant growth. By the year 2027, it is expected that solar employment opportunities within the Decommissioning & Recycling domain will expand to encompass 13,300 FTEs (Figure 10).

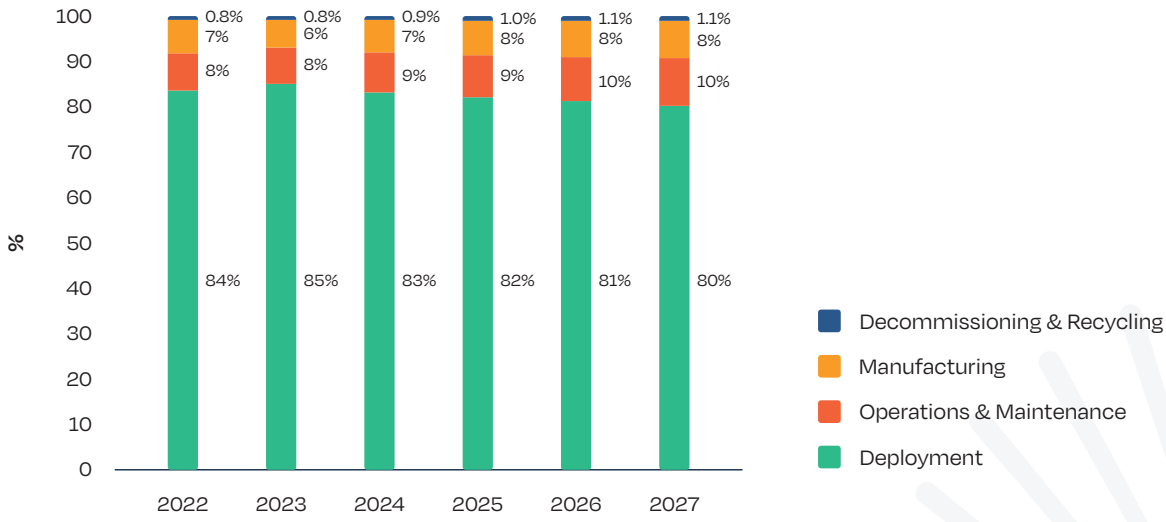
FIGURE 10 EU-27 SOLAR DECOMMISSIONING & RECYCLING JOBS SCENARIOS 2023-2027



During the course of our projected five-year forecast period, the total count of EU solar jobs is set to experience growth across all four segments of the value chain. However, their relative distribution is anticipated to undergo only minor adjustments. The solar job breakdown per segment according to our Medium Scenario is illustrated in Figure 11.

While jobs linked to Deployment will remain predominant by a significant margin, their proportion is expected to exhibit a minor reduction from 85% to 80% over the period 2023-2027. Concurrently, the remaining three segments are projected to marginally enhance their respective shares: Manufacturing jobs will increase from 7% to 8%, O&M from 8% to 10%, while Decommissioning & Recycling positions are expected to grow and slightly exceed the 1% mark by the end of this period.

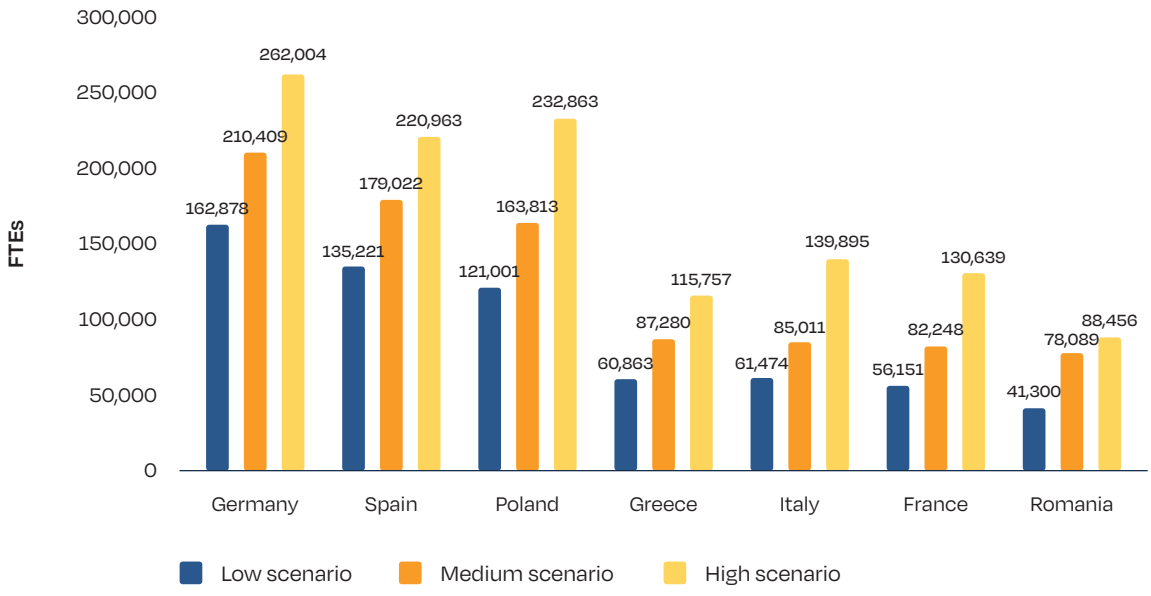
FIGURE 11 EU-27 SOLAR JOBS BREAKDOWN EVOLUTION 2022-2027



