SolarPower Europe

# EU Solar Jobs Report 2024

A solar workforce ready for stronger growth

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# Foreword

**Welcome to our Solar Job Report 2024,**

In recent years, the solar sector has turned into an important job machine for the European Union. The solar industry has been constantly and strongly growing, adding more power generation capacity than any other technology and creating hundreds of thousands of meaningful jobs. Solar in Europe has offered a concrete way to directly participate in the renewables-led energy system that provides competitive, affordable, secure energy – and future-proof jobs.

In fact, the solar sector has grown much faster than anyone anticipated. During the years of the energy crisis, solar accelerated its growth to reduce dependency on Russia's gas and shield EU citizens' from power price hikes. In 2023, the European solar sector grew beyond the prior 40% annual growth levels, managing an outstanding 50% growth and delivering a new yearly installation record of 61 GW. At a time when other industries struggled to recruit a qualified workforce, solar was taken to new heights by the workers who flocked to it, drawn by demand and a sense of purpose.

While EU solar job numbers were soaring in the EU until a few months ago – employing 826,000 by the end of 2023, and 27% more than a year before – this situation has changed dramatically. For 2024, we expect very slow solar installation capacity growth by only around 5% to about 64 GW new solar in the EU. As consequence, the solar job market will stagnate, and job numbers are likely to increase by less than 1%.

With power prices having normalised, for now, the psychological and financial impact of the energy crisis has waned, with fewer citizens seeking home solar as a shield from energy prices or blackout. Accordingly, the rooftop segment, Europe's main solar market force in recent years, has lost steam, despite much lower solar system prices today. The segment balance is also turning toward a developing utility-scale segment, which is less job-intensive than rooftop installations.

As Europe's solar sector today is currently highly dependent on installation jobs – 87% of the workforce was active in that segment last year, it's key to bring back solar on the fast lane. Otherwise, we risk more headlines of layoffs of recently recruited installation staff. While installation will remain solar's main job engine for the foreseeable future, diversification is important. One key point will be to strengthen the solar manufacturing sector and workforce, which only provided 5% of solar jobs in 2023 – 2% less than the year before.

Although there's further employment growth on the solar horizon in the next few years, we had to lower our 5-year forecast, now expecting the million solar jobs mark to be reached only in 2027, two years later than previously estimated.

In the long run, however, there's no way around it; solar will be the largest contributor towards net zero in 2050. Therefore, as well as providing the right policy frameworks for further strong solar market growth generally, we must develop a strategy for electrification skills as part of the expected EU Electrification Action Plan, among other measures asked for in our Policy Recommendations (see p. 8). Taking up these asks will address the stuttering solar job motor, supporting the solar sector to take its full role as a major pillar of a true EU Clean Industrial Deal.

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SolarPower Europe


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**Methodology:** The modelling for this Job Report is based on SolarPower Europe's five-year PV forecast scenarios (Low, Medium and High Scenarios) from the Global Market Outlook for Solar Power published in June 2024. The Medium Scenario anticipates the most likely development given the current state of play of the market. The Low Scenario forecast is based on the assumption that policymakers halt solar support and other issues arise, including interest rate hikes and severe financial crisis situations. Conversely, the High Scenario forecasts the best optimal case in which policy support, financial conditions and other factors are enhanced.

Segmentation is based on the following system size: Residential (<10 kW); Commercial (<250 kW); Industrial (<1000 kW); Utility-scale (>1000 kW, ground-mounted). SolarPower Europe's methodology includes only grid-connected systems. Installed capacity is always expressed in DC, unless otherwise stated.

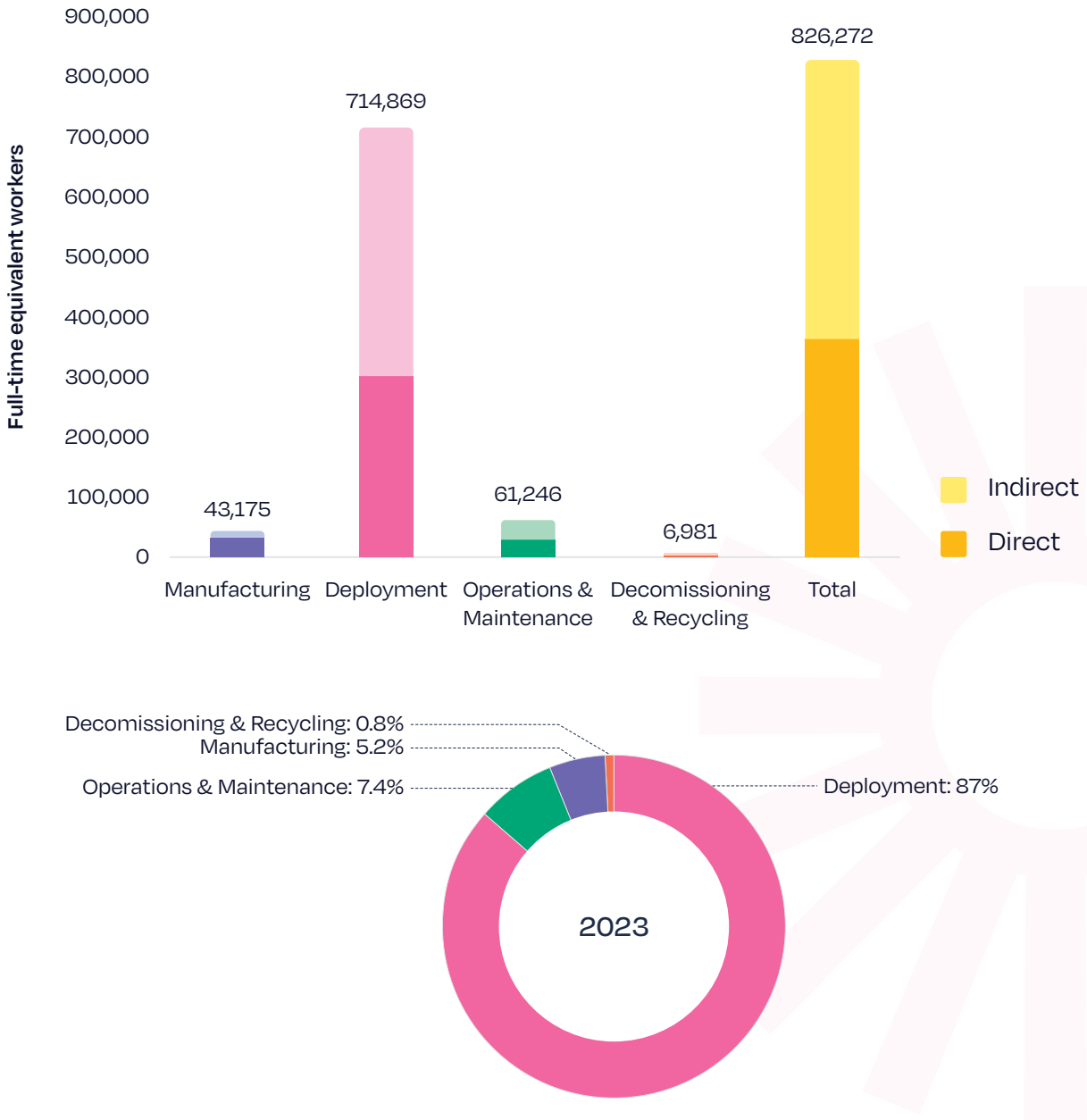
All figures are based on SolarPower Europe's best knowledge at the time of publication.

# Executive summary

**Solar employment in the EU has been steadily on the rise in the last few years, and that trend continued in 2023, when job creation increased by about a third, thanks to large project pipelines and strong product demand caused by the energy crisis. This rapid growth, however, is coming to an abrupt halt in 2024, due to changing market conditions.**

At the end of 2023, the solar sector employed 826,000 full-time equivalent workers (FTEs) in the European Union. Among these, 362,000 FTEs were direct jobs, accounting for 44% of the total, while the remaining 464,000 FTEs (56%) represented indirect jobs (Fig. 1).

**FIGURE 1** EU-27 SOLAR JOB MARKET & TOTAL SOLAR JOBS BREAKDOWN IN 2023



The number of workers in the EU solar sector saw a notable increase compared to the previous year, driven by a sharp growth of the annual EU solar market, which grew by 50% year-on-year to 60.9 GW. As jobs in solar deployment constitute the dominant share of total solar jobs, this was reflected in an 28% increase in EU solar jobs.

Compared to the previous years, the majority of jobs in the solar industry concentrated even more in the deployment phase, accounting for 715,000 FTEs, or 87% of the total jobs (see Fig. 1). The steep growth in installed solar capacity in recent years also drove Operation & Maintenance activities, which generated 61,000 jobs, representing 7% of the total end of 2023. Conversely, the EU's manufacturing sector experienced several closures and job cuts due to intense international competition, resulting in a 5% share and 43,000 FTEs, a decline of 11% from 2022 levels. Finally, due to the long lifetime of solar modules, with performance warranties of about three decades, Decommissioning & Recycling jobs remained a minor component, comprising less than 1% of total employment.

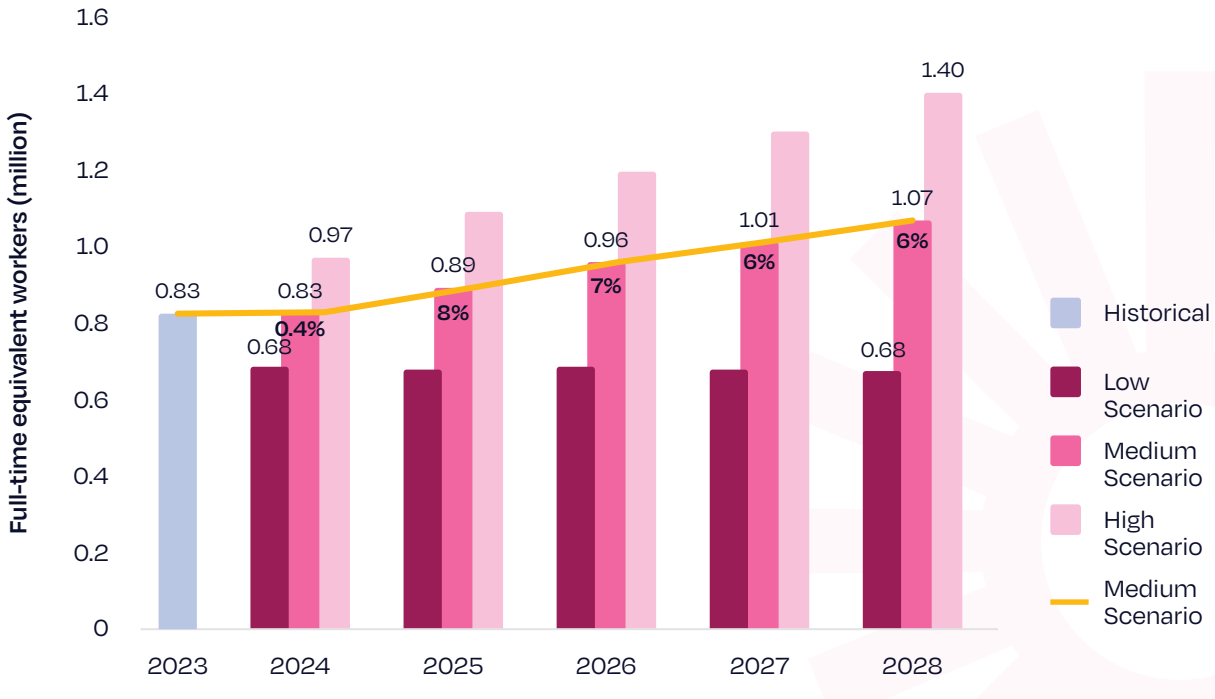
Looking at country specific job creation, Germany leads the European Union with approximately 154,000 direct and indirect FTEs, representing a 19% share (Fig. 2). The growth in solar employment in Germany is a direct result of the expansion of the PV market, with the country installing 15.0 GW – a 104% increase from 2022. Poland takes second place with 113,000 direct and indirect FTEs. Most of Europe's largest PV markets, including Spain, Italy, Romania, the Netherlands and France all rank within the top 7 contributors. While companies in Spain generated 91,000 jobs, Italy employed 76,000, Romania was responsible for 55,000, Holland for 48,000, and France for 45,000 FTEs.

**FIGURE 2** EU-27 TOP 7 FTE COUNTRIES AND ANNUAL INSTALLED SOLAR PV CAPACITY 2023

After a year of gigantic solar market growth and the subsequent enlargement of the solar workforce to enable that rapid development, a very moderate increase in the solar PV market is expected in 2024, leading to a negligible rise in solar jobs. The PV market is projected to grow by 5%, reaching 63.9 GW and resulting in a less than 1% increase in solar jobs due to a changing market environment, bringing the total to approximately 830,000 FTE positions (Fig. 3). In the more ambitious, though rather unlikely High Scenario, with 75.0 GW of installations and 23% market growth, solar jobs could rise by 17%, approaching 1 million workers already by the end of this year.

As our Medium Scenario for solar PV market development until 2028 is somewhat less upbeat compared to our previous assessment, the expected pace of solar jobs growth has also slowed down. By 2025, the trajectory suggests 895,000 solar jobs – down from the 1 million previously forecast for that year. Looking ahead to 2028, solar jobs could surpass 1 million under the Medium Scenario, and up to 1.4 million in the High Scenario.

