UNEF
Unión Española Fotovoltaica

FORGING THE TRANSFORMATION TOWARDS SUSTAINABILITY

ANNUAL REPORT
UNEF 2024

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA, COMERCIO Y EMPRESA
ICEX INVEST IN SPAIN


SMA
FULL OF ENERGY
All the power of the sun in one solution
The SMA Commercial Energy Solution is the perfect combination of high-quality equipment, smart software, and exceptional service. Its modular design makes it easy for your customers to start and allows hassle-free upgrades to fit their budget and needs anytime. SMA serves as the one-stop shop for PV, storage, and eMobility Solutions.
Ready for a partnership full of energy?
SMA.de/en

FOREWORD

This yearbook carries the appropriate title "Forging the Transformation Towards Sustainability." It is a particularly well-fitting title because it announces from the outset that the Spanish economy is in the midst of a transition toward a more competitive, sustainable, and adaptive production model in line with the dual green and digital transitions that will drive the growth of the European economy in the coming years.

The term "Forging" refers to the idea that a hard and skilled effort is underway. Indeed, this transformation of the Spanish economy toward sustainability, for it to have a true structural impact, will require significant effort and perseverance, a sufficient supply of highly qualified personnel, and abundant investment—both public and private, Spanish and foreign.

Foreign investment will be key to completing the energy transition toward a decarbonized, efficient, and sustainable energy production model. It is estimated that, in order to keep the world on track to meet the goals set in the Paris Agreement, about 1.5 times the current global GDP will need to be invested by 2050. The investment needs are staggering, and it is crucial to have ample capital and international know-how. In fact, foreign investment in the global renewable energy sector has nearly tripled since the adoption of the Sustainable Development Goals and the Paris Agreement.

Elisa García Grande

Executive Director
Invest in Spain
ICEX Spain Trade & Investment

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA, COMERCIO Y EMPRESA ICEX INVEST IN SPAIN

Spain is an attractive country for these types of investments. According to the FDI Markets database from the Financial Times Group, in 2023 Spain was the largest global recipient of greenfield projects in the renewable energy sector and the second-largest recipient of clean hydrogen-related projects after the United States. Additionally, Spain is the third-largest recipient of projects involving research and development (R&D) activities.

The energy transition is not just about addressing climate change challenges from an environmental perspective. It also has a significant positive impact on the economy and industry, opening up new opportunities for economic development for businesses and fostering innovation and the development of new technologies. For Invest in Spain, sectors related to green energy and clean hydrogen are a priority and strategic for the development of our activities in the coming years.

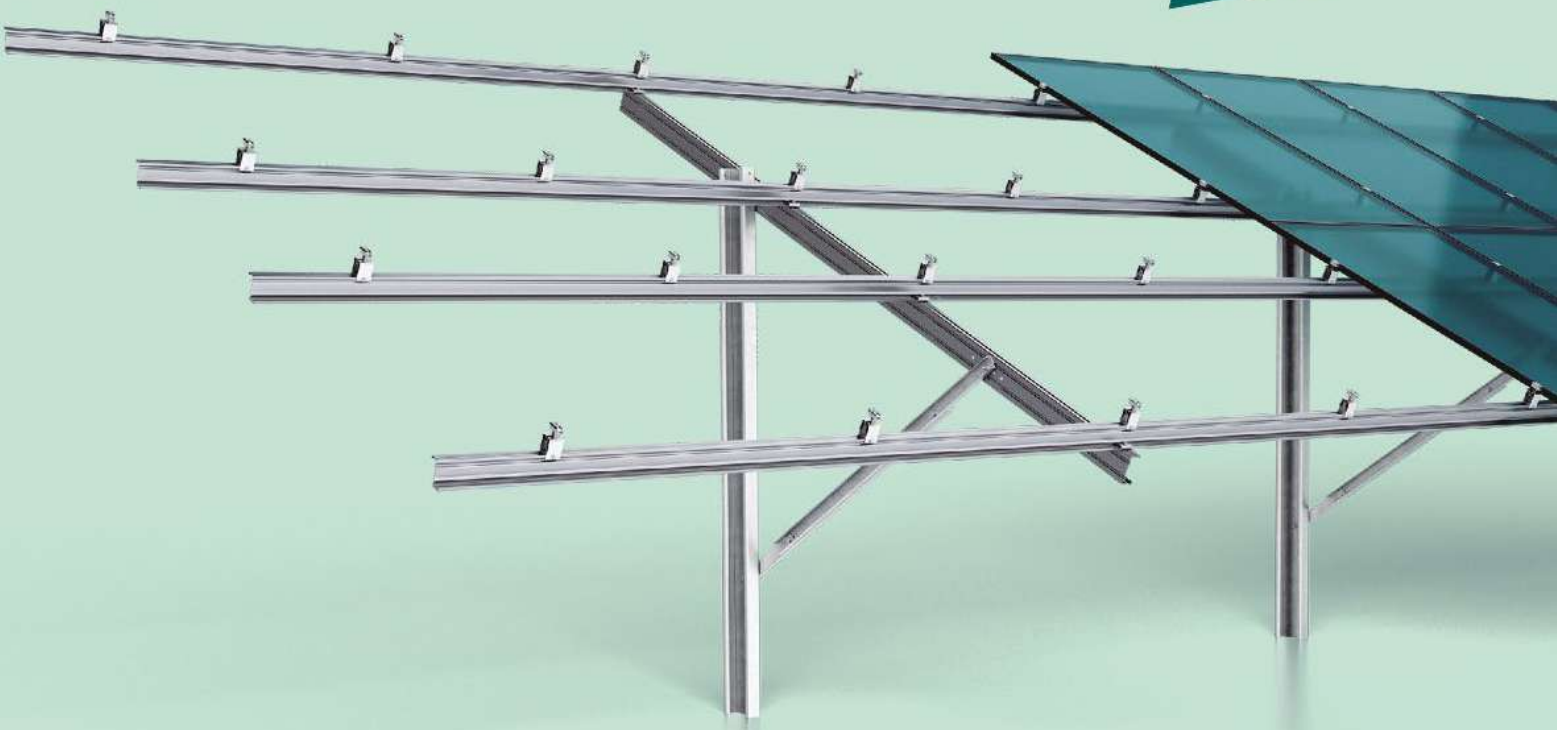
The transformative potential of the photovoltaic solar energy industry in Spain is further enhanced by the sector's high propensity to invest in research and development. In 2023, investment in R&D by the Spanish companies in the sector exceeded €610 million, with an average budget of 3.6% of their turnover, three times the average innovation spending in Spain's industrial sector.

The development of photovoltaic solar energy in Spain presents an extraordinary business opportunity for both Spanish and foreign investors in the sector. To facilitate these investments, ICEX has collaborated with the UNEF in producing this annual report, providing all interested parties with a comprehensive overview of the Spanish photovoltaic sector.

At ICEX/Invest in Spain, the agency under the Ministry of Economy, Trade, and Business of the Spanish Government dedicated to promoting and developing foreign investment, we encourage foreign companies in the photovoltaic sector - across all its facets (development, EPC, operations, component manufacturing, etc.) - to explore the opportunities that Spain offers for their activities. Together with UNEF, we are happy to assist them in finding information and in establishing or expanding their operations in our country.

SCHLETTER
WE SUPPORT SOLAR.

>55 GWp
SYSTEMS INSTALLED WORLDWIDE



WE SUPPORT SOLAR.

AT SCHLETTER, WE BELIEVE ANY ENTERPRISE, BIG OR SMALL, CAN ONLY BENEFIT FROM PASSIONATE SUPPORT.

SCHLETTER-GROUP.COM

Letter from the Chairman

Rafael Benjumea

Chairman of Unión Española Fotovoltaica (UNEF)

Dear member companies,

As we present our Annual Report, I am pleased to offer you a brief overview of the activities UNEF has undertaken throughout 2023, along with a review of the results achieved and an outlook on the Spanish photovoltaic sector.

The past year has witnessed significant growth in our sector, reaffirming solar energy's central role in Spain's energy transition. The figures are impressive: 5,783 MW of new capacity were installed in ground-mounted PV plants in 2023, marking substantial growth of 26.5% compared to the previous year. This progress highlights not only the vitality of our sector but also its ability to adapt and expand in a changing environment.

In the area of self-consumption, the data highlights the maturity and potential of this segment, as well as the challenges that lie ahead. In 2023, 1,706 MW of photovoltaic self-consumption capacity were installed, marking a 32% decrease compared to 2022 and bringing the cumulative total to 6,955 MW. The industrial sector has made significant strides, emerging as the leader in self-consumption installations, accounting for 60% of the total, up from 47% the previous year.

Overall, combining ground-mounted and self-consumption plants, 7,489 MW were installed in 2023, increasing Spain’s cumulative photovoltaic capacity to 32,488 MW. We remain a leading example in Europe and reaffirm our commitment to the goals of decarbonisation and sustainability.

An especially significant achievement is that photovoltaic energy has firmly established itself as the fourth largest source of electricity generation in Spain, making up 13.6% of the national energy mix. This highlights not just the quantitative growth of our sector but also its increasing qualitative significance in Spain's energy landscape.