Member States' contributions to solar job creation in 2027 are not projected to undergo significant shifts compared to the present landscape (Figure 12). Germany, which currently stands as the largest EU's solar fleet, is anticipated to ascend to the forefront of solar job creation as well. Envisioned to have 210,000 FTEs under the Medium Scenario, Germany should surpass the current leading contributor, Poland, by a 47,000 margin. Spain, expected to rank second in 2027, will play a substantial role with 179,000 FTEs.

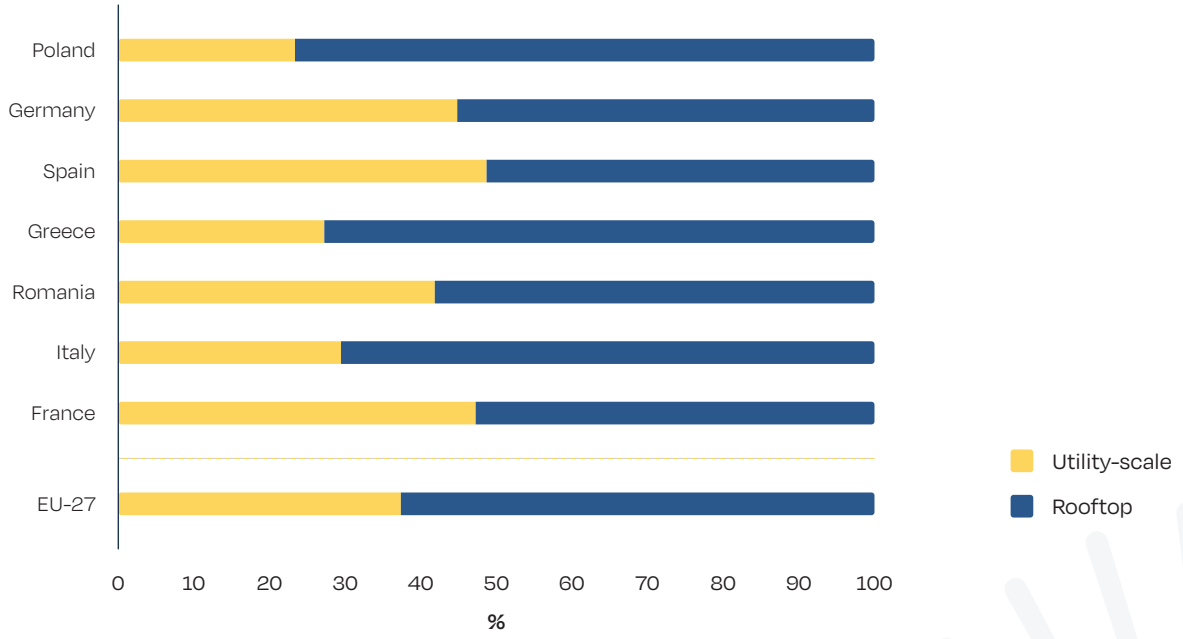
Poland will keep its position among the top job-contributing countries with 164,000 FTEs but will drop two spots to rank #3. Greece, Italy, and France, already occupying positions in the top 7 last year, will remain amongst the largest solar employers. In the Medium Scenario, the leading 7 markets are expected to yield 886,000 FTEs, constituting 73% of total EU solar jobs in 2027, while the remaining 20 Member States are set to contribute the remaining 27% share.