**FIGURE 3** EU-27 SOLAR PV JOB MARKET SCENARIOS 2024-2028




# Policy recommendations

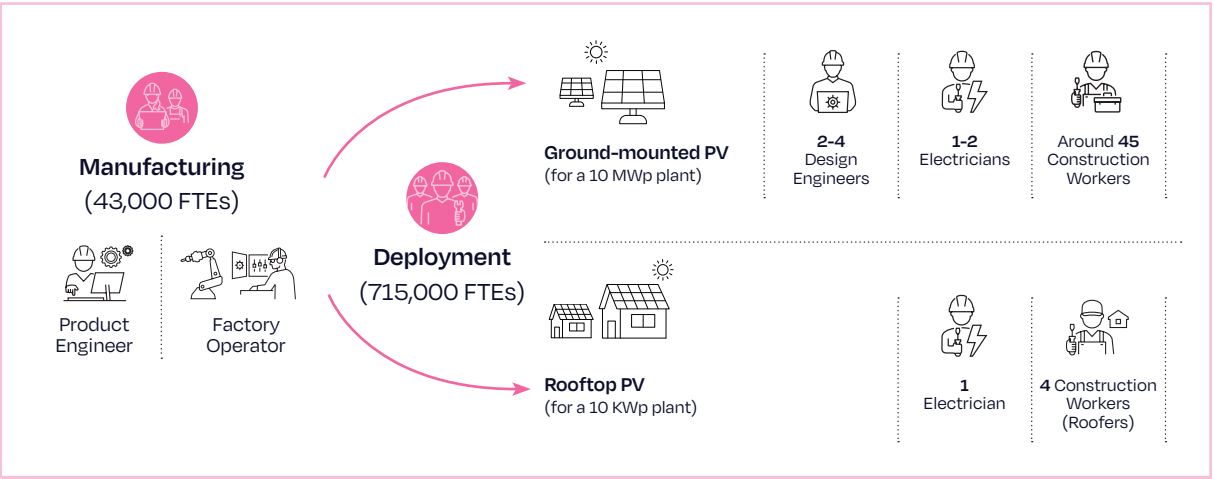
## Policy recommendations

While the growth of the solar workforce may be slightly slower than initially expected, the numbers are still significant. At the end of 2023, 826,000 people were employed by solar in the EU, and in 2025 this could increase up to 1 million in our High Scenario. This workforce will design, manufacture, construct, connect, maintain, and retire solar PV installations across Europe. It, therefore, must be appropriately qualified, empowered by professional training, and held to clear, comprehensive, and harmonised standards.

Key roles include:

- **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 science, technology, engineering and mathematics (STEM) students, and the general European level in mathematics, decreases.
- **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, battery and EV charging point), one electrician is needed.
- **Construction workers** are the hands of the solar revolution. The rooftop PV market has been impacted by a lack of roofers and construction workers in recent years. 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.
- **Manufacturing workers** are integral to Europe's reindustrialisation goals. The solar sector is calling for the effective implementation of the EU Net-Zero Industry Act, to reach the EU target of 30 GW of solar PV production by 2030, and real support for related, essential industries, like inverters and Balance of Systems. Getting Europe on track for its solar manufacturing goals depends on the legal and economic frameworks, as well as the sector's ability to hire and retain highly qualified and specialised workers, designers, and engineers.

The workforce in the overall solar industry is expected to grow from around 826,000 today to 1.1 million by end of 2028 , provided there is a matching demand of qualified workers.




1. **Assess the need for workers and skillsets.** As mandated under the EU Renewable Energy Directive, Member States must multiply efforts in identifying the 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. We welcome the EU Solar Academy, set up following the Net-Zero Industry Act (NZIA), which should become a central coordination body for the EU-level assessment, monitoring and forecasting of workforce demand and supply, in accordance with the NZIA, and facilitate access to EU funding for skills trainings under the European Social Fund Plus.

2. **Shape a renewable industry career path, for skills in manufacturing and deployment along the value chain.** While the renewable energy sector offers numerous career opportunities, traditional career paths often focus on specific industries. This can be limiting, as the growth and decline of individual renewable energy sectors can fluctuate rapidly. For instance, the fluctuation of the solar and wind market can lead to oversupply of skills or undersupply between the two sectors. Similarly, while Europe has committed to reinforce solar module and solar inverter manufacturing capacity, as well as equipment manufacturers in Europe, the tense industrial conditions threaten the attractiveness of those careers. To address this challenge, we propose developing **a cross clean technology career path** that highlights the common skillsets required across various renewable energy industries. This approach will empower professionals to explore a wider range of career options and facilitate seamless transfers between sectors. The Renewable Energy Skills Partnership will lead the development of a Blueprint on Renewable Energy Skills to outline this cross-renewable career path. The European Commission and Member States should complement this initiative with a **targeted communication campaign** to raise awareness among key stakeholders, including education professionals, employment platforms, vocational education and training (VET) providers, and local authorities.

3. **Develop a strategy for electrification skills as part of an EU Electrification Action Plan.** Renewables go together with smart electrified technologies; your home's rooftop solar PV powers your electric vehicle or your heat pump. The lack of appropriate knowledge in electrified technologies, or prejudice toward clean technologies, is often a barrier for electricians or mechanical workers to offer the installation, or only promote,

# Policy recommendations / continued

electrified products. This could be part of the Electrification Action Plan that is expected from the new European Commission and mentioned in the Mission Letter for the next Energy & Housing Commissioner. The Action plan should include a dedicated chapter diagnosing the barriers to electrification skills and addressing those barriers with appropriate measures.

4. **Boost the visibility and attractiveness of technical, scientific, and engineering renewable careers.** While we need more STEM workers, education policies in Europe often prioritise service and theoretical careers over technical ones, necessitating a shift in the education system. Governments should therefore better promote green job needs and training opportunities. Manual careers need greater value among students and job seekers as viable, more socially respected options. A dedicated chapter should be added to the European Strategy for Vocational Education and Training foreseen by the European Commission. The Strategy should include a strong promotion campaign of renewable technical careers, and ensure the integration of appropriate training into VET programmes. Technical education should be valued for its strategic importance, bridges should connect theoretical and technical education, and apprenticeships should be promoted across different educational paths.

5. **Develop sector-agreement for training and retraining workers affected by the energy transition, such as the oil and gas industry, and create or support public and private training programs.** Many solar professions, like solar construction workers or roofers, can be accessed through retraining, and some workers join the industry after career changes. Lifelong training should be encouraged, particularly in transitioning industries. Programs should prioritise workforce reconversion for clean energy jobs, especially in areas impacted by the climate transition. Private retraining efforts can be publicly supported through funding or practical assistance. As the solar industry evolves, with advances in solar panels, digitalised inverters, and new opportunities like electric vehicles, electricians and installers need access to upskilling programs, in cooperation with manufacturers. Net-Zero Academies can play a crucial role in this.

6. **Support the circulation of skills in Europe.** The Single Market of Energy should also be a Single Market of Energy Skills. Workers need to be able to move from countries to countries for projects, or migrate to another country and have their skills recognised by the host countries. Yet too often, technical skills are not seamlessly recognised across Europe, nor are certifications required to exert renewable installation services or electrical services. The Skills Portability Initiative is a unique opportunity to address this issue and take initiatives to allow for the easier movement of skills across Europe.

7. **Develop adequate training modules on solar quality and safety knowledge.** Two main types of professionals are needed for rooftop solar installations: qualified electricians for design, grid connection, and project supervision, and construction workers (especially roofers) for mechanical work. To meet the growing demand for solar projects, accelerating training for both professions is key. More specialised construction workers will be better equipped for numerous installations, ensuring quality and safety in this emerging subsector. Electricians' apprentices should be encouraged to gain solar PV training during their studies, under the supervision of experienced electricians, to develop the necessary skills. Here too, the European Solar Academy, as part of the Net-Zero Academies, can help create relevant learning content for these needs, as well as for skills in module and inverter manufacturing and engineering.

# 1 Introduction & methodology


**In 2023, the EU experienced solar growth that was much larger than expected, adding 60.9 GW and reaching a cumulative capacity of 269 GW. This marked a 50% year-on-year growth, a substantial increase from the 40.4 GW installed in 2022. This increase was driven by a combination of high energy costs, record-low module prices, improved permitting and administrative processes, and an unexpectedly large order pipeline from 2022 that was finally met with ample product and installer availability. As a result, 2023 not only achieved the highest annual growth rate since 2018 but also recorded the largest absolute market growth ever, exceeding the 2022 market size by over 20 GW. Despite an overall lack of workforce across the EU, the solar sector was able to attract enough people to manage the challenge of largely meeting market demand.**

Strong solar PV growth, however, should not be taken for granted. Grid congestion, the need for system flexibility, and the lack of stable permitting frameworks are among the challenges that led to a reduction of our forecast for this year, with the EU solar market poised to only grow 5%. This trend has also therefore not only brought much lower job numbers than previously forecasted; several larger installers across Europe have been cutting jobs across Europe in recent months.

In the medium term, the outlook for solar energy remains overall positive. Projections suggest that the EU's solar market will grow by 10% Compound Annual Growth Rate (CAGR) over the next 5 years, and reach an annual installation volume of 96.7 GW in 2028 under our most-likely Medium Scenario. This is expected to drive job creation across all segments of the value chain. Against this background, the primary aim of this study is to highlight the current and future employment opportunities linked to the expansion of solar power in the EU. Our analysis is grounded in historical data and market scenarios outlined in SolarPower Europe's Global Market Outlook 2024-2028.

## 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 end-producers/consumers. On the other hand, indirect jobs arise from business-to-business transactions within the supply chain, which are classified as intermediate activities. These jobs represent the roles in upstream industries that provide goods and services to support the core operations of the solar PV sector. The expenditures by the solar PV industry on these intermediate sectors lead to the creation of indirect full-time equivalents (FTEs) in those 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 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. The FTEs numbers presented in this report are therefore always reflecting the end of year situation.

**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 |

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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 |

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.

# Employee testimonial

## Yolanda Hoyos

**Job Title:** Engineering Manager
**Department:** Growth (Engineering and Construction)

1. **Can you briefly describe your job and what you do on a typical day?**

   *In my day to day, together with my team, I work to support any engineering requirement to the different departments: Development, Acquisitions, Construction and Operations.*

   *Currently I am more focused on reviewing and supervising the engineering in the different projects under construction that we have in Spain (Betierra 150 MW and Covatillas 150 MW), Portugal (Oasis portfolio, 4 projects under construction totalling about 225 MW) and UK (Aria portfolio, 5 projects with almost 300 MW).*

   *However, I am also participating in some new development projects or acquisitions that will bring us new projects to build very soon.*

2. **How did you get into the solar PV industry, and what has your career path been like so far?**

   *Since I started my university career, it was clear to me that I wanted to dedicate myself to renewable energies and specifically to solar energy.*

   *When I finished my university studies, I could not find a job in this sector so I started working in another sector, but I continued my studies specialising firstly in renewable energies and then I did a master's degree at the Instituto de Energía Solar de Madrid (Polytechnic University of Madrid).*

   *These last studies opened the door for me to start my first job as a junior engineer. There my main role was to carry out studies and technical designs for distributed generation projects in a solar plant construction company.*

   *Gradually I was involved in larger projects, participating also in the generation of bids, discussions with suppliers and negotiations.*

   *After more than 4 years in this company, I had the opportunity to join the Sonnedix team where I am going to complete 5 years.*

   *My career here has been very enriching, as I have gone from providing technical support to projects under development to coordinating acquisitions from the technical department, to coordinating a team of 3 people with which we are currently supporting a large portfolio of projects under construction.*

3. **What do you enjoy most about working in the solar PV industry and at your company specifically?**

   *I have always wanted to work in the PV sector, so I consider myself lucky because I love my job.*

   *I am a great believer in renewable energies, and I think there is a huge range of opportunities to improve society with these new technologies.*

   *Fortunately, Sonnedix is a company that integrates many departments and has allowed me to learn from different areas, such as development, finance and operations, which means I can continue to expand my knowledge. This only happens because I am fortunate to work both in my team and others, with generous people who share their knowledge and also they help the work go forward as a single team.*

# Yolanda Hoyos

sonnedix

4. **Can you share a memorable experience or project you've worked on at the company?**

   *Undoubtedly, the Portugal portfolio has been a great challenge for all of us who have been involved since the beginning.*

   *Acquiring the portfolio was not easy and involved a lot of work on the part of all the teams. But the big challenge has been to build them. Apart from opening a new country, the projects are located in the north of Portugal, in very difficult terrain, with steep slopes and very rocky soils.*

   *The construction has been a great challenge, but I have certainly learned that all plants can be built, no matter how complicated it may seem, you just have to find the right team.*

5. **What advice would you give to someone considering a career in the solar PV industry?**

   *I believe that if you are as passionate as I am about the solar energy sector you should not hesitate to start, there are a lot of options to develop a professional career. Engineering, research, purchasing, construction, operation and maintenance, financial, legal...*

   *Let's not forget that apart from the big projects that attract everyone's attention, there are also small projects to supply industries, homes or even off-grid projects to supply energy or water to small territories that right now are not self-sufficient.*

   *I'm grateful I get to experience solar every day and work in an industry I care about – and grateful to Sonnedix for always providing me opportunities to grow and expand my career opportunities!*

© Sonnedix, Galiesto PV plant.

### 1.2. Manufacturing scenarios

EU manufacturing capacities through 2028 are evaluated in three different scenarios:

- A **Low Scenario**, in which EU production capacity remains limited. Only serious expansion plans are realised, with a delay, but no other companies expand their production;
- A **Medium Scenario**, in which most of the current companies' announcements are realised, sometimes with a delay;
- A **High Scenario**, in which the production increases 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 | Medium Scenario | High Scenario |
|---|---|---|---|
| Polysilicon | Solar polysilicon manufacturing is decreasing as the production is focusing on the semiconductor segment. | Polysilicon manufacturing increases marginally following large PV market growth, but production focuses on the semiconductor 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 ingots and wafers production expands but cannot fully serve the domestic cell industry. |
| Cells | The current plans for expansion of cell factories are realised, with a delay, but no other develop. | Most serious cell factory plans announced in 2020/2023 complete financing and open factories, sometimes with a delay. | The EU industry manages to redevelop cell production capacity, and is on track to reach 30 GW by 2030 as prescribed by the European Solar PV Industry Alliance. |
| Modules | Only advanced plans for expansion of EU module factories are realised, sometimes with a delay, but some smaller manufacturers cannot face the strong competition and stop their production activities. | Certified and planned expansions come online. Existing EU module manufacturers resist to international competition but struggle to expend their capacity. | Certified and planned expansions come online, existing module manufacturing expend their capacity, most prospect projects come online. |
| Inverters | Inverter manufacturing in Europe decreases as it cannot compete with foreign producers' prices. | Inverter manufacturing in Europe grows slightly and serves both the domestic market and exports. | Inverter manufacturing in Europe grows and serves both the domestic market and exports. |

### 1.3. Changes from previous EU Solar Job Reports

In this edition of the study, we have refined our evaluation of jobs in the manufacturing sector. Previously, we estimated the number of workers based on the manufacturing capacity of factories, but this approach does not fully reflect the actual activity levels, as factories generally do not operate at full capacity. This issue has become increasingly relevant as European manufacturers face strong competition, leading to reduced production levels. To address this, we have now adjusted the number of workers by integrating the utilisation rates of factories, which represent the ratio between actual production output and the theoretical production capacity.