Throughout 2023, UNEF has maintained ongoing relations with all key stakeholders in the sector. Taking advantage of the election year, we have communicated our demands and future challenges to all political parties. Numerous meetings were held, focusing on municipalities or Autonomous Communities where difficulties have been encountered when developing photovoltaic projects. Notably, in some municipalities, UNEF has engaged in mediation efforts at the request of both local authorities and the companies involved, achieving excellent results.

In the regulatory arena, 2023 has been a year of stability, yet it has also seen significant activity. Key consultations have been conducted, including those on the reform of the electricity market, aligning with changes at European level and setting the objectives for the new integrated National Energy and Climate Plan (NECP).

Several Royal Decree-Laws have shaped the legislative landscape this year, leaving a significant impact on the electricity market. Notable among these are the extension of administrative milestones, adjustments to the PVPC and changes to environmental assessment criteria.

A particularly significant milestone has been the update of the objectives in the NECP. In June 2023, the Ministry for Ecological Transition launched this update for public consultation. It is a crucial tool that shapes Spain's decarbonisation policies and energy planning. The new targets, set to be finalised in Brussels during the summer of 2024, have been revised upwards, aiming for greater ambition in the deployment of photovoltaic energy, storage and hydrogen by 2030.

Specifically, photovoltaic capacity installation targets have been increased from 36 GW, as set in the 2021 NECP, to 76 GW in this new draft, aligning with UNEF's recommendation of 70-80 GW. Additionally, a specific target for self-consumption has been set at 19 GW, surpassing our 15 GW proposal and marking a significant advance compared to the previous NECP, which did not specify a target in this area.

UNEF is pleased to see this heightened ambition in the new targets, which underscores the critical role of solar PV in Spain's energy transition and provides significant support for the work we have been doing.

One of the key moments of the year was the 10th Solar

Forum, which once again set attendance records, making us immensely proud. During this event, we fostered collective discussion on critical issues for the sector such as the potential extension of milestones set to expire in July 2025, the social acceptance of projects, the challenges of residential self-consumption and the obstacles facing energy storage, among other vital topics.

Looking ahead, our commitment remains steadfast: to continue championing solar energy as a cornerstone of Spain's energy transition. This means not only advancing the deployment of ground-mounted plants and encouraging self-consumption but also investing in energy storage as an essential complement to photovoltaics and promoting the integration of solar energy across all economic sectors.

At UNEF, we will continue to work on overcoming regulatory barriers, fostering the training of qualified professionals and promoting best practices in sustainability and environmental responsibility. Our UNEF Seal of Excellence in Sustainability remains a leading standard in the sector, ensuring that the growth of solar energy benefits society as a whole and is conducted responsibly.

In closing, I would like to express my heartfelt gratitude to all our member companies for their trust and continued support. Your commitment is the driving force behind our industry. I also want to extend my thanks to the UNEF team and the Board of Directors for their dedication and relentless effort.

Together, we are building a cleaner, more sustainable and prosperous energy future for Spain and the planet. I am confident that we will continue to work together to transform challenges into opportunities and strengthen the leadership of solar photovoltaic energy in our country.

Rafael Benjumea Chairman of UNEF

TABLE OF CONTENTS

4. STORAGE AND HYDROGEN

5. PHOTOVOLTAIC INDUSTRY

6. UNION ESPAÑOLA FOTOVOLTAICA (UNEF)

Executive summary

International

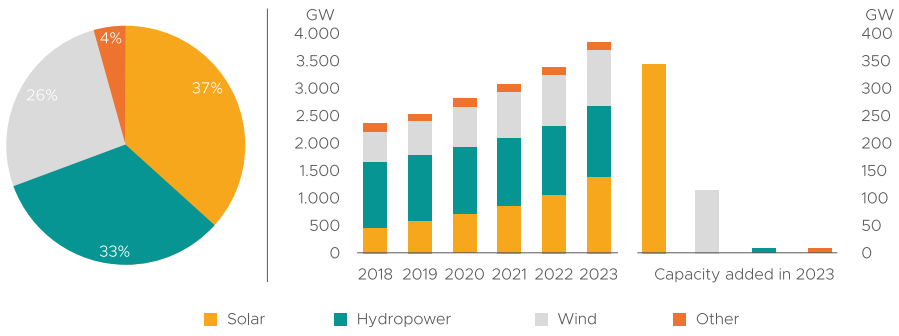
Internationally, in 2023, photovoltaic technology was once again the fastest growing, outpacing both renewable and non-renewable sources. According to the IEA PVPS programme, **446 GW of new PV capacity** was installed this year, marking an 85% increase from 2022.

IN 2023, 75% OF NEWLY INSTALLED RENEWABLE ENERGY WORLDWIDE WAS PHOTOVOLTAIC.

Global cumulative capacity in **2023 surpassed 1624 GW**. The ranking for annual installed capacity is unchanged from 2022: **China leads the world** with 235.5 GW installed, **followed by the European Union** with 55.9 GW and the USA with 29.6 GW.

Photovoltaic energy production globally accounted for 37% of renewable generation capacity according to IRENA data, making it the leading source, ahead of hydroelectric energy.

Figure 1: Generation capacity and capacity growth by energy source



Source: IRENA: Renewable capacity highlights

Europe

The **European Union** continued to be the world's second-largest player in PV development with annual installations growing by 40% (15 GW) compared to 2022. In 2023, the EU reached a cumulative capacity of 263 GW, according to SolarPower Europe. This growth met the expectations and forecasts from 2022, with a 27% increase in installed capacity over the previous year.

Spain emerged as **Europe's second-largest market with 8.8 GWdc** (7.4ac) installed in 2023. Germany once again led Europe in terms of annual installed capacity, achieving 14.3 GW, while Italy secured third place with a total of 5.2 GW installed.

Forecasts for 2024 predict that Europe's annual installed capacity **will reach 61 GWdc, a 9% increase compared to 2023**. SolarPower Europe estimates that by 2030, European growth will achieve an annual capacity of 119 GWdc.

IN 2023, SPAIN WAS THE SECOND-LARGEST PHOTOVOLTAIC MARKET IN THE EURO AREA AFTER GERMANY.

Spain

In 2023, the photovoltaic market in Spain reached a state of

stabilisation. A total of 6,939 MWdc (5,783 MWac) of ground-mounted plants were installed, marking a 26% increase over 2022. Conversely, self-consumption installations totalled 2,047 MWdc (1,706 MWac), a 32% decrease compared to 2022. Despite this contraction in self-consumption, installation numbers indicate that the sector is stabilising after experiencing a peak year in 2022.

There are promising growth prospects for ground-mounted plants by 2024. In 2023, a substantial amount of photovoltaic capacity was undergoing administrative authorisation. By July 2024, 28 GW of photovoltaic projects had been approved for construction, accounting for 90% of all permits for new renewable capacity installations.

IN JULY 2024, 28 GW OF GROUND-MOUNTED PLANTS WERE AUTHORISED FOR INSTALLATION.

Regarding legislation, several regulatory measures have been approved **at European level** that will support photovoltaic development in the coming years. In January 2023, the European Commission introduced the **Green Deal Industrial Plan**, aiming to boost the competitiveness of European industries with net zero emissions. Within this framework, the EU has initiated several actions to achieve these objectives: The **Net Zero Emissions Industry Act**, which seeks to expand clean technology manufacturing to meet at least 40% of its needs by 2030, simplify regulations and attract investment. The **Critical Raw Materials Act**, designed to ensure a sustainable supply of critical raw materials (such as lithium, cobalt, nickel, gallium and others) within the renewable value chain. This is aimed at developing Europe's domestic industry, enhancing the resilience of supply chains and promoting a circular and sustainable economy.

Within this framework, the **European Electricity Market Reform** was approved in May 2024, through the Directive on common rules for the internal electricity market (EU/2019/944) and the Regulation on the internal electricity market (EU/2019/943). This reform aims to achieve price stability by promoting long-term instruments such as PPAs, thereby fostering price stability and predictability while reducing reliance on short-term market fluctuations.

On 8 May 2024, the Energy Performance of Buildings Directive, which includes the **EU Rooftop Solar Standard**, came into effect as part of the Solar Energy Strategy package. It will apply to non-residential and public buildings from 2027, existing non-residential buildings undergoing renovation from 2028, new residential buildings from 2030 and all existing public buildings from 2031.

At European level, the **Nature Restoration Act** was approved on 18 June 2024. This Act is part of the European Green Pact, aimed at fulfilling the objectives of the European Biodiversity Strategy for 2030. It mandates the restoration of 30% of areas in poor condition by 2030, increasing to 60% by 2040 and 90% by 2050, through obligations to rehabilitate natural habitats.

At national level, 2023 has been a year of legislative stability with regulatory changes implemented through the publication of several Royal Decree-Laws (RDLs). These laws addressed sector needs by **extending administrative timelines**. The administrative authorisation for construction has been extended by an additional 6 months, bringing the total to 49 months, while the Administrative Authorisation for Operation has been lengthened to 8 years. **Network capacity for self-consumption has been increased**, ensuring the efficient use of surplus energy from installations. **Tax changes have also been made to the Tax on the Value of Electrical Energy Production (IVPEE)** and **storage** has been prioritised among the preferred uses of water.