FIGURE 12 EU-27 TOP 7 COUNTRIES SCENARIOS 2027



With the anticipated changes in the distribution between rooftop and utility-scale annual capacities, primarily characterised by an increasing share of utility-scale PV power plants, a corresponding shift in the division of jobs will appear (Figure 13). The rise of large-scale installations will reduce the dominance of rooftop-related FTEs from 73% in 2022 to 63% in 2027.

FIGURE 13 EU-27 TOP 7 COUNTRIES - ROOFTOP VS. UTILITY-SCALE JOBS BREAKDOWN 2027



Our projections in last year's EU Solar Jobs Report proved to be an underestimate of the actual job creation observed in 2022. At that time, our Medium Scenario forecasted approximately 530,000 jobs for 2022. However, the figure reported in this year's report is 22% higher than our previous estimate. This discrepancy can be attributed to the disparity in anticipated solar PV deployment. In our 2022 study, we had projected the addition of 33 GW of solar PV in 2022. In reality, over 40 GW was installed, surpassing our initial forecast by 21%, due to the extraordinary circumstances driven by the Russian war in Ukraine and the energy crisis. As a result, our updated Medium Scenario outlook is now more optimistic compared to a year ago. Consequently, we anticipate higher levels of job creation for the coming years (2023-2027), with increased job creation expectations ranging from 40% to 47%, reflecting the elevated ambition and expanded solar deployment across the EU.

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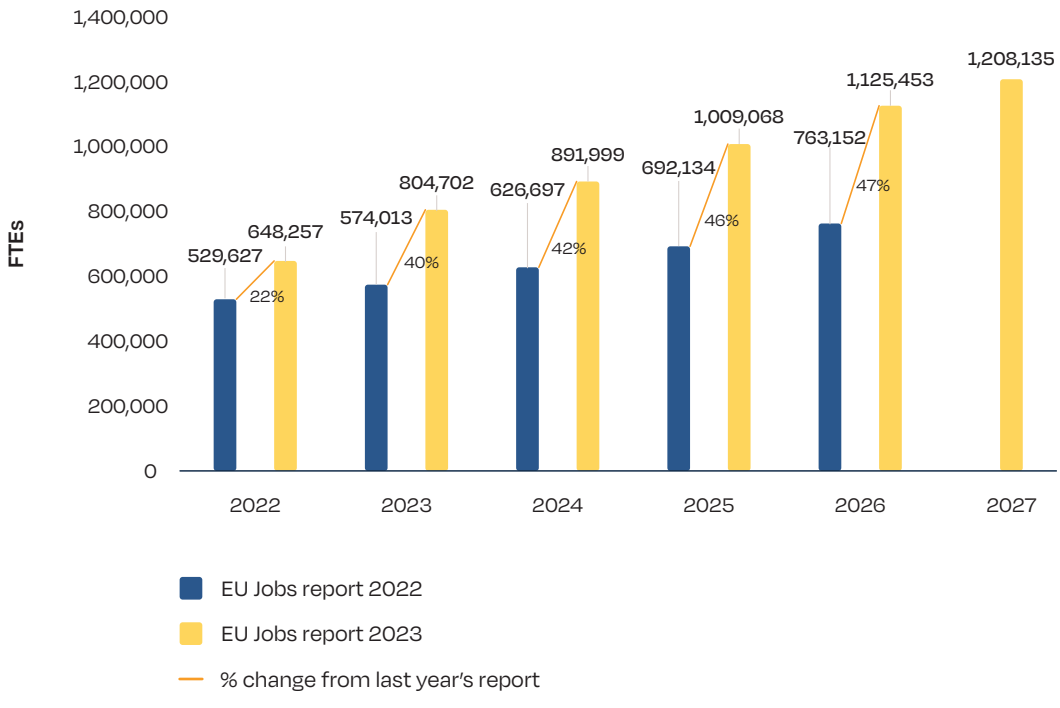
FIGURE 14 COMPARISON MEDIUM SCENARIO OF EU JOBS REPORT 2022 AND EU JOBS REPORT 2023