As for this edition, we have also reviewed and updated the manufacturing capacities across all value chain segments, incorporating information from public company announcements and insights provided by our members. 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.

Starting from our EU Solar Job Report 2023, 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 previous year's figures; however, the change in the overall number of jobs was negligible and counterbalanced by the increase in the other segments. The revised methodology for the Decommissioning & Recycling has been used in this edition.

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# Employee testimonial

## Chaima Chebbi

**Job Title:** Technical Support
**Department:** Technical department in the French market: Otovo France

1. **Can you briefly describe your job and what you do on a typical day?**

   *As a technical support specialist, my main responsibility is ensuring client satisfaction by addressing and resolving technical issues related to PV systems. On a typical day, I handle support tickets raised by clients, carefully analyse the issues they are experiencing, and provide effective solutions. If the issue requires the intervention of an installer, I contact them, explain the problem in detail, and arrange for them to carry out the necessary repairs. In cases where a part needs to be replaced, I coordinate with the manufacturer to ensure the installer receives the new material to complete the job.*

2. **How did you get into the solar PV industry, and what has your career path been like so far?**

   *I studied civil engineering, which provided a strong foundation in technical knowledge and problem-solving. Otovo then gave me the opportunity to enter the world of renewable energy, specifically the solar PV industry. The skills and knowledge I gained during my studies helped me quickly understand how PV systems work, which improved my performance from the start. Additionally, my highly skilled co-workers provided excellent onboarding and training, which allowed me to grow and continuously improve in my role. This combination of education and hands-on experience has been key to my career development in this field.*

3. **What do you enjoy most about working in the solar PV industry and at your company specifically?**

   *What I enjoy most about working in the solar PV industry, and at Otovo specifically, is the diversity of cultures within the company, which caters to residential customers in 13 European markets. It gives me the opportunity to learn a lot about different perspectives and backgrounds. The youthful spirit in the office also creates a dynamic and energetic atmosphere. But the best part is my co-workers, who are incredibly friendly, always willing to help, and open to diversity, which makes for a supportive and welcoming work environment.*

4. **Can you share a memorable experience or project you've worked on at the company?**

   *A memorable experience I had at Otovo was receiving my first 5-star review from a very friendly client. The client needed help finding a home automation system compatible with the inverters we install, which is typically challenging since most inverters aren't compatible with standard systems. After a lot of research and problem-solving, I managed to find a solution that worked for them. The client was extremely satisfied and continues to recommend Otovo to this day. This experience made me feel proud and motivated to put in even more effort to ensure our clients are always satisfied with our service.*

5. **What advice would you give to someone considering a career in the solar PV industry?**

   *My advice for someone considering a career in the solar PV industry is to prioritise studies in this field, as a solid educational foundation will help you solve any technical issues you might encounter. It's also important to take the time to explore the market and become familiar with the best brands and technologies to offer clients. Additionally, staying up to date with new technologies, especially artificial intelligence, can make a significant difference, as they can simplify system use and monitoring, ultimately improving performance and customer satisfaction.*

# RECRUITING IN SOLAR?

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# 2 EU solar jobs

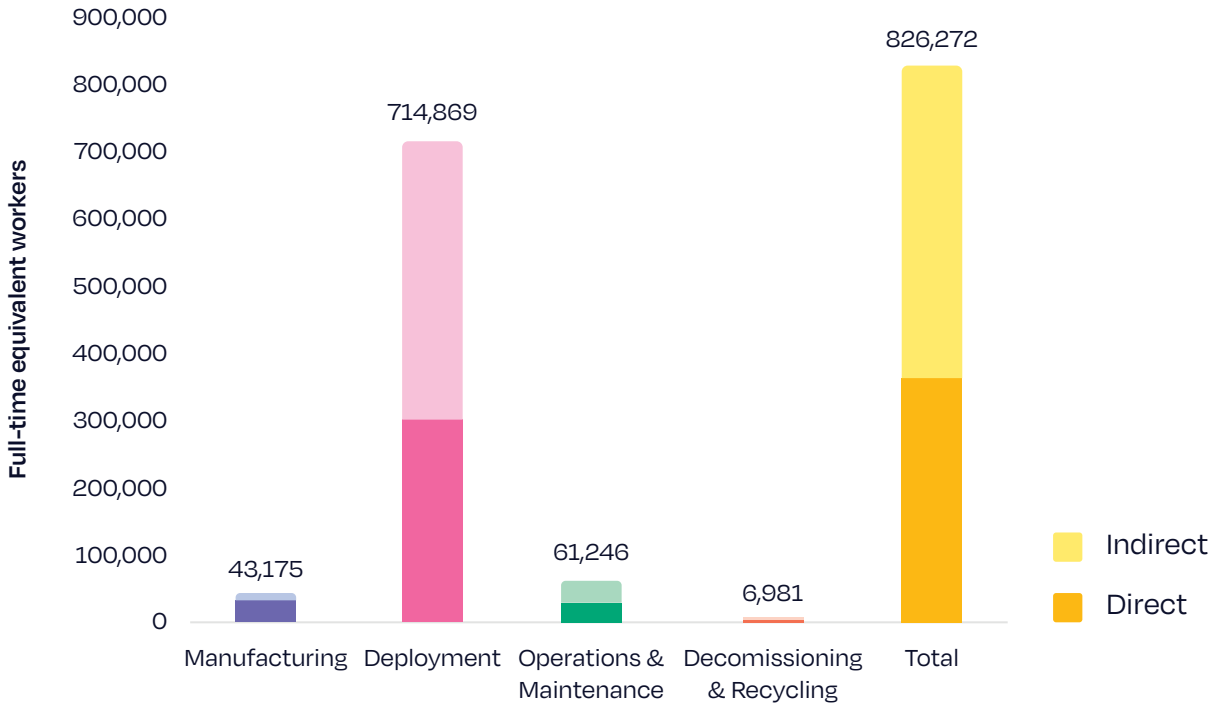
## 2.1. Update 2023

End of 2023, the solar sector employed 826,000 FTEs in the European Union. Among these, 362,000 FTEs are direct jobs, accounting for 44% of the total, while the remaining 464,000 FTEs (56%) represent indirect jobs (Fig. 4). In our previous report, we forecasted the count of EU solar jobs between 2022 and 2023 to increase by 24%. It turns out that, as often happens in the solar industry, the reality outpaced expectations as the headcount jumped by 28%. This is mostly explained by a larger annual EU solar PV market than expected, deploying 60.9 GW in 2023, while our previous job report's forecast of 805,000 FTEs was based on new installations of 53.8 GW in that year.

### Solar job segmentation

The majority of jobs in the solar industry concentrated even more in the deployment phase, accounting for 715,000 FTEs, or 87% of the total jobs, a slight increase from 84% in 2022 (see Figure 4). The growing installed solar capacity is also driving Operation and Maintenance activities, which generated 61,000 jobs, representing 7% of the total. Conversely, the EU manufacturing sector experienced several closures and job cuts due to intense international competition, resulting in 43,000 FTEs by end of 2023 and 5% of total EU solar jobs — a 5,000 FTEs decline from 2022 levels, when they represented 7% of total jobs. This significant drop is also due to methodological adjustments, such as the inclusion of utilisation rates of factories (see details in the Methodology section). If we assumed that factories were running at full capacity, the manufacturing job count would have reached slightly over 60,000 people. Finally, Decommissioning & Recycling jobs remain a minor component, comprising only 0.8% of total employment.

**FIGURE 4** EU-27 SOLAR JOB MARKET IN 2023






The dominance of deployment jobs over those in the Operation & Maintenance (O&M) segment is primarily due to the substantial workforce required for installing solar panels on roofs and in fields – and as long as the market grows strongly this segment will strongly dominate. However, once these systems are installed – and despite the fact that solar modules can operate over 30 years –, solar power plants generally do require minimal physical maintenance, reflected in much less O&M jobs.

As in previous years, Decommissioning & Recycling FTEs remain the smallest portion by far of total employment, representing only 0.8% in 2023, as solar PV waste streams are currently limited in volume and are expected to stay low for the foreseeable future. It is projected that significant solar PV waste volumes will not emerge until around 2030, when the first large-scale systems installed in Europe reach the end of their operational lifetimes.

The FTE figure for any given year represents a snapshot of the industry's workforce at the end of that year. Deployment jobs are directly linked to the solar capacity installed annually, making them dependent on the market size each year. With the EU solar market's sustained growth in recent years, deployment jobs have seen a substantial increase in recent times. The EU annual market more than tripled from 19.9 GW in 2020 to 60.9 GW in 2023, which has led to a corresponding rise in deployment-related jobs.

In contrast, O&M jobs are tied to the cumulative installed solar capacity, and as this capacity has grown significantly in recent years, the absolute number of jobs has also increased. Between 2020 and 2023, the EU's total solar capacity expanded from 139 GW to 269 GW, and in that period O&M jobs have grown from 34,000 to 43,000 FTEs.

Manufacturing roles within the EU's solar sector are intricately tied to the production capacities spanning across Member States, which represent a modest share of the global solar PV supply chain and cover only a limited amount of EU demand for solar products. While the production of polysilicon and inverters forms the backbone of the European industrial capacity, there is a significant shortfall in the manufacturing of ingots and wafers, and although there are plans and ambitions to expand cell and module manufacturing within the EU, today's global overcapacities along the value chain that have resulted in record-low prices of these products in international markets present a major challenge. EU manufacturers are struggling to compete, often operating at low utilisation rates; and several companies have even stopped their module manufacturing activities.

In terms of employment, inverter manufacturing remains the dominant solar production sector, significantly contributing to solar manufacturing jobs within the EU. Inverter manufacturers account for approximately 29,000 jobs across both direct and indirect roles, representing 66% of the total FTE positions in the manufacturing sector (Fig. 6). This outcome reflects the strong presence of solar inverter companies throughout Europe, several of which are global market players.

Polysilicon production also plays a significant role, accounting for 10% of solar manufacturing jobs, which translates to 4,100 FTEs. In terms of production capacity, the module segment experienced the highest growth between 2022 and 2023, with capacity expanding from 7.5 GW in 2022 to over 13 GW in 2023, resulting in an increase in jobs from 7,400 to 9,000. However, this rise in capacity was planned and initiated before the decline in module prices in international markets began. The low utilisation rates of these new factories explain why, despite a near doubling in production capacity, the job numbers did not increase substantially. Some companies were forced to halt production during 2023. While this reduction is temporary for some, as they scale back

**FIGURE 5** EU-27 TOTAL SOLAR JOBS BREAKDOWN IN 2023

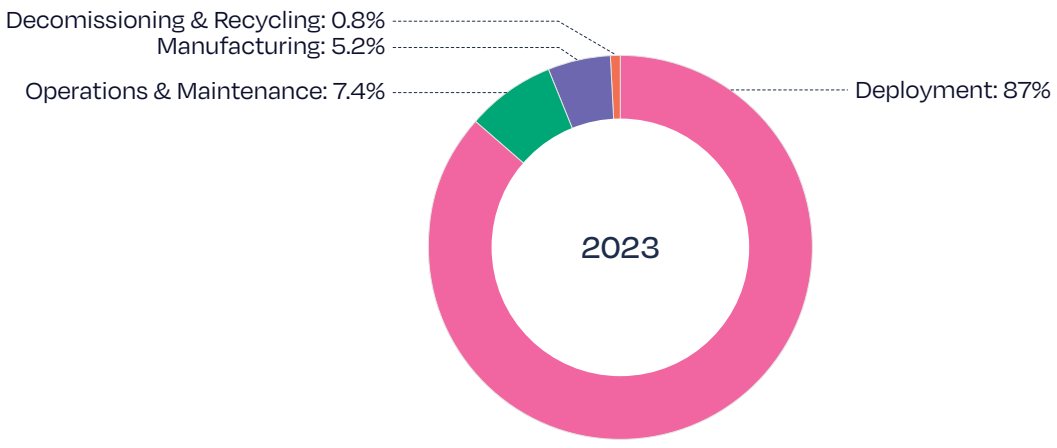
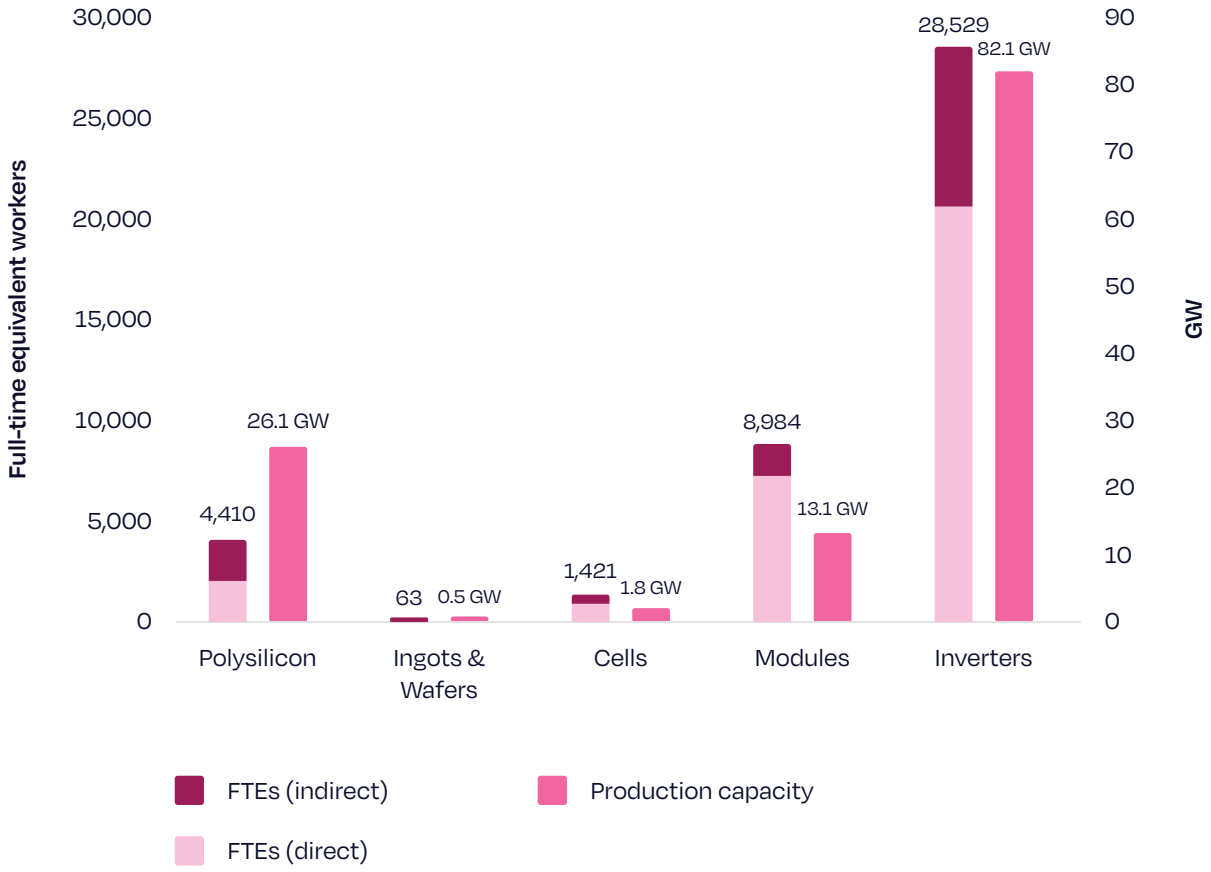