EUROPEAN ELECTRICITY MARKET REFORM AIMS FOR PRICE STABILITY BY INCREASING THE USE OF FORWARD CONTRACTS AND PPAs.

There have also been changes concerning **consumers**. A new Royal Decree-Law has been introduced for **electro-intensive consumers**, including extractive industries, altering the criteria for obtaining certification as an electro-intensive consumer and revising the methodology for calculating subsidies. In addition, the **calculation of the Voluntary Price for Small Consumers** (PVPC) **has been modified**. It now includes indexation to forward products and incorporates the financing of the subsidised rate into the PVPC calculation. This allows energy retail suppliers to recover amounts financed up until the RDL comes into effect.

The **modification of the Environmental Assessment Act** is significant. Changes have been made to Annexes I, II, and III, which relate to ordinary and simplified environmental assessments. These modifications alter the criteria that determine the type of environmental assessment each project must undergo.

For **Renewable Hydrogen**, in 2023, the EU approved two Delegated Acts and held the first auction for renewable hydrogen projects under the **European Hydrogen Bank** framework. Nationally, efforts to stimulate the sector are driven by targets set in the **new draft of the integrated National Energy and Climate Plan (NECP)**, proposing **11 GW** of installed electrolyser capacity by 2030. Additionally, a second call to boost the hydrogen value chain is backed by €66.6 million.

495 MWH OF NEW BEHIND-THE-METER STORAGE WAS INSTALLED IN 2023.

Concerning **photovoltaic self-consumption and energy communities**, measures have been advanced through RD-L 8/2023. These include allowing the free amortisation of investments in self-consumption facilities and freeing up the transmission grid capacity reserved for access tenders.

In 2023, a total of 1,706 MW of new self-consumption capacity was commissioned across all forms. The variation in total installations compared to 2022 is due to a misconception of low energy prices, combined with high inflation and interest rates, which have impacted household and small business economies.

Energy Communities have started to develop, supported by the regulatory framework of RD-L 5/2023 and facilitated by the Community Transformation Offices and the CE Implements programme. These initiatives have played a key role in their establishment.

In 2023, the **new draft NECP** was released for public consultation and presented in Brussels in the summer of 2024. This draft raises the photovoltaic target to 76 GW of installed capacity by 2030.

RD-L 5/2023 PROPOSES A FACILITATIVE FRAMEWORK FOR THE CREATION OF ENERGY COMMUNITIES IN SPAIN.

The **PV sector contributed significantly to the economy**, with our estimates indicating a direct impact of €5.33 billion on GDP in 2023, a 1% decrease from 2022. The sector's total economic footprint, combining direct, indirect and induced GDP generation both domestically and internationally, reached €18.02 billion in 2023, marking a 4% increase from the previous year.

In **employment**, the total footprint in Spain accounted for 162,396 national workers connected to the PV sector in 2023, comprising 34,037 direct, 86,968 indirect and 41,391 induced roles.

Geopolitical challenges have underscored the necessity to advance the **national and European PV industry**, encouraging the relocation of supply chains within the EU. Spain is currently able to cover up to 65% of the photovoltaic value chain with strengths in power electronics, solar trackers, structures and design. It boasts one of the top ten inverter manufacturers and three of the ten leading solar tracker manufacturers. However, it is essential to bolster and expand domestic production, particularly of PV panels, which account for about 35% of the remaining costs.

A trend of negative electricity prices emerged in 2023 due to a mismatch between electricity supply and demand. This situation underscores the **necessity to electrify the economy** to facilitate the energy transition, maintain low energy prices and reduce reliance on fossil fuel imports. UNEF supports the electrification of industry and the economy, capitalising on Spain's advantages of high solar irradiation and ample land availability for installations.

Finally, in 2023, **UNEF continued to enhance and expand its services, adapting to sector growth in Spain**.

Taking into account the context, notable achievements for the year include:

- The number of member companies exceeded 780.
- Over 25 submissions were made in response to various regulatory proposals.
- We produced 25 studies and reports.
- Addressed more than 500 queries from member companies.
- Published over 50 regulatory analysis notes.

Maintained direct communication with member companies, issuing more than 500 updates. Our media presence has established us as the **sector's leading source**, with over 5,200 features in news and opinion articles.

In terms of **events and training courses**, we organised more than 24 activities, including conferences, webinars, summits and other events, significantly increasing attendance compared to previous years. In October 2023, the 10th edition of the Solar Forum took place under the theme ‘A decade of solar dialogues: Forging the transformation towards sustainability’, attracting over 1,200 attendees. Notable participants included Teresa Ribera, Third Vice-President of the Government and Minister for Ecological Transition and the Demographic Challenge of Spain;

Antonio Lopez-Nicolas, Deputy Head of Unit C1 (Renewable Energy Policy and Energy System Integration) at the European Commission; Beatriz Corredor, Chairwoman of Redeia; Rocío Prieto, Director of Energy at the National Securities Market Commission; and Gaëtan Masson, Co-Chair and CEO of the Becquerel Institute, among others.

1

INTERNATIONAL FRAMEWORK

1.1. The global photovoltaic sector

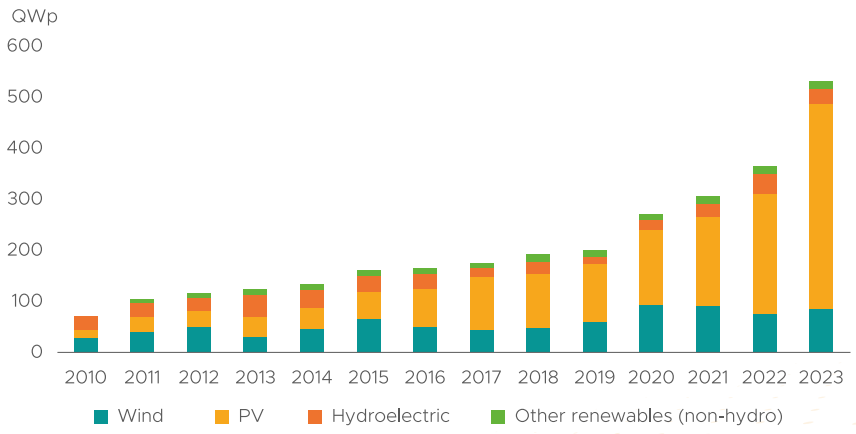
Electricity and photovoltaic module prices both fell in 2023. Despite this decrease, the cost of electricity remained high compared to the rates provided by photovoltaic generation. This allowed the photovoltaic sector to maintain a strong presence in the electricity market, supporting its expansion throughout the year. According to the Photovoltaic Power Systems Programme (PVPS) of the International Energy Agency (IEA), with UNEF representing the photovoltaic sector in Spain, **446 GW of new capacity was installed worldwide**.

IN 2023, 446 GW OF NEW PHOTOVOLTAIC CAPACITY WAS INSTALLED, BRINGING THE TOTAL TO 1,610 GW WORLDWIDE.

In 2023, solar photovoltaic energy accounted for 75% of new renewable capacity and 60% of its generation, contributing to a global reduction of 1.4 billion tonnes of CO2 emissions, consistent with the previous year's levels.

SPAIN RANKED SEVENTH GLOBALLY FOR NEW PHOTOVOLTAIC CAPACITY INSTALLATIONS.

Figure 2: Trend in installed renewable capacity, 2010-2023.



Source: International Energy Agency, PVPS Programme

In 2023, there has been an overall increase in **installed capacity across countries**, resulting in a reshuffle in the ranking of the top ten countries compared to 2022. China leads the list, having installed 235 GW, which accounts for 35% of its total capacity and is more than double the amount installed in 2022.

The **European Union** follows in second place with 55.9 GW of newly installed capacity, representing a growth of over 40% from 2022. The United States ranks third with 29.6 GW, followed by India with 16.6 GW.

Completing the list of the top ten countries with the most photovoltaic capacity installed globally are Germany (14.3 GW), Brazil (11.9 GW), Spain (8.8 GW[1]), Japan (6.7 GW), Poland (6.6 GW), Italy (5.3 GW) and the Netherlands (4.2 GW).