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Annex

ANNEX TABLE 1 SUPPLY CHAIN NACE CODES USED IN FTE MULTIPLIERS FOR THE CALCULATION OF INDIRECT JOBS

VALUE CHAIN	EMPLOYMENT TYPE	NACE CODE	NACE SECTOR
Manufacturing	Polysilicon	C20	Manufacturing of chemicals and chemical products
	Ingot/wafer	C26	Manufacturing of computer, electronic and optical products
	Cells	C26	Manufacturing of computer, electronic and optical products
	Modules	C26	Manufacturing of computer, electronic and optical products
	Inverters	C27	Manufacturing of electrical equipment
Deployment	Deployment	F	Construction
O&M	O&M	F	Construction
Decommissioning & recycling	Decommissioning	F	Construction
	Recycling	E37T39	Sewerage, waste management and remediation activities
Source: Eurostat.			

ANNEX TABLE 2 EMPLOYMENT FACTORS USED FOR SOLAR MANUFACTURING JOBS (FTE/MW)

COMPONENT	FTE/MW
Polysilicon	0.12
Ingot/wafer	0.25
Cells	0.80
Modules	0.80
Inverter	0.36
Source: IRENA, Industry survey.	

Annex

ANNEX TABLE 3 CAPEX OF PV SYSTEMS IN EU-27 MEMBER STATES

CAPEX OF PV SYSTEMS (EUR/W) IN 2022 (PRICES WITHOUT VAT)				
COUNTRY	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	UTILITY-SCALE
Austria	1.66	1.07	0.80	0.64
Baltic States	1.42	0.94	0.75	0.76
Belgium	1.36	1.02	0.85	0.91
Bulgaria	1.20	0.82	0.71	0.73
Czech Republic	0.94	0.64	0.55	0.46
Denmark	1.44	0.98	0.90	1.04
Finland	1.40	0.93	0.73	0.76
France	1.85	1.36	1.05	1.05
Germany	1.66	1.17	1.07	0.90
Greece	1.64	1.12	1.12	1.06
Hungary	0.94	0.64	0.55	1.15
Italy	1.40	1.10	0.97	0.70
Netherlands	1.55	1.29	1.22	1.10
Poland	1.17	0.99	0.84	0.95
Portugal	1.39	1.14	0.99	0.89
Romania	1.64	1.12	0.96	0.78
Slovakia	1.17	0.80	0.69	0.59
Slovenia	1.16	0.79	0.68	0.87
Spain	1.44	0.94	0.87	0.70
Sweden	1.47	1.20	1.05	1.05
Rest of EU	1.47	1.19	1.11	1.19

Source: IRENA Power Generation Cost (2021 & 2022), SPE calculation.

Annex

ANNEX TABLE 4 CAPEX BREAKDOWN FOR ROOFTOP AND UTILITY-SCALE PV SYSTEMS

CAPEX BREAKDOWN – ROOFTOP SYSTEMS		
MAIN COSTS	**COST CATEGORY**	**PERCENTAGE**
Hardware costs	Module	27.19%
	Inverter	10.54%
	BOS	17.54%
Installation labour	Installation labour	14.80%
Soft cost	Customer acquisition	3.28%
	Procurement & permitting	5.89%
	Margin	20.75%
Source: IEA-PVPS.		
CAPEX BREAKDOWN – UTILITY-SCALE SYSTEMS		
MAIN COSTS	**COST CATEGORY**	**PERCENTAGE**
Hardware costs	Modules	36.7%
	Inverters	6.6%
	Racking & mounting	17.2%
	Grid connection	8.5%
	Cabling/wiring	2.5%
	Safety & security	1.9%
	Monitoring & control	2.4%
Installation labour	Mechanical installation	6.1%
	Electrical installation	2.3%
	Inspection	0.5%
Soft costs	Margin	5.5%
	Financing costs	1.5%
	System design	4.7%
	Permitting	2.2%
	Incentive application	1.0%
	Customer acquisition	0.6%
Source: IEA-PVPS, IRENA, Industry survey.		

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ISBN NUMBER 9789464669084