**FIGURE 6** EU-27 SOLAR MANUFACTURING JOBS AND PRODUCTION CAPACITY IN 2023






operations in anticipation of improved international market conditions and a rebound in module prices, others closed permanently in 2024.

Due to the current limited production capacity for ingots, wafers, and cells within the EU, these activities together generate less than 1,500 jobs, representing just 3% of the solar manufacturing segment's total.

Job intensity varies significantly across different manufacturing processes. Cell and module production require a higher job intensity, inverter and ingot/wafer production need lower levels, while polysilicon production has the lowest job intensity. As a result, despite polysilicon's production output being twice as high as for modules in 2023, it generated less than half the direct and indirect jobs.

As mentioned earlier, part of the decline in manufacturing jobs from 2022 to 2023 is also attributed to a revised FTE calculation method, which now factors in companies' utilisation rates and considers their actual production output, rather than assuming full capacity operation. This adjustment, which corrects previous overestimations of the European manufacturing sector's real activity, has become more relevant as European companies are facing much tougher competition from abroad. If we had assumed that companies were producing at full capacity, the job count would have not decreased by 5,000 to 43,000 jobs but slightly exceed 60,000. However, this would not reflect today's manufacturing conditions, which is why we have implemented and will keep utilisation rates in our modelling.

# Employee testimonial

## Christian Breyer

**Job Title:** Professor
**Department:** LUT School of Energy Systems – Electrical Engineering

1. **Can you briefly describe your job and what you do on a typical day?**

   *I am leading the Solar Economy research team at LUT. The activities comprise lecturing, research, and societal discourse for linking scientific insights to a broader audience. One of the central research questions is about the role of solar PV for energy systems in the years and decades to come. The daily tasks strongly vary from meetings, workshops, conferences, lectures, writing, revising, and being in exchange.*

2. **How did you get into the solar PV industry, and what has your career path been like so far?**

   *My educational background is in physics with specialisation in solar PV, in energy systems engineering with specialisation in concentrating solar thermal power plants, and in general business. My career led me to the PV industry in the mid-2000s right after graduation, from where I moved back to science a few years later, now being since 2014 professor for Solar Economy at LUT University in Finland. Important milestones had been raising the level of ambition of the PV community with progressive targets, such as the 12% PV supply aim in Europe in the late 2000s, ambitious scenarios in ITRPV reports, co-working with international colleagues to establish the 75 TW aim for PV, and supporting to understand that very low-cost solar electricity can finally power up to 70% of all primary energy demand in the world.*

3. **What do you enjoy most about working in the solar PV industry and at your company specifically?**

   *As an university researcher I strongly appreciate the room to ask new questions and to find new answers, or confirm existing views … and that we shall publish and communicate our insights.*

4. **Can you share a memorable experience or project you've worked on at the company?**

   *In 2020 we have published a common report with SolarPower Europe on the future prospects of solar PV for Europe where we pointed to the opportunity to contribute 50-60% of the primary energy supply of Europe, while non-scientific stakeholders had been still stuck in an about 20% contribution, typically limited to direct electricity. Collaboration with different stakeholders and subsequent dissemination across different societal stakeholders brings all of us further.*

5. **What advice would you give to someone considering a career in the solar PV industry?**

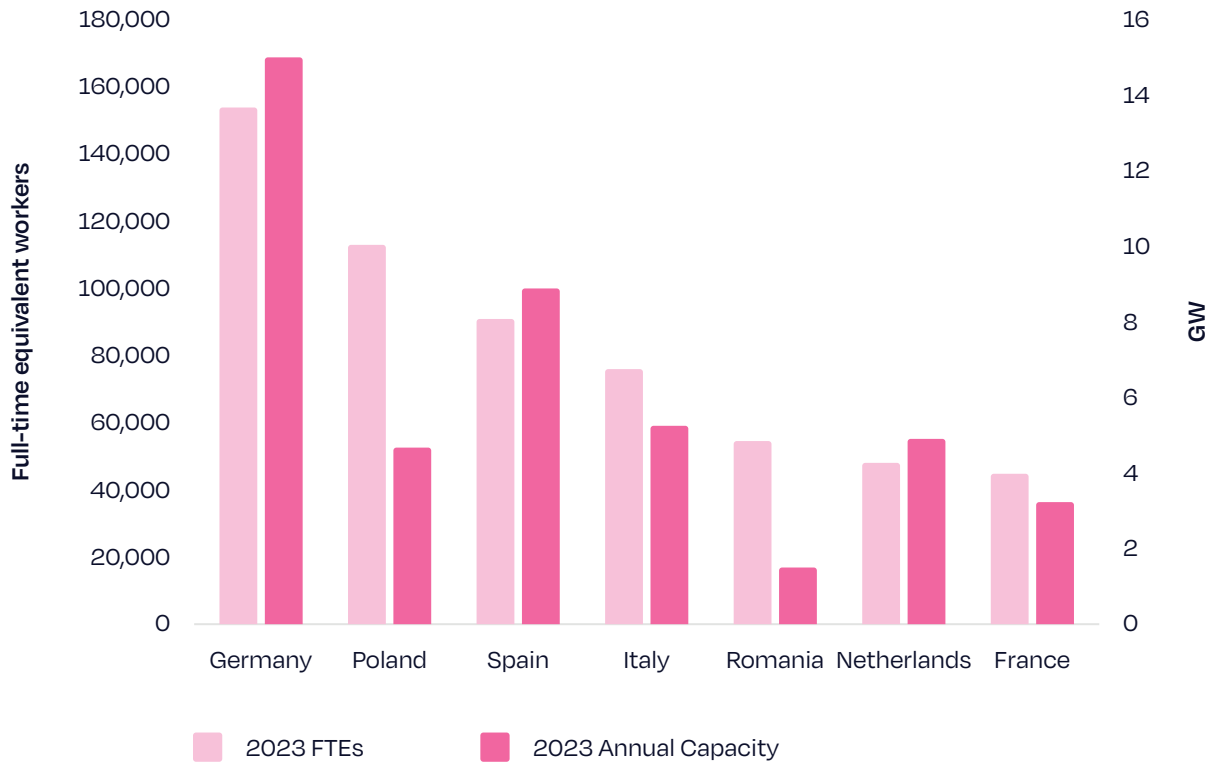
   *In research on solar PV it always helps to be an open-minded and reflected person linked to visions for the future … and for the special case of the PV industry, a robust personality helps for the ups and downs in the business environment. In the end solar PV knowledge is much required given the high supply share projected for PV.*

### Country breakdown

Examining country-specific employment figures, Germany now leads the European Union with approximately 154,000 direct and indirect FTEs at the end of 2023, representing a 19% share (Fig. 7). After ranking second in 2022, Germany has emerged as the top contributor to solar job creation within the EU, surpassing Poland, which held the lead in both 2021 and 2022. The growth in solar employment in Germany is a direct result of the expansion of the PV market, with the country installing 15.0 GW, a 104% increase from 2022, which means a new annual installation record across Europe.

Poland takes now the second place with 113,000 direct and indirect FTEs end of 2023. Despite having a smaller market than other countries, several factors explain Poland's significant role in solar job creation. First, deployment jobs are calculated by dividing the total cost of PV installation work by labour cost in the construction sector. Since Polish construction wages are relatively low compared to the rest of Europe, this results in a higher number of workers, according to the CAPEX model. Additionally, Poland's PV market has historically been heavily skewed toward residential installations, which require more labour per installed unit compared to larger ground-mounted PV systems. However, the Polish market didn't grow much from 2022 and 2023 and the recent shift from small residential to larger systems resulted in a decrease in FTEs from 2022 to 2023. While the country employed close to 147,000 workers in 2022, the number dropped to 113,000 in 2023. Lastly, Poland's input/output matrix shows high FTE multipliers in the construction sector compared to other major European PV markets, meaning that each direct job in the PV industry generates more indirect jobs in Poland compared to other countries. This trend is also observed in several other Eastern European countries, such as Romania.

**FIGURE 7** EU-27 TOP 7 FTE COUNTRIES AND ANNUAL INSTALLED SOLAR PV CAPACITY 2023

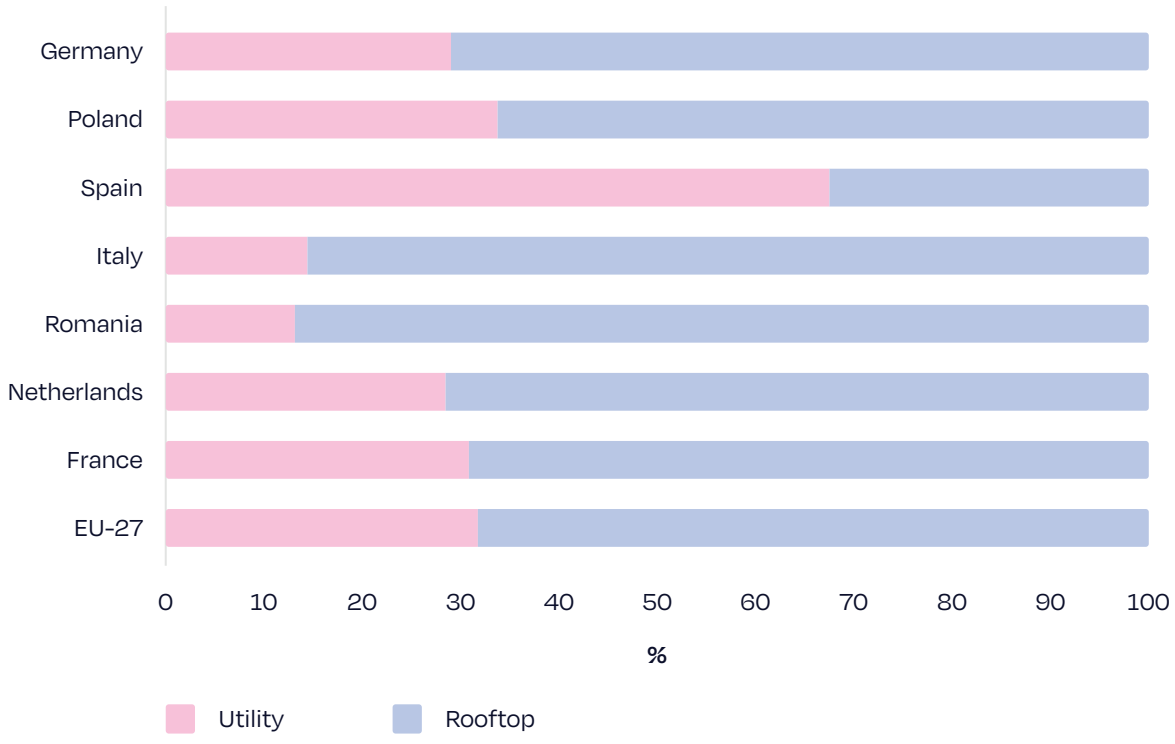


Predictably, most of Europe's largest PV markets, including Spain, Italy, Romania (not one of the largest PV markets in Europe, but a large job contributor for the same reasons as Poland, as presented above), the Netherlands and France all rank within the top 7 contributors. While Spain had 91,000 solar jobs at the end of 2023, Italy employed 76,000, Romania 55,000, the Netherlands 48,000, and France 45,000 FTEs.

Compared to the previous edition of this study, 8 EU Member States saw a decrease in the number of FTEs despite a slight increase in their market size. This can be attributed to the way our model calculates employment. First, it looks at annual PV installations in a country and the total cost of a PV system (in €/Watt). The model then determines the total monetary value of the installed PV system and isolates the portion attributed to labour costs (in %), which is then divided by the labour cost to estimate the number of workers. Consequently, when all other factors remain constant, a decrease in solar PV CAPEX results in fewer FTEs. This is precisely what occurred in 2023 when module prices dropped sharply, leading to a reduction in total CAPEX, while labour costs increased. This is reflected in real market dynamics as we observed several large installers facing financial difficulties in early 2024 in countries such as Germany and the Netherlands.