Figure 3: Top 10 countries by highest annual (left) and cumulative (right) PV installed capacity

ANNUAL INSTALLED CAPACITY				ACCUMULATED CAPACITY			
1		China	235.5GW	1		China	662.0GW
(2)		European Union*	55.8GW	(2)		European Union*	268.1GW
3		USA	29.6GW	2		USA	169.5GW
3		India	16.6GW	3		India	95.3GW
4		Germany	14.3GW	4		Japan	91.4GW
5		Brazil	11.9GW	5		Germany	81.6GW
6		Spain	7.7GW	6		Spain	37.6GW
7		Japan	6.4GW	7		Brazil	35.5GW
8		Poland	6.0GW	8		Australia	34.6GW
9		Italy	5.3GW	9		Italy	30.3GW
10		The Netherlands	4.2GW	10		Korea	27.8GW

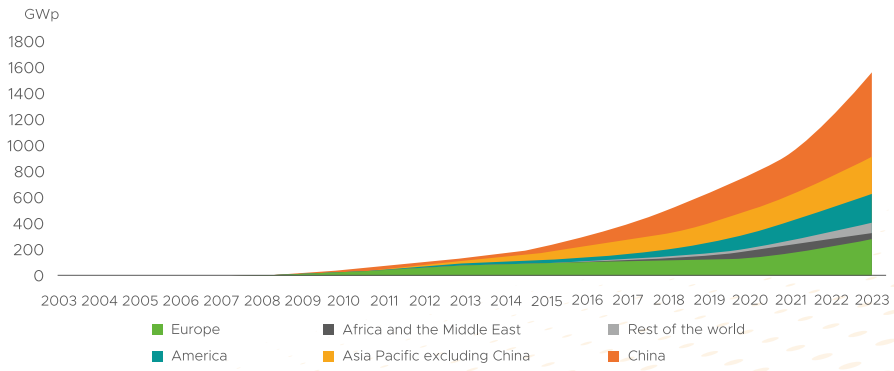
Source: International Energy Agency, PVPS Programme

Global **cumulative capacity** reached 1,624 GW in 2023. China continues to hold the largest cumulative capacity globally (662 GW), followed by the European Union (268.1 GW) and the United States (169.5 GW). India has overtaken Japan for fourth place with 95.3 GW compared to Japan's 91.7 GW. Within the European Union, Germany leads with 81.6 GW, followed by Spain (37.6 GW), Italy (30.3 GW), France (23.5 GW) and the Netherlands (22.4 GW).

SPAIN JOINED THE TOP 10 COUNTRIES WITH THE HIGHEST INSTALLED AND CUMULATIVE CAPACITY IN 2023.

Regional distribution of cumulative capacity remains the same as in 2022. The Asia-Pacific region is still in the lead, accounting for 60% of the global total, driven by substantial growth in China, India and Japan. Europe ranks second, contributing 19% to the total, supported by Germany, Spain and Italy. In third place is America, which has achieved 15% of cumulative capacity.

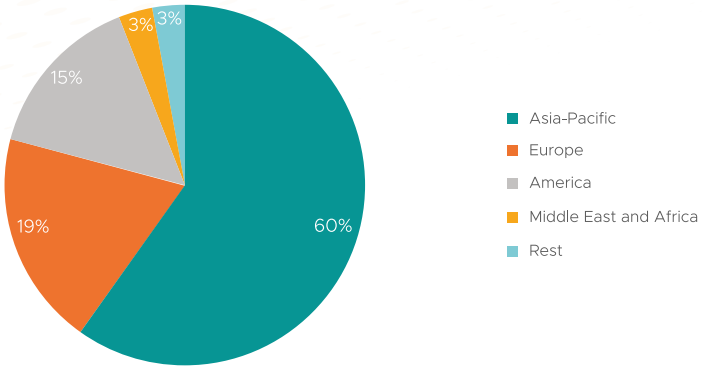
Figure 4: Regional trends in cumulative PV capacity.



Source: International Energy Agency, PVPS Programme

1. Updated April 2024

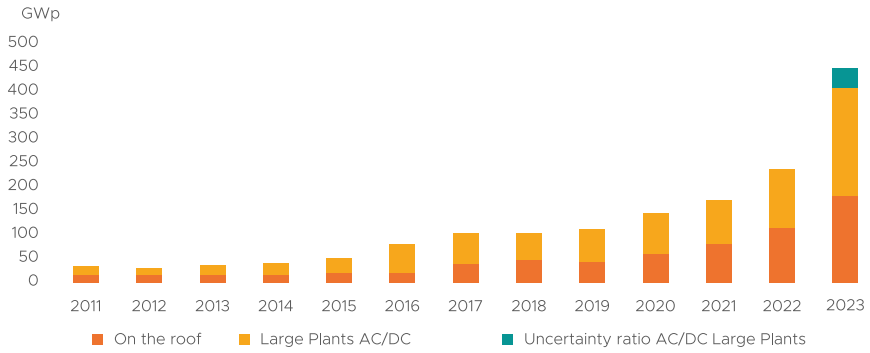
Figure 5: Regional trends in cumulative PV capacity.



Source: International Energy Agency, PVPS Programme

In 2023, both ground-mounted plants and self-consumption have grown and maintained their balance from 2022. Self-consumption accounts for 45% of the installed capacity. Agrivoltaic projects, building-integrated PV (BIPV) and vehicle-integrated PV (VIPV) are also continuing to expand.

Figure 6: Breakdown of annual installed PV capacity, 2011-2023.

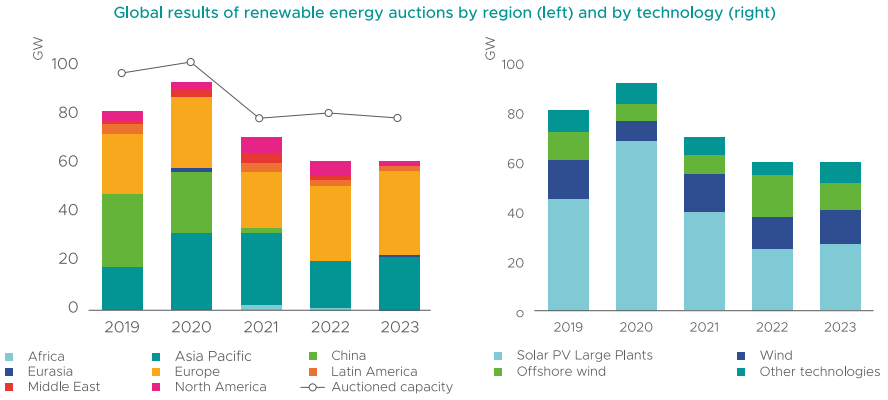


Source: International Energy Agency, PVPS Programme

1.2. Auctions and PPAs

According to the Renewables Report 2023 by the International Energy Agency (IEA), capacity from renewable energy auctions has stayed at the same levels as in 2022. Regionally, the volume of renewable energy auctions has risen in Asia-Pacific and Europe, while it has declined in North America, the Middle East and Africa. In terms of solar PV, there has been a 7% increase in auctioned capacity.

Figure 6. Results of renewable energy capacity auctioned in 2023 by region (right) and technology (left).



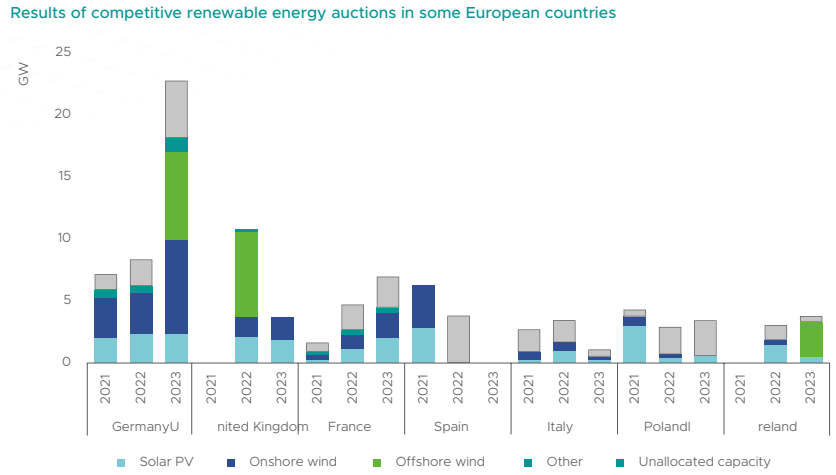
Note: For China, these charts only cover centrally held competitive auctions; provincial auctions are excluded because capacity and price data for these auctions are limited. The Asia-Pacific region does not include China.

Source: International Energy Agency, Renewables 2023.

In the **Asia-Pacific** region, auctioned renewable capacity increased by 2.9 GW. In 2023, China launched its nationwide green certificate programme, which accelerated the development of new projects. India announced a target for its annual auctioned renewable capacity to reach 50 GW, with the volume of published tenders doubling compared to 2022 and nearly 90% of the capacity on offer being awarded. Japan and the Philippines have experienced a reduction in the volume of auctions offered. Specifically, Japan held four PV capacity auctions in 2023, awarding a total of 309.9 MW at an **average minimum price of 60.13 USD/MWh**, compared to around 560 MW in 2022 at an average minimum price of 62.31 USD/MWh.

In **Europe**, 34.3 GW have been auctioned, marking an 8.57% increase from the previous year. Germany leads by awarding 18 GW in tenders, accounting for about 78% of the capacity auctioned. In contrast, the UK has seen its awarded auction capacity fall to a third of what it was in 2022. France, however, has increased the number of tenders awarded compared to the previous year.

Figure 7. Results of renewable energy capacity auctioned in 2023 in European countries.



Source: International Energy Agency, Renewables 2023.

In Germany's last auction of 2023, held on 1 December, 1.61 GW of PV power was awarded at a **maximum price of 54.7 USD/MWh**. Poland's latest auction saw 123 MW awarded for PV projects under 1 MW capacity, with a maximum price of 92.3 USD/MWh, and 471 MW for larger projects, at a maximum price of 101.14 USD/MWh.

Compared to 2022, Poland has allocated more PV capacity in its auctions, which has led to higher prices. The PV sector emerged as the sole beneficiary of these auctions due to a drop in the number of participants in renewable energy auctions, resulting in a participation rate of 6.8%. This lower participation is attributed to the country's increasing interest in Power Purchase Agreements (PPAs) over auctions.