Among EU Member States that significantly contribute to solar job creation, a large portion of employment still stems from the rooftop segment (Fig. 8). In Italy and Romania, favourable policies for rooftop systems have resulted in over 85% of solar jobs being concentrated in this segment. Similarly, in other major GW-scale PV markets like the Netherlands and Germany, rooftop jobs account for 71% of their total employment. In contrast, Spain experienced an abrupt shift, with the share of rooftop-related jobs dropping from 52% in 2022 to 32% in 2023, reflecting a significant slowdown in the country's rooftop market. Across the EU, the share of rooftop-related employment declined to 68% in 2023, down from 73% in 2022 and 76% in 2021.

**FIGURE 8** EU-27 TOP 7 FTE COUNTRIES – ROOFTOP VS. UTILITY-SCALE JOBS BREAKDOWN 2023



## European cooperation across industries to solve the skills gaps in the energy transition

Skills are a crucial topic for the PV sector, as growing deployment rates and rapidly evolving technologies require both an expansion of the solar workforce and regular updating of workers' qualifications, skills and know-how. Other renewable energy sectors – such as wind energy, heat pumps, geothermal – are facing similar challenges, with significant overlap in the types of competencies in demand.

These sectors are therefore coming together in the RESKILL4NETZERO project, supported by the Erasmus + programme of the European Union. The project aims to create and test an EU wide scalable skills blueprint for the critical job profiles needed to tackle the skilled labour shortage in the renewable energy industries. It focuses on addressing key structural challenges, including:

- Bridging the Skills Gap;
- Standardising Workforce Knowledge and Skills;
- Tailoring Training for Phase-out Industries;
- Aligning Vocational education and training initiatives Programs (VET) with Renewable Industry Needs;
- Enhancing the Attractiveness of VET and Apprenticeships.

The RESKILLS4NETZERO project comes as another step in the conjoint efforts between renewable energy industries and the European Commission to address the topic of skills in the context of the energy transition. It ensures that European workers are not left behind by the reshaping of the energy landscape and that European renewable targets are not threatened by a lack of qualified personal and remain strategic European priorities.

The project is a key initiative within the broader framework of the Pact for Skills which supports large-scale skills partnerships in different industrial ecosystems, including Renewable Energy. It mobilises and encourages commitments from corporations, educational providers, and social stakeholders to enhance the skill sets or transition the careers of the working-age population. This initiative focuses on cultivating a workforce of skilled professionals and transitioning individuals in roles such as gas boiler installers to new technological domains, including heat pumps, solar panels, and more.

As part of the RESKILL4NETZERO project, SolarPower Europe will be cooperating with other renewable energy sectors and training experts to promote the adoption in Europe of a "blueprint" for green, digital and safety-related skills and competences for transferable job roles that are needed across several renewable industries including batteries, solar, wind, hydrogen, geothermal, critical raw materials etc. The objective of this approach is to enable easier pathways for reskilling and professional reconversion of qualified workers looking to enter the renewable energy industry as it keeps growing.

SolarPower Europe will coordinate the activities linked to dissemination and activation of the findings of this project: bringing the best practices outlined as part of the RESKILLS4NETZERO project to policy makers, the solar industry and other relevant stakeholders. In parallel, SolarPower Europe will also actively contribute to shaping the outputs of the project, making sure the solutions identified by the EU funded project are closely matched to solving the challenges faced by the photovoltaics industry throughout the value chain, from research to installations, from Operation & Maintenance to manufacturing.

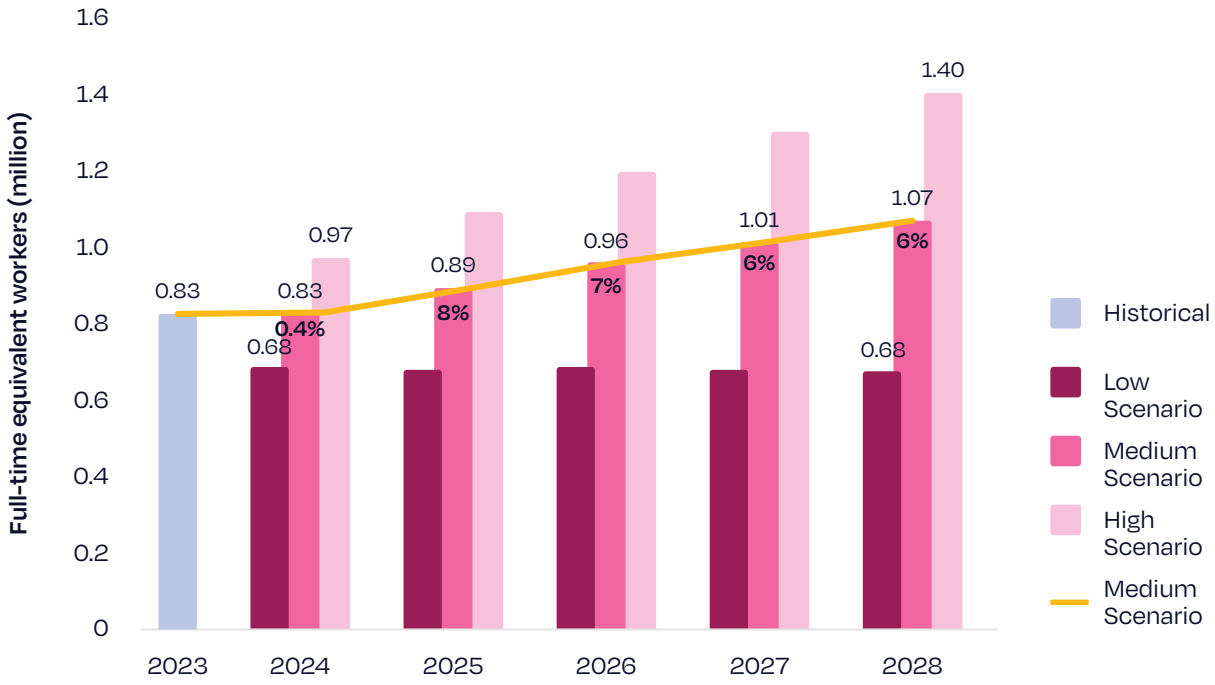
### 2.2. Prospects 2024-2028

With limited annual growth in the EU solar PV market expected in 2024 under our Medium Scenario, solar jobs are expected to stagnate this year. The annual solar PV market is projected to grow by 5%, reaching 63.9 GW, which would result in a less than 1% increase in solar jobs, bringing the total to approximately 830,000 full-time equivalent positions (Fig. 9).

In the more ambitious High Scenario, with 75.0 GW of installations and 23% market growth, solar jobs could rise by 17%, approaching 1 million workers by the end of this year. However, the reduced ambition in our Medium Scenario for solar PV market development compared to our previous assessment has tempered the expected pace of job creation. By 2025, the trajectory suggests 895,000 solar jobs, which is down from the 1 million previously forecast for that year, but it still marks a 7% increase from 2023 levels. A stronger policy push, aimed at accelerating solar deployment, boosting energy self-sufficiency, and expanding manufacturing capacities across the EU, could drive solar job numbers beyond 1 million FTEs by 2025 under the High Scenario, representing a robust 32% growth from 2023.

Looking ahead to 2028, solar jobs could slightly surpass 1 million under the Medium Scenario, and up to 1.4 million in the High Scenario. Conversely, the Low Scenario envisions market trade barriers, worsening system flexibility with inadequate storage deployment, which could weaken the economics of solar PV and constrain the European solar market. This, coupled with continued reliance on global supply chains, could reduce solar jobs to 675,000 FTEs by 2028 – a 19% decline from 2023 levels.

**FIGURE 9** EU-27 SOLAR PV FTE SCENARIOS 2024-2028



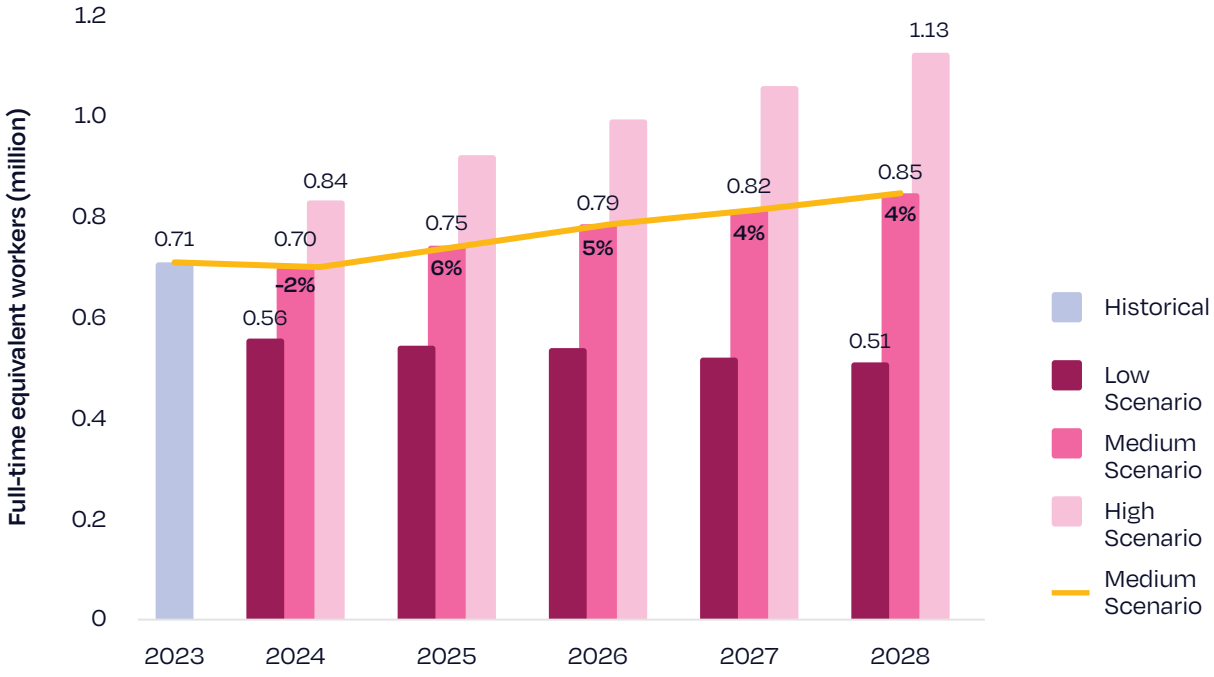
### Solar job segments development

The vast majority of PV job creation in the EU is linked to **deployment jobs**, which are directly tied to the growth pace of the PV solar market. While the annual market growth rate from 2021 to 2023 was fluctuating in a range of 41 to 51%, the next years are expected to experience growth rates in the 5% to 13% range. Naturally, as the market has grown larger year-on-year, the absolute difference between each year is generally smaller and total market size growth is decreasing. With the amount of workers expanding rapidly in the last years, the workforce does not need to increase as drastically to integrate a flattening PV market growth curve. Adding the efficiency gains and learning curve in the process, the pool of installations workers will remain more stable in the coming years.

The various activities involved in procurement, construction, installation, and other aspects of PV system deployment are projected to generate 703,000 jobs in 2024, reflecting a 2% decrease from the previous year (Fig. 10). This decline mirrors this year's expected growth rate of 5%, which would be not only the lowest seen in the past seven years, but also the lowest projected rate for the next five years, marking a current rock bottom in the market expansion. Coupled with decreasing system capital expenditures and rising labour costs, these factors lead towards a lower job creation rate for 2024.

This temporary reduction in deployment jobs underscores the fact that, while the solar PV sector successfully responded to the surge in demand over the past few years by rapidly expanding its workforce, companies are now struggling to retain staff as market growth slows. This has resulted in layoffs and even business closures. Unless improved regulatory frameworks enable faster solar sector growth, the industry has to adjust to this slowdown, requiring a shift in strategy to keep their businesses up and running.

**FIGURE 10** EU-27 SOLAR DEPLOYMENT JOBS SCENARIOS 2024-2028



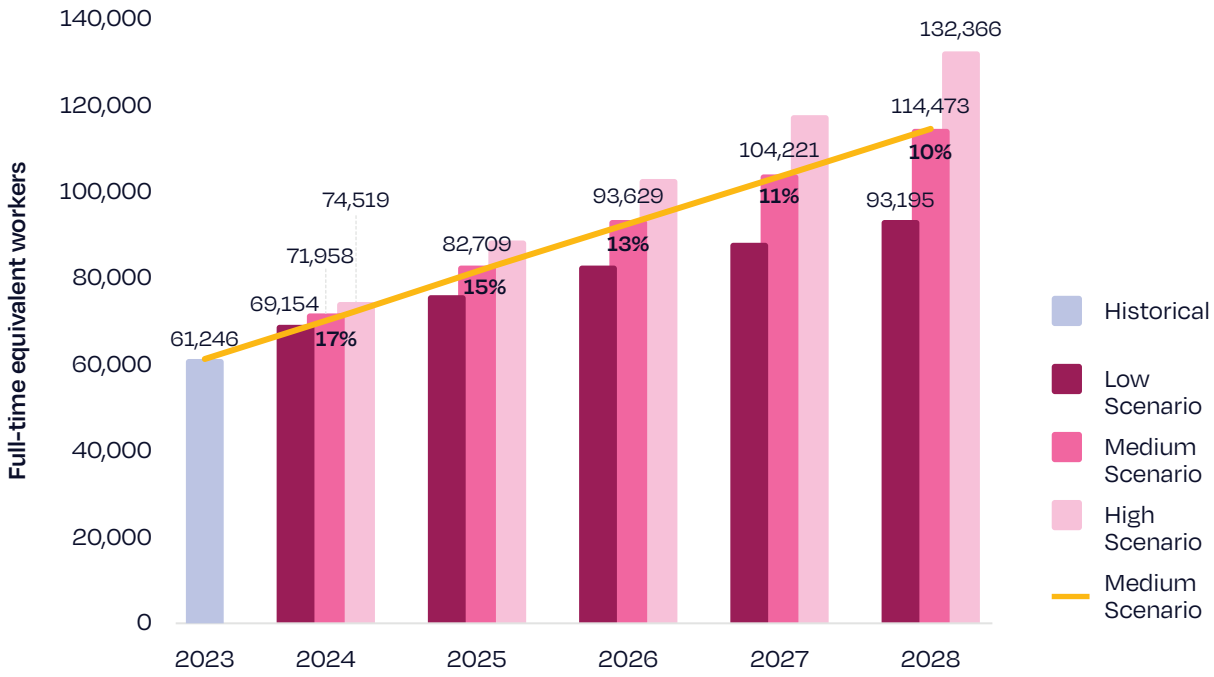
Looking further ahead, deployment jobs are still expected to grow and reach 849,000 FTE positions by end of 2028 under our Medium Scenario. However, due to their sensitivity to fluctuations in the annual EU solar market, deployment job numbers could vary widely in 2028, ranging from a low of 512,000 FTEs, reflecting a 60.2 GW annual market in our Low Scenario, to a as much as 1.1 million, based on new installations of 126 GW in our High Scenario.