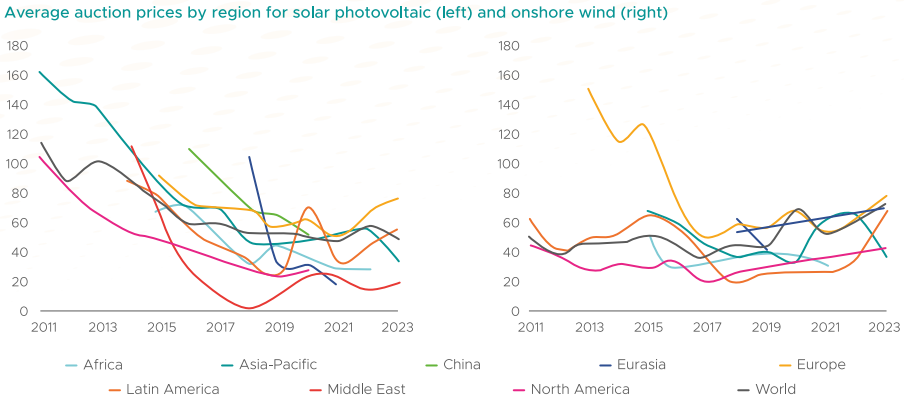
In **Latin America**, no auctions were held in Brazil and Chile in 2023. However, auctions took place in countries like Ecuador, Guatemala and Argentina. Argentina conducted its first auction since 2018, announcing 500 MW for photovoltaic power. Guatemala auctioned 191 MW of renewable energy, which made up 81% of the energy awarded in its mid-year auction. In January 2023, Ecuador auctioned 500 MW, with approximately 350 MW allocated to PV projects at a **maximum price of 66.99 USD/MWh**. Colombia's first auction awarded around 6 GW of PV out of a total 7.5 GW of renewable energy, followed by another auction awarding 4.4 GW of PV. In December 2023, Paraguay announced a tender for 100 MW of PV for the year 2024.

In the Middle East and North Africa, renewable energy auction processes were started but did not reach a conclusion.

Auction prices for solar PV vary by region. In Europe and Latin America, prices in USD/MWh have risen compared to the previous year, averaging close to USD 80/MWh in Europe and USD 60/MWh in Latin America. In contrast, the Asia-Pacific region has seen a decrease, with average prices around USD 35/MWh, excluding China. Globally, auction

prices have fallen by about 14% compared to 2022, leading to an increase in the number of participants, with 77% of the capacity on offer being awarded.

Figure 8. Trends in average auction prices between 2011-2023 for solar PV (right) and wind (left).



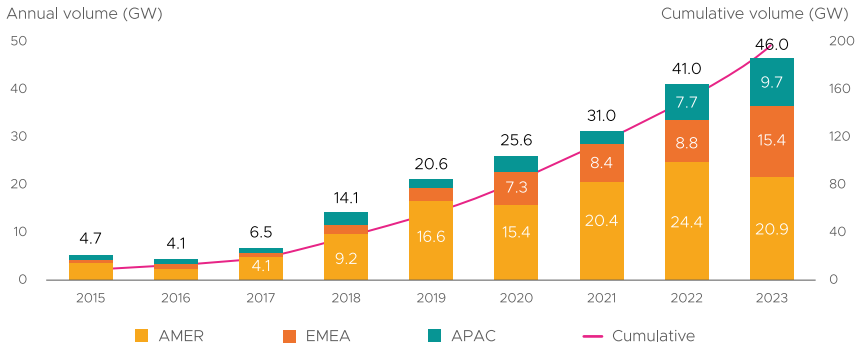
Note: Asia-Pacific excludes China

Source: International Energy Agency, Renewables 2023.

PPA CONTRACTS INCREASED BY 12% FROM 2022, REACHING 46 GW WORLDWIDE.

In 2023, power purchase agreements (PPAs) have grown globally by 12% compared to the previous year. According to Bloomberg, 46 GW of renewable energy PPAs were signed, up from 41 GW in 2022.

Figure 9. Renewable capacity awarded by PPA contracts between 2015-2023.



Source: BloombergNEF Note: The chart refers only to trades published off-site and may be subject to change as more information is made public. Capacity is expressed in GW DC.

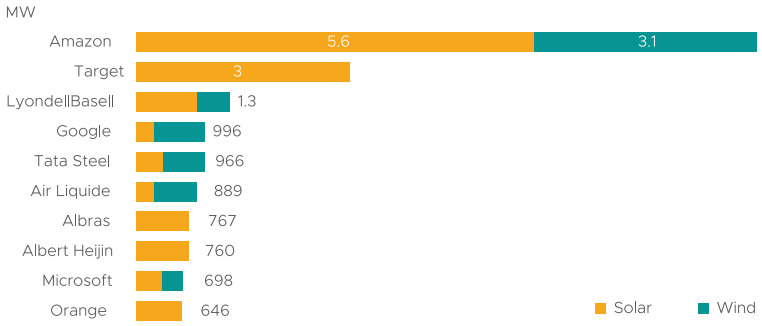
Source: BloombergNEF.

Despite a 15% decrease in capacity awarded through these contracts compared to 2022, America leads with 20.9 GW awarded in 2023. The US has emerged as the largest market for PPA contracts with 17.3 GW, although this is a 16% decrease from 2022.

Europe, the Middle East and Africa have awarded 15.4 GW in 2023, marking a 75% increase from 2022. The Asia-Pacific region has also increased its capacity to 9.7 GW.

Among leading buyers, Amazon holds the top position for the fourth consecutive year with a total of 8.8 GW of renewable capacity across 16 countries, 5.6 GW of which is from photovoltaic projects. Meta ranks second with 3.1 GW, all in PV projects, followed by LyondellBasell with 1.33 GW and Google with 996 MW.

Figure 10. Top buyers of renewable energy via PPAs worldwide in 2023l.



Source: BloombergNEF Note: The chart refers only to trades published off-site and may be subject to change as more information is made public. Capacity is expressed in GW DC.

Source: BloombergNEF.

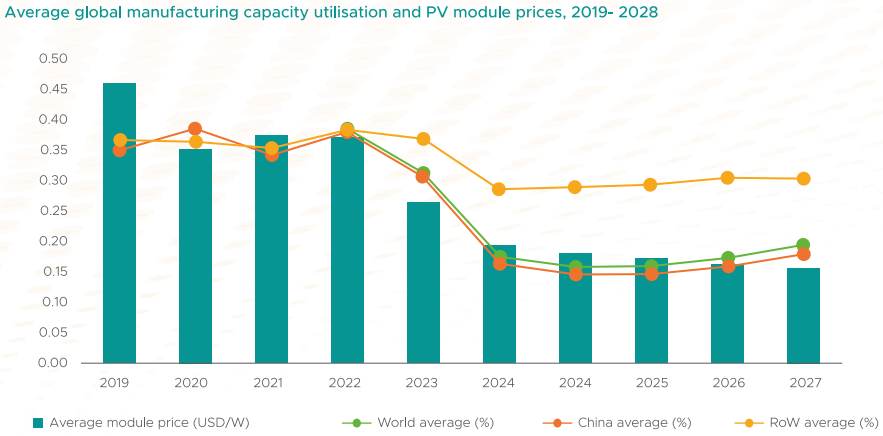
1.3. Developments in costs

In 2023, three-quarters of new PV and wind capacity had lower generation costs than fossil fuel plants, as reported in the IEA's Renewables 2023.

Between 2022 and 2023, both the EU and the US increased their module imports due to high growth expectations and potential future restrictions on panel imports. This led to an increase in module stocks, with the EU and the US holding 80 GW by the end of 2023—double the amount in 2022.

The rise in module stocks resulted in a decrease in module prices. In terms of capacity utilisation, 2022 saw a rate of 75%, which dropped to 60% in 2023. The average module price fell from around 0.35 USD/W in 2022 to 0.12 USD/W in 2023. According to the IEA, the combination of low utilisation rates and the trend towards reducing production costs suggests that the fall in module prices seen this year is likely to continue in the future.

Figure 11. Average capacity utilisation in % and price of PV modules.

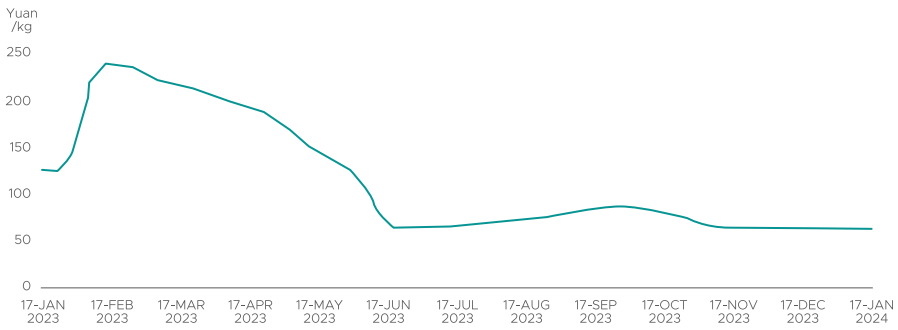


Note: RoW = rest of the world
Sources: IEA analysis based on BNEF; IEA PVPS; SPV Market Research; RTS Corporation; PV InfoLink.