Unlike deployment jobs, which fluctuate with the annual swings of the PV market and are subject to year-to-year changes, **Operations & Maintenance** roles are tied to the cumulative operational capacity of solar installations and exhibit greater stability. These positions are expected to experience consistent double-digit growth from 2024 to 2028, with minimal fluctuations – though the pace of growth slows down due to economies of scale, increased automation and a steady reduction in the growth rate of cumulative installations, from 24% in 2024 to 17% in 2028. O&M, next to project development and system design, is seeing much innovation through digitalisation, resulting in new jobs but also rationalisation of work. The solar O&M workforce, comprising 61,000 full-time equivalent (FTE) positions in 2023, is projected to increase by 17%, reaching 72,000 FTEs in 2024, and further expanding to 114,000 jobs by the end of 2028 (Fig. 11). This equals a CAGR of 13% between 2023 and 2028.

Examining the **manufacturing sector**, the next five years could unfold very differently depending on the intensity of international competition and the extent of European support, particularly the effectiveness of the EU's efforts to reshore solar manufacturing. The EU Solar PV Industry Alliance (ESIA), a tool of the European Commission, aims to achieve at least 30 GW of European solar manufacturing capacity, spanning the entire value chain from polysilicon to modules, by 2030.

In our Medium Scenario, where ESIA targets are only partially met (see methodology in Section 1.2), EU manufacturing jobs are projected to rise slightly to 47,000 FTEs in 2024, driven primarily by the expansion of inverter manufacturing, as SMA's new inverter factory in Germany increases production capacity from 21 GW to 40 GW. Most other segments

**FIGURE 11** EU-27 SOLAR O&M JOBS SCENARIOS 2024-2028



## The Impact of AI on the Solar Workforce: Insights from the SUPERNOVA Project

SolarPower Europe is part of the SUPERNOVA project, a 42-month Horizon Europe funded initiative that aims to enhance the operation, maintenance, and efficiency of PV plants. By utilising advanced technologies such as AI and big data, SUPERNOVA seeks to improve the reliability and profitability of PV systems. The project focuses on several objectives: improving solar plant design, developing new sensor technologies, employing robots to reduce costs and automate tasks, and integrating data for better asset management. AI will also assist in classifying solar components, optimising maintenance strategies, and promoting data sharing.

Among others, SUPERNOVA will research the use of large language models (LLMs) to automate workflows. These AI models will simplify human-computer interactions, allowing users to obtain information and insights through natural language commands. This means users can bypass traditional interfaces and automate reporting, freeing up technical staff to focus on improving solar plant performance. LLMs will also generate detailed, actionable reports for operators, helping them make better decisions based on established metrics.

The project highlights the future skills development of the sector, underscoring a growing demand for professionals with expertise in AI, data analysis, robotics, and automation. Knowledge of big data management and natural language processing will also become increasingly important. It emphasises the importance of a skilled workforce that is capable of leveraging advanced technologies to enhance the efficiency and profitability of solar energy operations.

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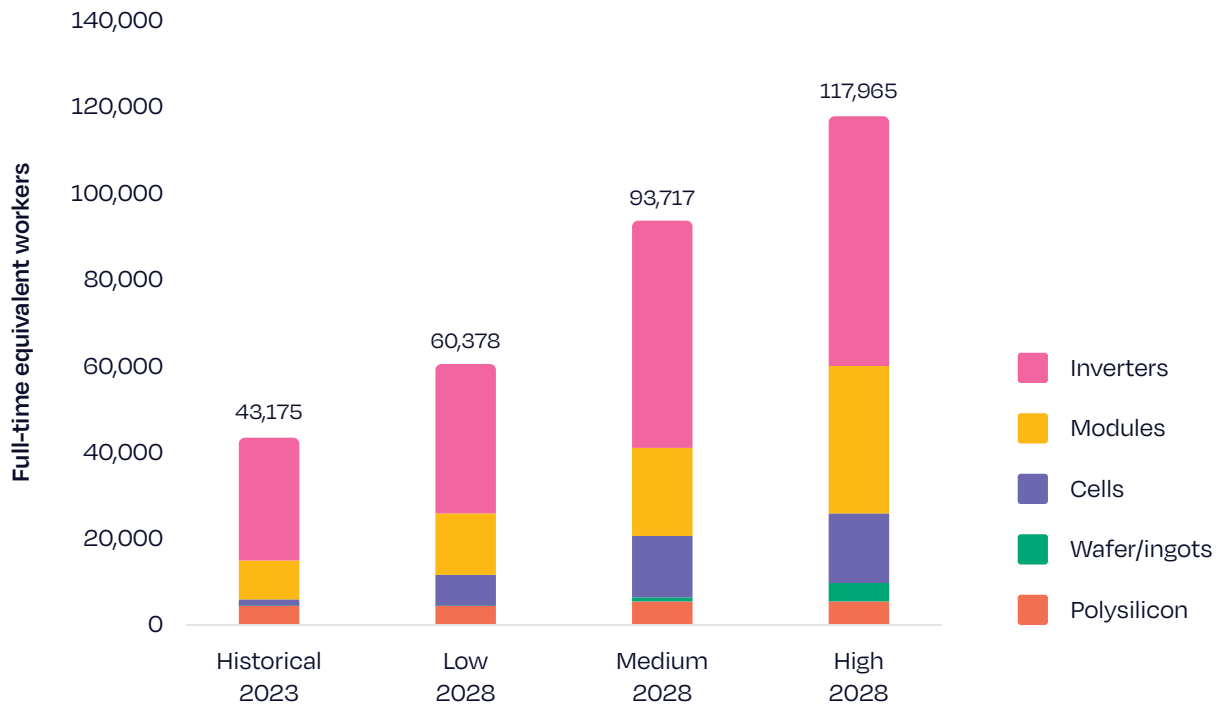
are expected to remain stable, while jobs related to module production decrease slightly due to company closures. By 2028, the job count is anticipated to more than double to 94,000 FTEs (Fig. 12).

Conversely, under our low-ambition scenario, where European manufacturing capacity struggles to compete with larger international players and lacks sufficient EU support, manufacturing jobs only reach 60,400 FTEs by 2028 – a 40% increase from today's levels. Alternatively, with strong political backing to establish a robust manufacturing base within the EU and reduce reliance on supply chains from third countries, domestic solar manufacturing jobs could surge to as many as 118,000 FTEs by 2028, representing a remarkable 173% increase from 2023.

While growth is anticipated across all segments of the value chain, the projected increase in solar manufacturing jobs has been revised downwards compared to the previous edition of this report. European manufacturers have faced fierce competition from international players, leading to delays or cancellations of several expansion plans. With just six years remaining to achieve the ESIA targets, and support mechanisms weak in comparison to other regions, any major implementation of new production facilities will require time to materialise. The establishment of large solar manufacturing capacities across the value chain poses a significant challenge under the current regulatory environment, particularly given the modest starting levels in various segments, notably in ingots, wafers, and cells. Additionally, much of the expected new production capacity is concentrated among a small number of companies, rather than reflecting broader sectoral development.

The disparity in manufacturing capacities among the three scenarios is already pronounced in the short term, as several companies have set interim targets for 2025 as part of their broader 2030 plans. This differentiation becomes increasingly apparent in the later years of the forecast period. Decisions made today require substantial planning, financing, and the construction of manufacturing plants, with the effects

**FIGURE 12** EU-27 SOLAR MANUFACTURING JOBS SCENARIOS 2023-2028

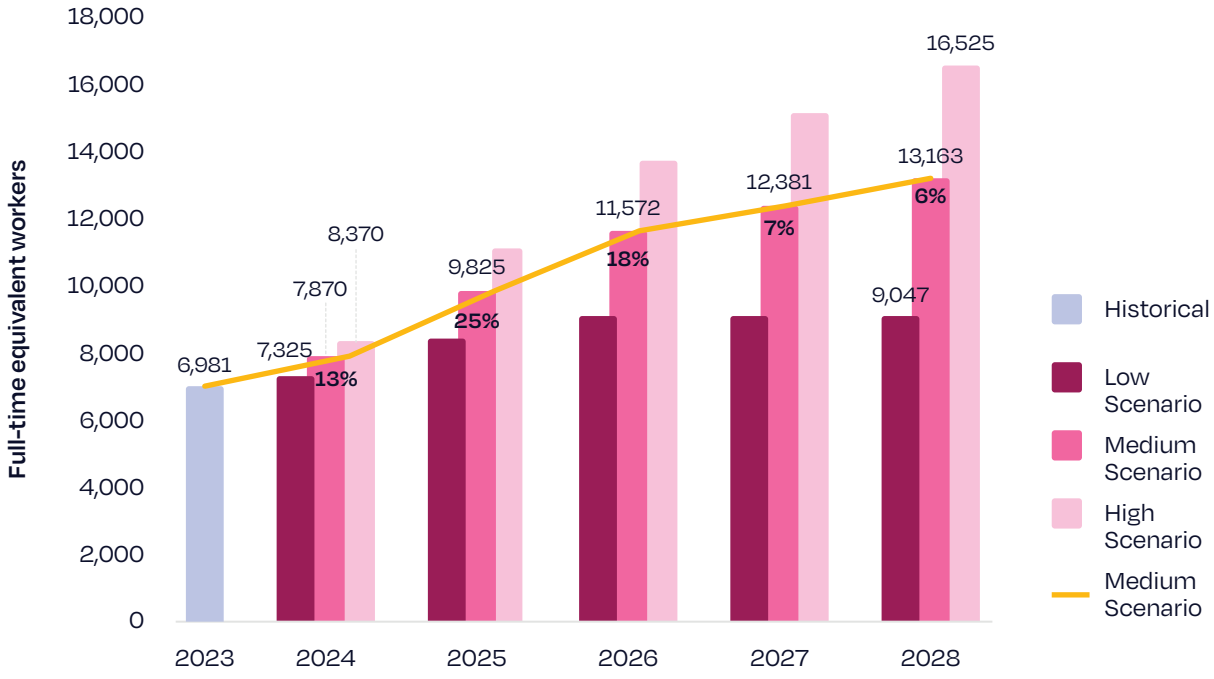


only becoming visible several years down the line. In the High Scenario, the number of manufacturing jobs is projected to surpass the symbolic 100,000 mark in 2028, compared to 2026 in last year's report. By 2028, the number of manufacturing jobs could range from as low as 60,400 to as high as 118,000, depending on the level of support and the development of a strong framework to foster industry growth. This underscores that developing a domestic solar PV industry is not just a matter of energy security and supply chain diversification, but also has significant downstream benefits, including the creation of numerous green and local jobs.

Employment opportunities in the Decommissioning & Recycling sector remain relatively small compared to the overall solar jobs landscape. This is largely because a significant portion of PV systems began deployment in the early 2000s, and with a product lifespan of 30 years or more, only a small fraction of currently installed modules are reaching the end of their operational life. Presently, most waste streams are generated from modules damaged during transportation and installation, early operational failures, or the repowering of older systems being replaced with newer, more efficient models. However, this employment trend is expected to shift significantly in the medium to long term as an increasing number of PV systems inevitably reach the end of their operational lifespans.

In 2023, jobs in this segment remain limited, with approximately 7,000 FTE positions. However, projections for the short to medium term suggest substantial growth, with solar employment in the Decommissioning & Recycling sector expected to rise to 13,200 FTEs by 2028 (Fig. 13). This segment also holds potential in affiliated areas such as R&D and advanced product design, and should require more attention in the education landscape.

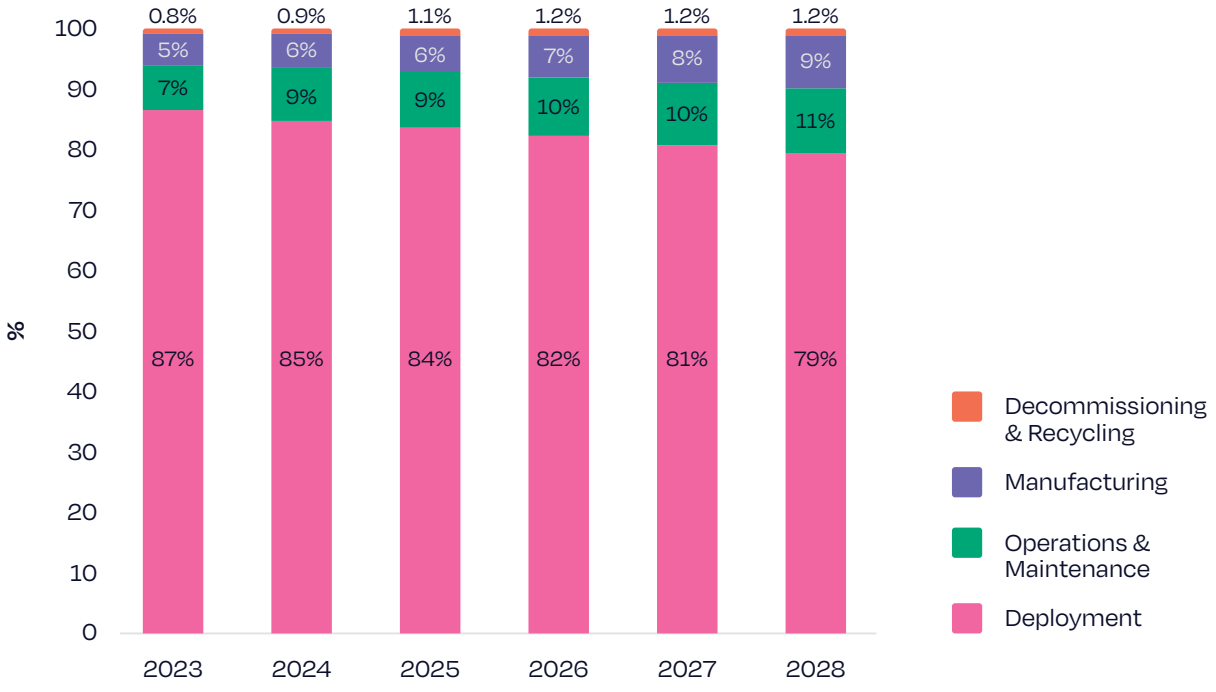
**FIGURE 13** EU-27 SOLAR DECOMMISSIONING & RECYCLING JOBS SCENARIOS 2024-2028



Over the course of our projected five-year forecast period, the total number of EU solar jobs is expected to grow across all four segments of the value chain. However, the relative distribution of the different solar jobs segments is likely to see only minor shifts (Fig. 14).