Source: International Energy Agency, Renewables 2023.

In 2023, China produced 1.45 million tonnes of polysilicon, marking an 81.4% increase over the previous year, according to the China Silicon Industry Association. Although the price per kg of polysilicon rose at the beginning of the year, from February 2023 onwards it decreased and stabilised at around 8.4 USD/kg.

Figure 12. Trend in the cost per kg of polysilicon in China throughout 2023.

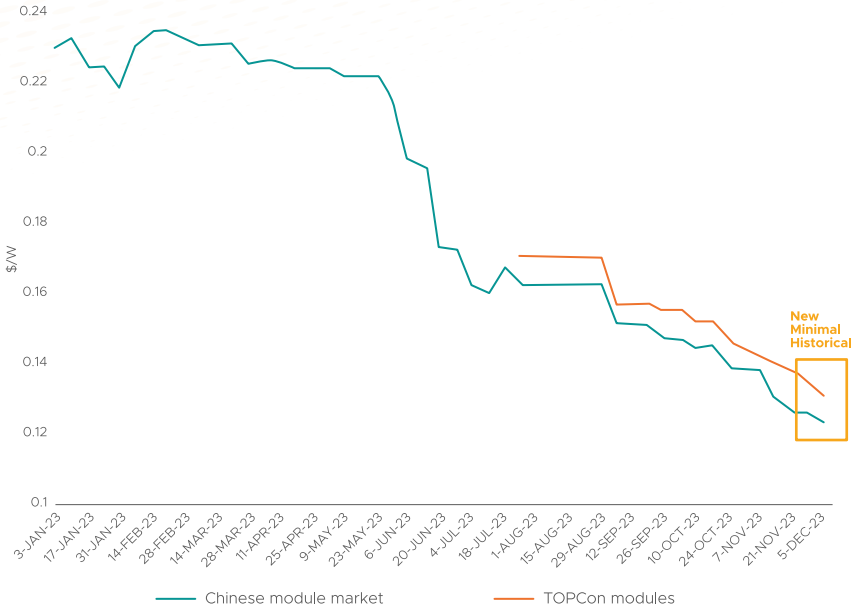


Source: PV Magazine.

In 2023, polysilicon panel prices were 10% higher in India, 30% higher in the US and 60% higher in the EU compared to China.

The market is mainly dominated by PERC-type panels; however, TOP-Con panel sales increased in 2023. Both types saw a price reduction, with **December prices averaging 0.123 USD/W for PERC modules and 0.131 USD/W for TOPCon.**

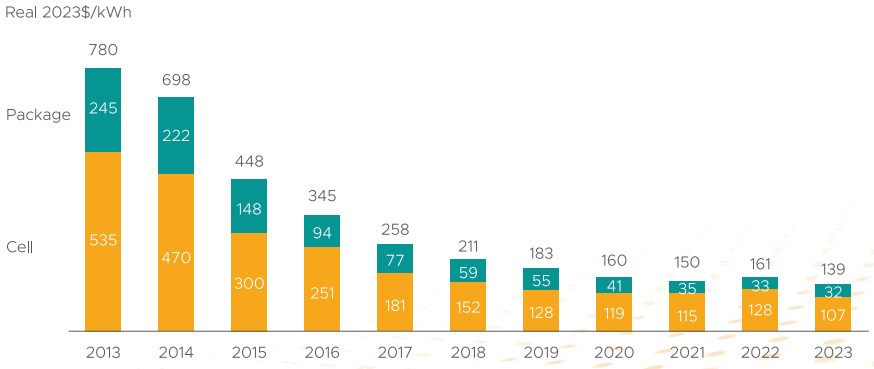
Figure 13. Price trends of Chinese modules in 2023



Source: PV Magazine.

According to BloombergNEF, **the price of lithium-ion batteries stood at 139 USD/kWh**, which is 14% less than the previous year when the price was 161 USD/kWh in 2022. Battery prices are closely tied to the costs of the raw materials used in their production, which have decreased in 2023.

Figure 14. Price trends of lithium-ion batteries from 2013 to 2023



Source: BloombergNEF. Historical prices have been updated to reflect actual 2023 dollars. The weighted average value of the survey includes 303 data points for passenger cars, buses, commercial vehicles and stationary storage.

Source: BloombergNEF.

1.4. Outlook

RENEWABLE CAPACITY IS EXPECTED TO TRIPLE BY 2030.

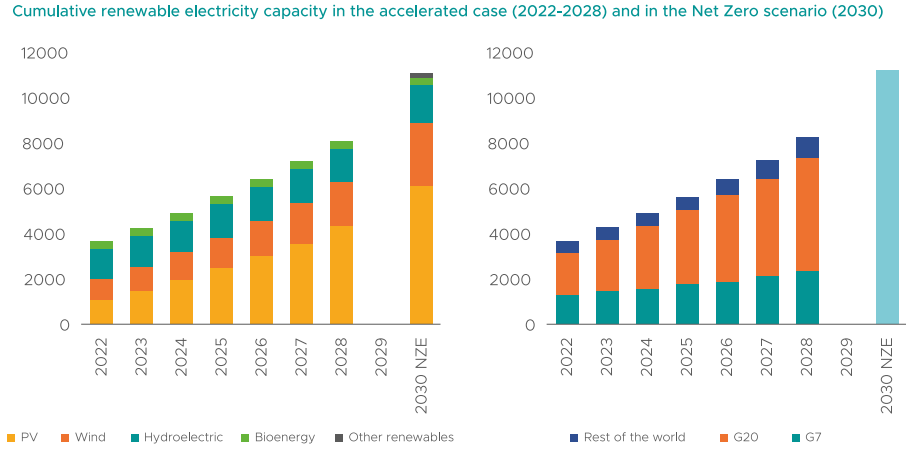
COP28 has announced its aim to triple renewable energy capacity by 2030, with a goal of generating at least 11,000 GW, nearly 6,000 GW of which will come from photovoltaics.

In 2023, **the challenges facing renewables** include insufficient grid infrastructure, administrative and social hurdles in obtaining permits, inadequate financing and uncertainty caused by a rising interest rate economic environment. In addition, renewable energy growth this year has been concentrated in a few countries. According to the IEA, the 2030 target is achievable if measures and policies are implemented to tackle these issues.

2023 has been a remarkable year for the growth of renewables, with **installed photovoltaic capacity increasing by 85% compared to the previous year**. If this growth trend continues, **the IEA expects that by 2028, renewable electricity capacity will reach 14,400 TWh**, representing 40% of total capacity, with the photovoltaic sector contributing 12%. By 2028, **the cumulative renewable capacity is anticipated to reach 7,300 GW**. In addition, renewable capacity is expected to become more evenly distributed globally, with 68 countries likely to rely on renewable energy as their primary source of generation by 2028.

BY 2028, PHOTOVOLTAICS ARE PROJECTED TO GENERATE 12% OF THE WORLD'S ELECTRICITY CAPACITY.

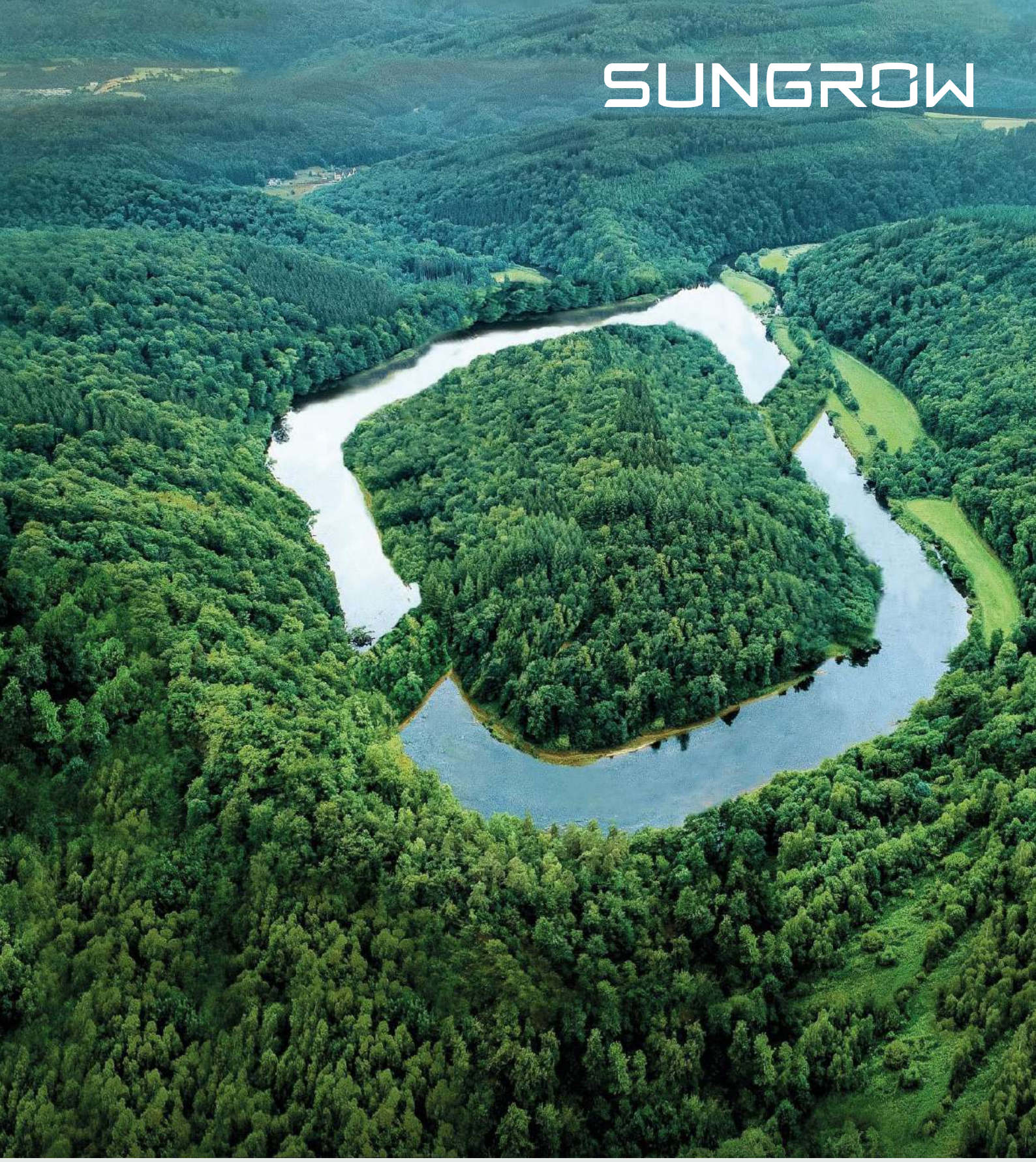
Figure 15. Cumulative renewable capacity planned between 2022-2028



Note: NZE = IEA Net Zero Emissions Scenario for 2050. The G7 and G20 aggregates include all EU countries. Solar photovoltaic and wind energy includes capacity dedicated to hydrogen production.
Source: For the Net Zero Scenario, IEA (2023)

Source: International Energy Agency, Renewables 2023

In **China**, renewable capacity is projected to triple over the next five years, aligning with the government's goal of achieving net-zero emissions by 2060. This initiative is supported by the 14th Five-Year Plan (2021-2025), which aims for 50% of the growth in electricity consump-



At Sungrow, we have been transforming the world with clean and sustainable energy for 27 years. Our mission has taken us to more than 170 countries. Join us and be part of the change.

CLEAN POWER FOR ALL

LEARN MORE ABOUT
OUR MISSION

tion to come from renewable sources. The plan also encourages distributed generation for local use and the integration of renewable energy and microgrids in rural areas. With the phase-out of feed-in tariffs, photovoltaic developers have been motivated to secure long-term power purchase agreements, lasting 15 to 20 years. In December 2023, it was announced that preliminary studies for the 15th Plan were underway, which will focus on further increasing the use of renewables.

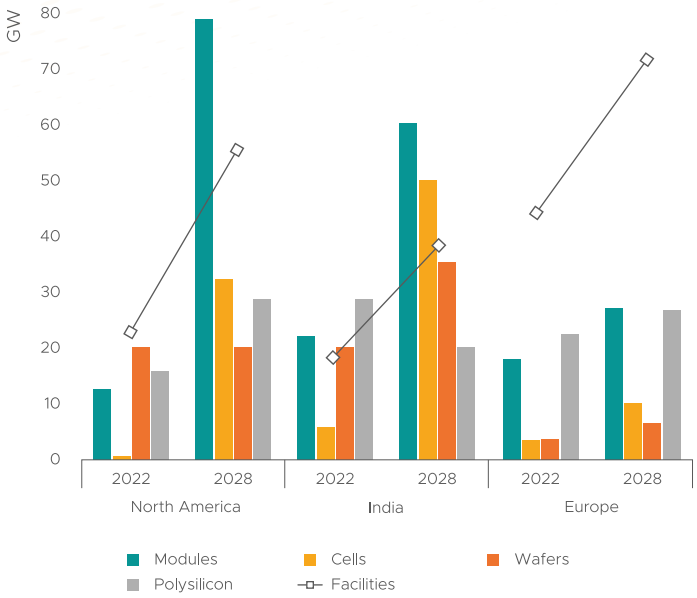
In the **USA**, the Inflation Reduction Act (IRA) was passed in the summer of 2022 to accelerate the energy transition. The impact of this legislation has become evident in 2023, with a total of $239 billion invested in the manufacturing and development of renewable energy. According to the IEA, the country is expected to add 340 GW of new renewable capacity, primarily solar and wind, between 2023 and 2028. Solar systems operational between 2022 and 2033 will benefit from tax credits, specifically the Investment Tax Credit (ITC) and Production Tax Credit (PTC). Additional incentives are available for self-consumption through the Residential Clean Energy Credit, applicable from 2022 to 2032, with a potential extension to 2034. To expedite grid connection processes, the Improvements to Generator Interconnection Procedures and Agreements Act was passed in July 2023.

In recent years, **India** has significantly boosted its investments in transmission and distribution, which should enhance grid access for photovoltaic systems. The country is also aiming to increase renewable capacity through its auctions. According to the IEA, India is expected to reach 205 GW of renewable capacity between 2023 and 2028, which would rank the country third in terms of renewable capacity.

The **EU** continues to work on the Net Zero Industrial Act (NZIA) and approved an electricity market reform and a new Renewable Energy Directive in 2023. To tackle grid access issues, the EU proposed the Grid Action Act by the end of 2023.

Legislation like the IRA in the USA, India's PLI and the EU's NZIA include measures to support domestic industry growth. By 2028, US solar PV manufacturing capacity is projected to meet about 35% of the region's solar PV demand. Meanwhile, India aims to significantly increase its production of cells and modules, intending to meet local demand and create export opportunities by 2028.

Figure 16. Manufacturing capacity and annual solar photovoltaic (PV) installations in North America, India and Europe, 2022-2028.



Source: International Energy Agency, Renewables 2023.

2

EUROPEAN FRAMEWORK

2.1. The photovoltaic sector in the European Union

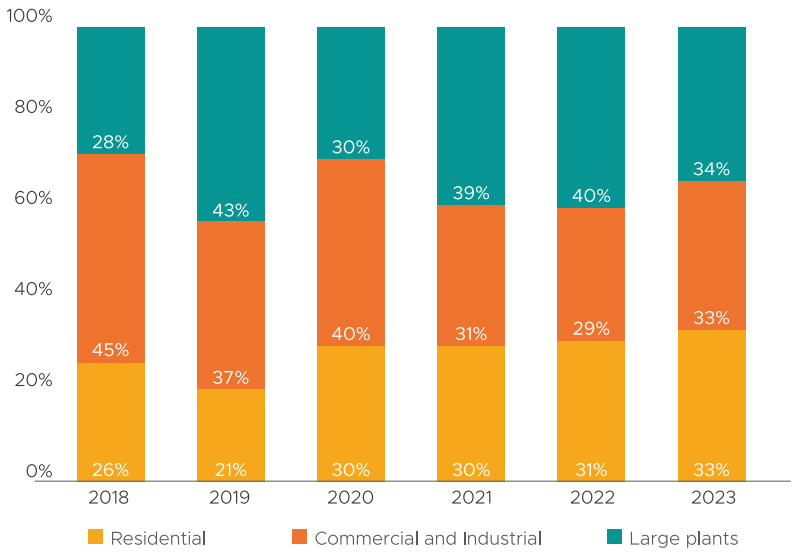
In 2023, the impact of measures taken in 2022, driven by instability from the war in Ukraine and rising energy prices, has become evident, with a focus on boosting photovoltaic growth. In 2023, **55.9 GW of new photovoltaic capacity was installed**, marking a 40% increase compared to 2022.

THE EU INSTALLED 55.9 GW OF NEW PHOTOVOLTAIC CAPACITY IN 2023.

The residential sector accounted for 33% of the installed capacity, while the industrial and commercial sectors each contributed a further 33%.

ROOFTOP INSTALLATIONS DOMINATED THE PV MARKET.

Figure 17: EU PV segmentation, 2018-2023

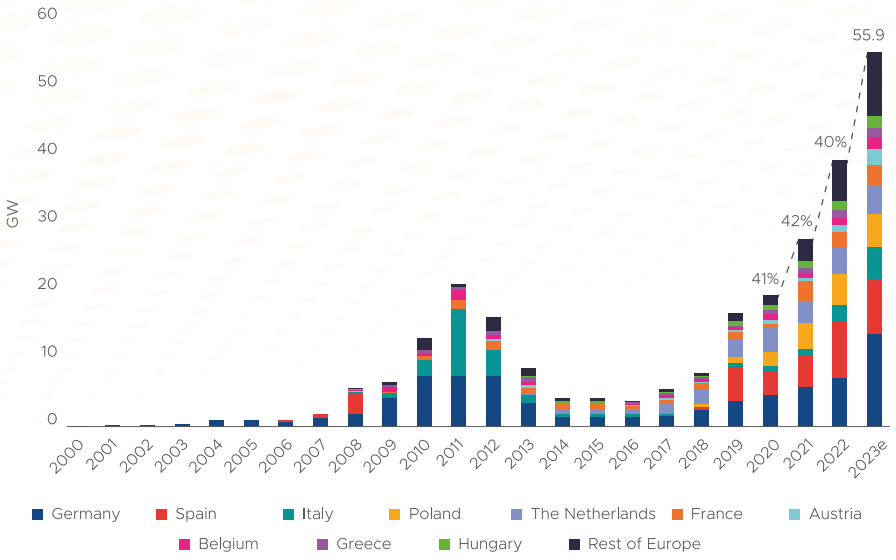


Source: SolarPower Europe

In 2023, leading countries have seen an increase in installed capacity, altering their rankings compared to 2022. Germany spearheaded growth in Europe with 14.3 GW of installed capacity this year, followed by Spain (8.8 GW), Italy (5.2 GW), Poland (4.6 GW) and the Netherlands (4.5 GW), with France (3.2 GW) dropping out of the top five. These figures represent peak power.