Although jobs related to Deployment will continue to dominate, their share is expected to decrease slightly from 87% to 79% between 2023 and 2028, as the market growth curve is generally flattening. Meanwhile, the other three segments are projected to see modest gains in their respective shares: O&M jobs are expected to rise from 7% to 11%, Manufacturing from 5% to 9%, and Decommissioning & Recycling roles are anticipated to surpass the 1% mark during this period.

**FIGURE 14** EU-27 SOLAR JOBS BREAKDOWN EVOLUTION 2023-2028



# Employee testimonial

## Lisa Hirvonen

**Job Title:** Sales Director and Product Manager
**Department:** Commercial office with close contact to technical and marketing departments.

1. **Can you briefly describe your job and what you do on a typical day?**

   *Regarding my role as sales director my daily tasks includes duties such overseeing the sales operations, working on sales strategies and targets for particular markets and segments and of course, cultivating relationships with clients.*

   *I also have the role of product manager, for which I actively work with the many departments of the company; from production and technical office to marketing and sales conveying information and visions internally and externally regarding the constant evolvement of the product assortment of FuturaSun. Also, I'm here in close contact with the customers and the general market aiming at anticipating new requirements and demands.*

2. **How did you get into the solar PV industry, and what has your career path been like so far?**

   *My passion for the solar industry started at my father's module factory in Swedish Lapland. And my first real work experience consisted in learning all steps of the manufacturing process working directly in the production line as an operator. At the age of 20, I had moved to Italy and started my career path growing into management roles that have touched several parts of the value chain; from the production of photovoltaic modules to the manufacturing of turn-key lines for module assembly moving on more vertically to the production of cells and then later back to modules.*

3. **What do you enjoy most about working in the solar PV industry and at your company specifically?**

   *The more knowledge I'm gathering about the solar industry and the possibilities of the products, the more triggered I'm getting to learn more. And the thing that I enjoy the most of the industry is to feel that it is more than a work, it is a contribution to a more sustainable tomorrow.*

   *At FuturaSun we have the possibilities to bridge experience between continents; Europe and Asia. We are strong of European expertise yet learning and growing further from a strong Chinese supply chain and technology development. In short, we can combine the best parts of both worlds.*

4. **Can you share a memorable experience or project you've worked on at the company?**

   *I have had many memorable experiences during my carrier, in particular the ones that develop the industry either by setting up manufacturing lines or by installing projects in rural areas where PV brings the best of its potential, providing power to areas lacking grid. Or seeing the growth of the industry in the far most Nordic countries such as Norway, that despite lower energy prices compared to other countries and many hours of darkness still invest in PV in support of the energy transition, hence in a more sustainable future.*

   *Another great experience is also the product development of FuturaSun with coloured panels, demonstrating the versatility of PV by meeting up with design requirements overcoming landscape constraints. For me the PV industry is full with memorable experiences since, as said, for me it's more than a work, it's a mission.*

5. **What advice would you give to someone considering a career in the solar PV industry?**

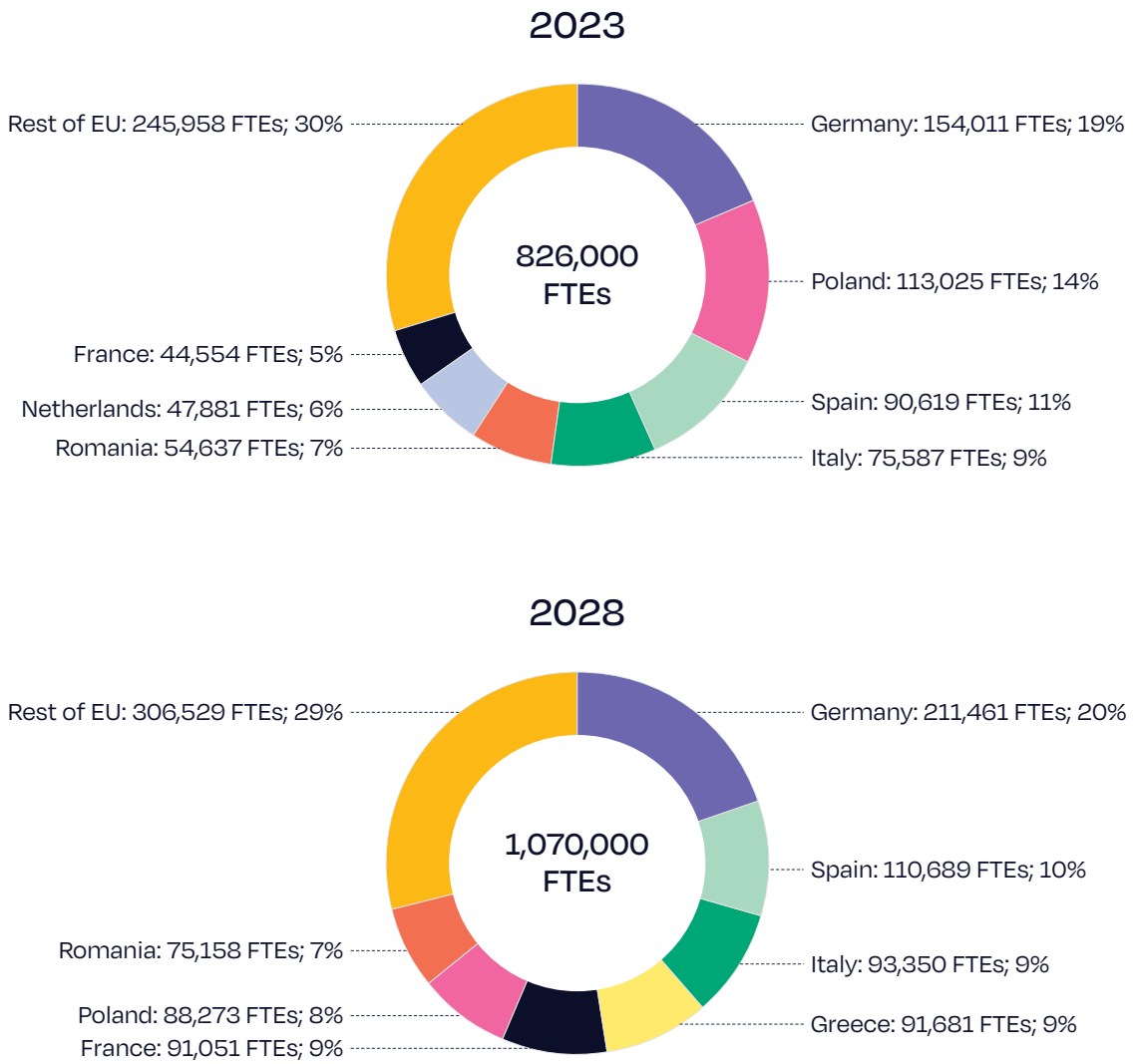
   *I would put passion and personal engagement for the field of environment and renewables as first important factors to succeed in this industry. In terms of education, of course, as all other industries, there is a need for everyone, from economists to physicists and a great start to get involved on professional level is to make one's university thesis at company in the industry that often welcomes these roles as new industry professionals are needed in this quickly expanding industry.*

**Solar job developments in EU Member States**

The list of Member States primarily contributing to solar job creation in 2028 is not expected to undergo major changes compared to the current landscape. The Netherlands, which was ranking 6th in 2023, is expected to exit the top 7, replaced by Greece, while Poland and Romania will be surpassed by Spain, Italy and France. (Fig. 15).

Nonetheless, some countries have seen notable shifts in job projections since our previous report (Fig. 13). Germany, which hosts the largest solar fleet in the EU and has the most ambitious installation targets for the coming years, is anticipated to remain the leading contributor to solar job creation, with 211,000 FTE positions under the Medium Scenario in 2028. Spain is expected to achieve the second position

**FIGURE 15** TOP 7 FTE COUNTRIES 2023-2028



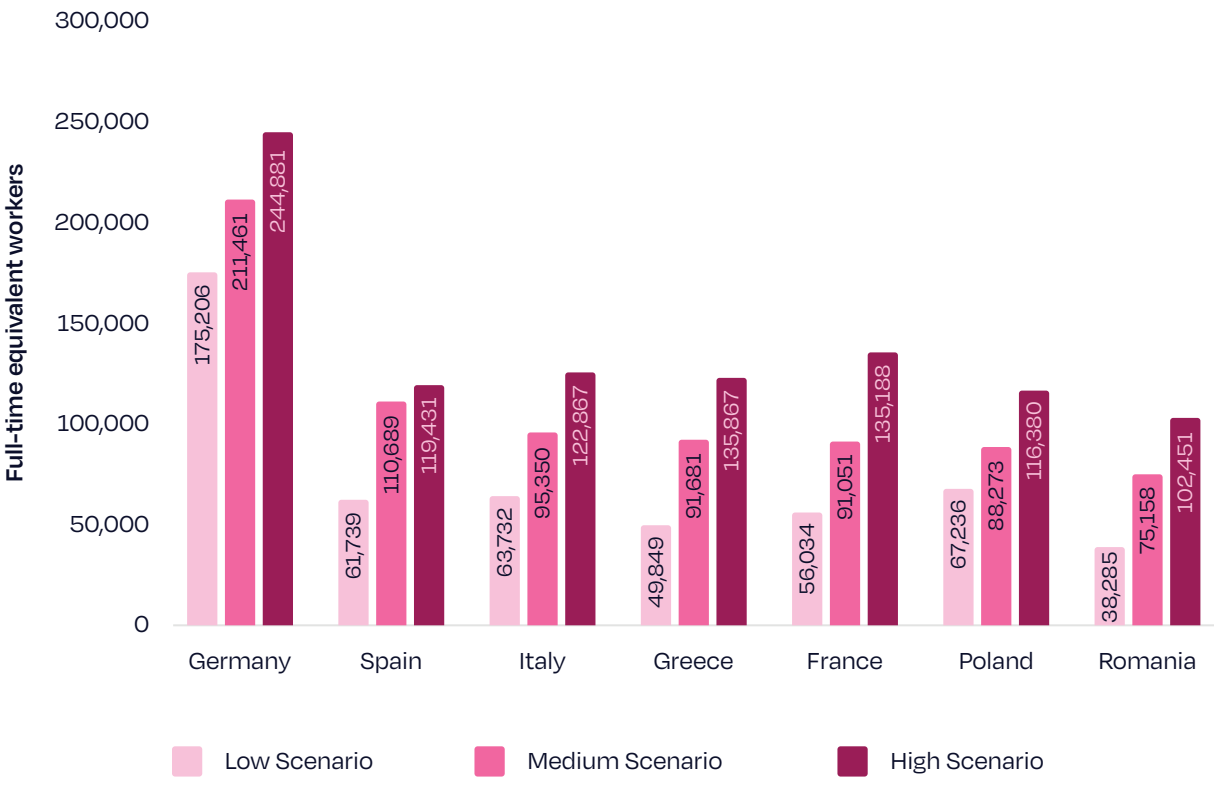
of the EU's largest solar employers in 2028, but the projected 111,000 workers fall short of the 179,000 FTEs forecasted for 2027 in our previous edition. This discrepancy is primarily due to a decreased PV development projection in the country. In addition, the strong growth in the rooftop market in 2022 was expected to continue, but it now appears to have been a temporary surge, with the segment currently struggling to grow. As the most job intensive segment, this uptick was leading to wide job creation in our precedent modelling.

Conversely, Italy's robust PV market is fuelling a thriving job market, with the country projected to approach the 100,000 FTE mark by 2028. This positions Italy as the third-largest contributor to EU solar jobs, a significant rise from its fifth-place ranking last year.

Greece, France, Poland, and Romania – all part of last year's ranking – continue to be steady contributors to job creation in the solar sector. Like Spain, Poland's market projection was slightly decreased compared to our previous modelling. In addition, the Polish PV market is currently transitioning from small rooftop systems to larger utility-scale projects. As a result, fewer workers are required to achieve the same level of installations, leading to a reduction in the anticipated workforce.

In the Medium Scenario, the top seven markets are projected to generate 767,000 FTEs, accounting for 71% of all EU solar jobs in 2027, while the remaining 20 Member States are expected to contribute the remaining 29%.

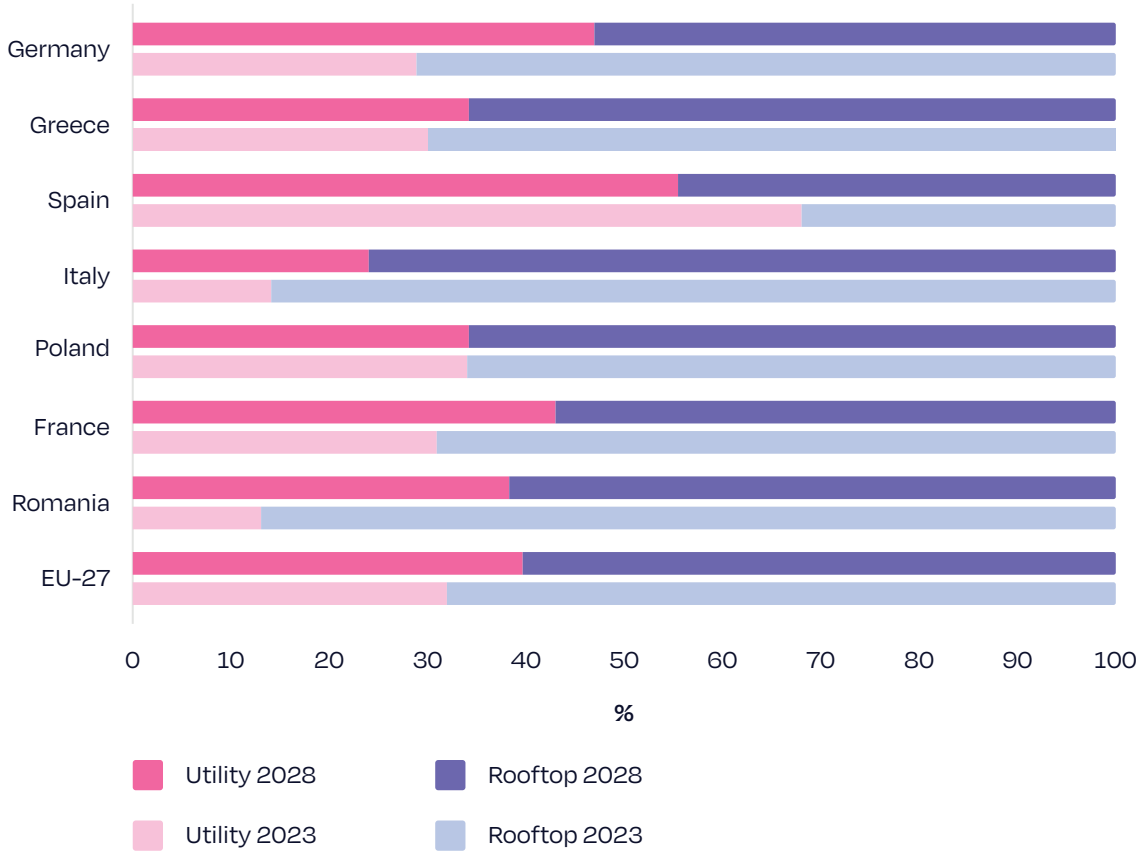
**FIGURE 16** EU-27 TOP 7 COUNTRIES SCENARIOS 2028



**Ground-mounted vs. rooftop installation jobs**

The expected shift in the balance between rooftop and utility-scale PV capacities, with a growing emphasis on utility-scale power plants, is becoming increasingly evident in solar job numbers. This rise in large-scale installations is projected to reduce the share of rooftop-related FTEs from 68% in 2023 to 60% by 2028 (Fig. 17).

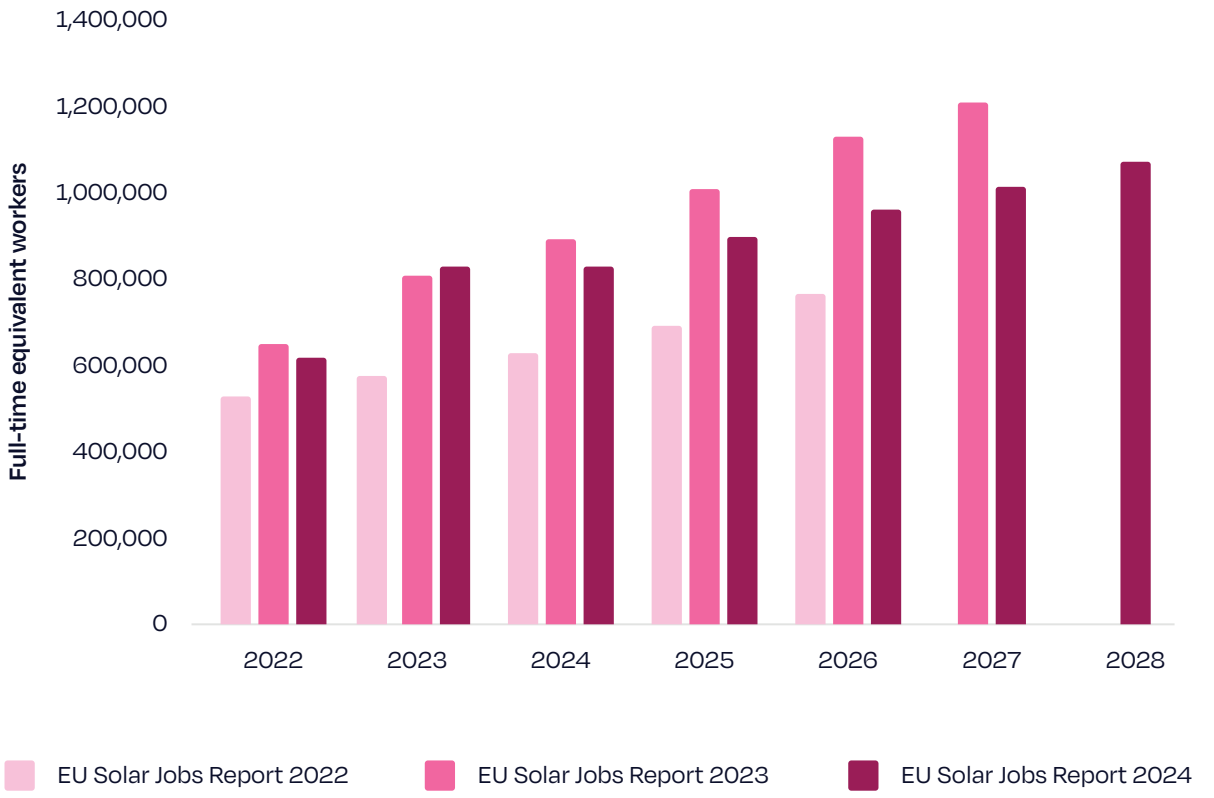
**FIGURE 17** EU-27 TOP 7 COUNTRIES - ROOFTOP VS. UTILITY-SCALE JOBS BREAKDOWN IN 2023 & 2028



Our projections in last year's EU Solar Jobs Report slightly underestimated the actual job creation observed in 2023. At that time, our Medium Scenario forecasted approximately 805,000 jobs for 2023. However, this year's report shows that the actual figure was 4% higher than our previous estimate. This variation can be attributed to the difference in anticipated solar PV deployment. In our 2023 study, we forecasted an addition of 53.1 GW of solar PV in 2023, but the actual installation exceeded 60 GW, surpassing our forecast by 13%. This surge was driven by extraordinary circumstances, including the Russian invasion of Ukraine and the subsequent energy crisis.

Although job numbers did increase, they did so at a smaller rate because the cost of solar systems dropped significantly during the same period and the shift to ground-mounted systems. Following this surge, last year's Medium Scenario outlook was more optimistic and anticipated higher job creation levels for 2024-2027 than we now foresee. With severe challenges on the manufacturing front and a slow-down in the pace of installations after the 2021-2023 rush, the market appears to be returning to a 'business as usual' state, leaving the strong momentum from the energy crisis behind. In addition, the global manufacturing overcapacities has led to dramatic prices drops that are not expected to rebound in the near term. As a result, our current job market forecast is 5% to 14% lower than last year's estimate, though still higher than in our 2022 report. This highlights the hype in 2023, which likely led to an overestimation in previous forecasts.

**FIGURE 18** COMPARISON MEDIUM SCENARIO OF JOB STUDY 2022, 2023 AND 2024



# 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 |
| | Inverter | C27 | Manufacturing of electrical equipment |
| Deployment | Deployment | F | Construction |
| Operation & Maintenance | 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 TABLE 3 CAPEX OF PV SYSTEMS IN EU-27 MEMBER STATES (€/W) IN 2023 (PRICES WITHOUT VAT)

| Country | Residential | Commercial | Industrial | Utility |
|---|---|---|---|---|
| Austria | 1.53 | 0.98 | 0.74 | 0.59 |
| Baltic States | 1.30 | 0.86 | 0.68 | 0.70 |
| Belgium | 1.31 | 0.99 | 0.82 | 0.88 |
| Bulgaria | 1.10 | 0.75 | 0.65 | 0.66 |
| Czech Republic | 0.86 | 0.58 | 0.50 | 0.42 |
| Denmark | 1.32 | 0.89 | 0.83 | 0.95 |
| Finland | 1.28 | 0.85 | 0.67 | 0.70 |
| France | 1.83 | 1.34 | 1.03 | 1.03 |
| Germany | 1.60 | 1.13 | 1.03 | 0.86 |
| Greece | 1.50 | 1.02 | 1.03 | 0.97 |
| Hungary | 0.86 | 0.59 | 0.51 | 1.06 |
| Italy | 1.36 | 1.07 | 0.94 | 0.68 |
| Netherlands | 1.42 | 1.18 | 1.12 | 1.01 |
| Poland | 1.05 | 0.88 | 0.75 | 0.85 |
| Portugal | 1.15 | 0.94 | 0.82 | 0.73 |
| Romania | 1.50 | 1.02 | 0.88 | 0.72 |
| Slovakia | 1.07 | 0.73 | 0.63 | 0.54 |
| Slovenia | 1.06 | 0.72 | 0.62 | 0.80 |
| Spain | 1.22 | 0.79 | 0.74 | 0.60 |
| Sweden | 1.20 | 0.99 | 0.86 | 0.86 |
| Rest of EU | 1.35 | 1.09 | 1.02 | 1.09 |

Source: IRENA, IEA-PVPS, Otovo, SPE calculation.

ANNEX TABLE 4 CAPEX BREAKDOWN FOR ROOFTOP AND UTILITY-SCALE PV SYSTEMS 2023

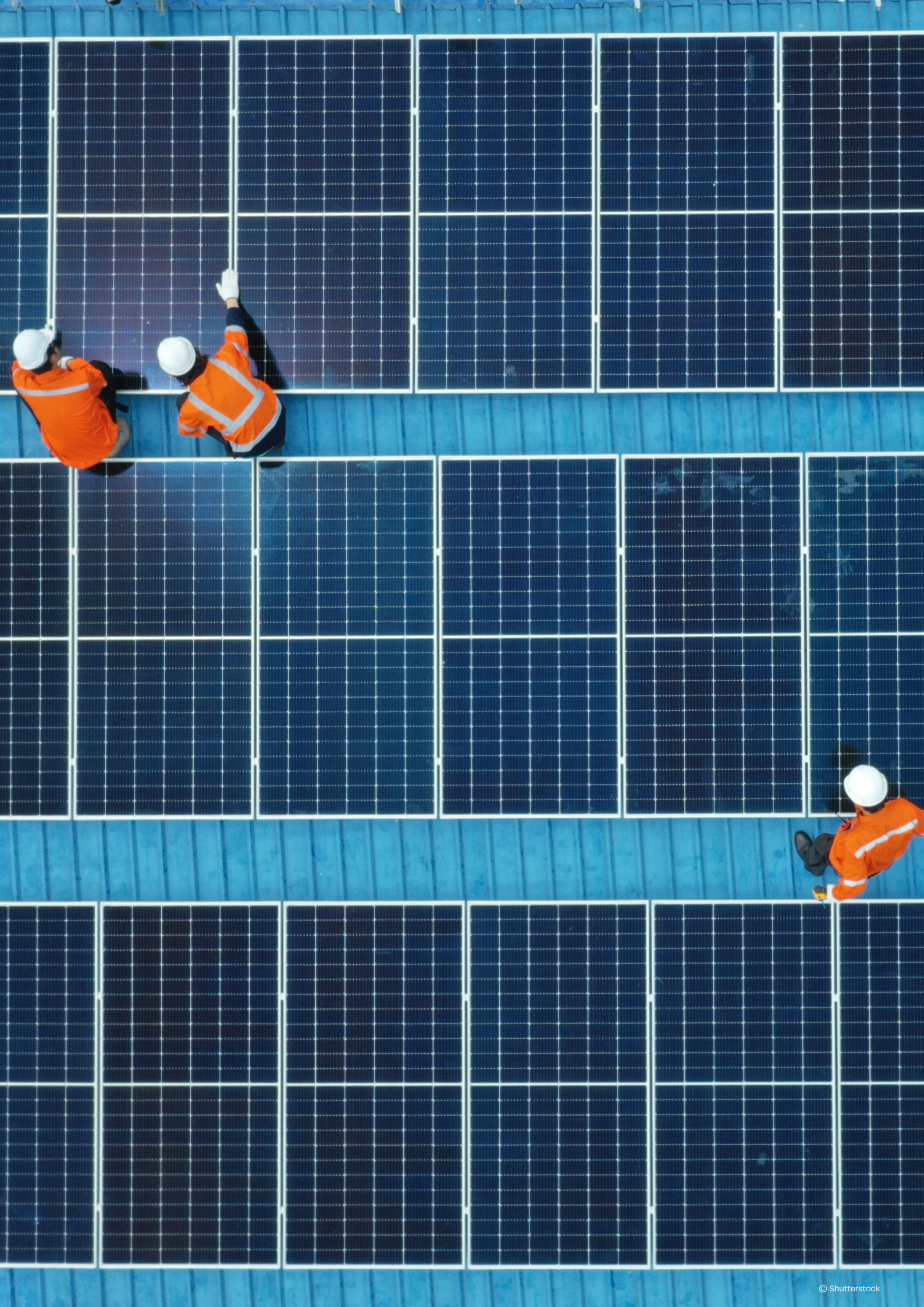
### Rooftop systems (residential scale)

| 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% |

### Ground mounted (utility scale)

| Main costs | Cost Category | Percentage |
|---|---|---|
| Hardware Costs | Modules | 24.1% |
| | Inverters | 8.6% |
| | Racking & Mounting | 20.9% |
| | Grid Connection | 11.9% |
| | Cabling/wiring | 4.2% |
| | Safety & Security | 1.0% |
| | Monitoring & Control | 1.3% |
| Installation Labour | Mechanical Installation | 8.0% |
| | Electrical Installation | 3.9% |
| | Inspection | 0.5% |
| Soft Costs | Margin | 5.7% |
| | Financing Costs | 2.4% |
| | System Design | 4.0% |
| | Permitting | 2.2% |
| | Incentive application | 1.0% |
| | Customer acquisition | 0.5% |

**Source:** IEA-PVPS, IRENA, Industry survey.



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