SPAIN WAS THE SECOND FASTEST-GROWING COUNTRY IN EUROPE FOR PHOTOVOLTAIC INSTALLATIONS IN 2023.

Figure 18: Total installed capacity EU 2023



Source: SolarPower Europe

Germany increased its installed capacity by 6.0 GW over 2022, reclaiming the top spot for installed capacity in the EU, after being surpassed by Spain in 2022. By the end of October 2023, Germany's installed capacity reached 14.3 GW, exceeding both the total installed capacity for 2022 and the target of 9 GW set for 2023. In response to low subscription rates in the 2022 auctions, Germany raised auction prices in 2023, successfully meeting its target and achieving a higher participation rate. Meanwhile, the German PPA market has continued to expand, reaching 150 MW by the end of October. Measures such as increased feed-in tariffs for small self-consumption systems, VAT exemptions for systems under 30 kW and specific policies like the Photovoltaic Strategy announced in May 2023, are helping Germany move closer to its goal of achieving 215 GW of installed capacity by 2030.

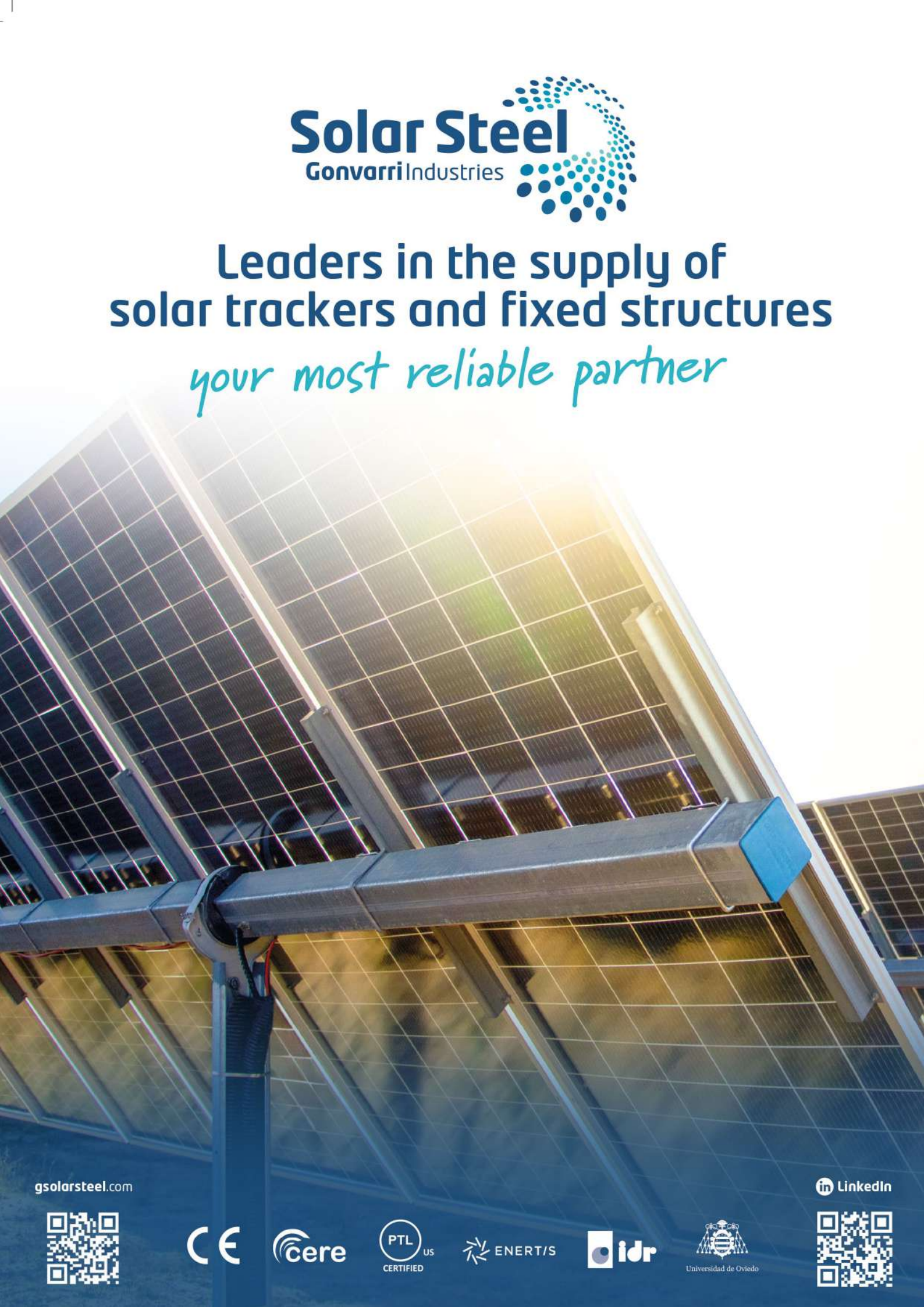
Italy experienced the fastest growth in installed PV capacity in 2023, with 5.2 GW—almost double the 2.5 GW recorded in 2022. Although residential installations declined this year due to changes in the government subsidy programme, this sector still accounted for 40% of the total installed capacity. The industrial and commercial sector underpins PV growth in Italy, contributing 43%, mainly from systems sized between 200-999 kW.

Poland has risen to fourth place in 2023, with 4.6 GW of new installed capacity, marking a 1% increase from 2022. This year, demand for residential PV systems has declined due to less attractive incentives and lower electricity prices following the end of the energy crisis. Residential power capacity has dropped from 60% in 2022 to 30% in 2023, while industrial and commercial PV systems have continued to grow rapidly.

Solar Steel
Gonvarri Industries

Leaders in the supply of solar trackers and fixed structures

your most reliable partner



gsolarsteel.com

LinkedIn

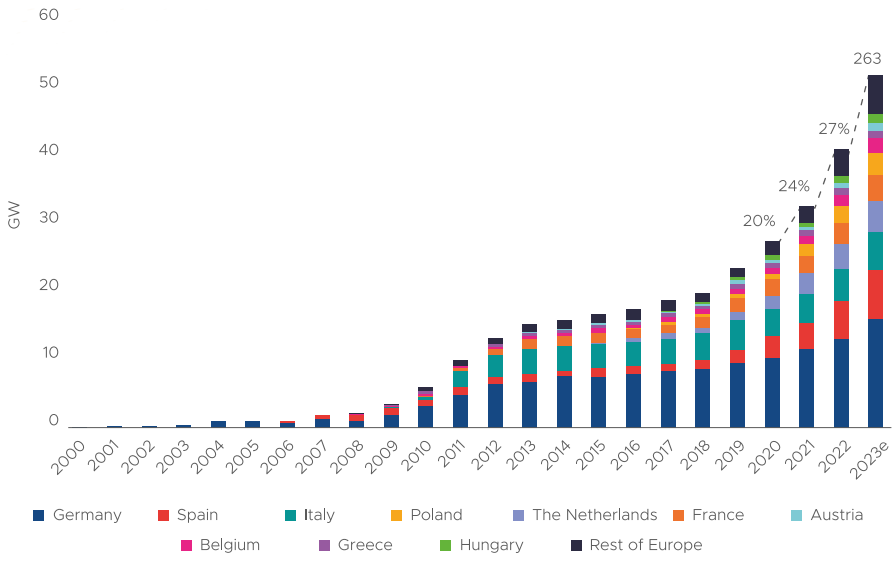
CE cere PTL US CERTIFIED ENERTIS idr Universidad de Oviedo

The Netherlands installed 4.5 GW of new PV capacity, representing a 10% increase compared to 2022. The residential sector accounted for 1.8 GW of this in 2023. Larger systems have also expanded this year, though they continue to face challenges such as grid congestion and space constraints.

EUROPE'S CUMULATIVE CAPACITY ROSE BY 27% COMPARED TO THE PREVIOUS YEAR.

Cumulative PV capacity in the EU reached 263 GW, a 27% increase from 2022. The rankings for cumulative capacity remain unchanged from last year, with Germany in first place with 82 GW, followed by Spain (38 GW), Italy (29.5 GW) and the Netherlands (22.5 GW).

Figure 19: Total cumulative capacity EU 2023



Source: SolarPower Europe

PPA CONTRACTS GREW BY 41% SINCE 2022, WITH 65% OF THEM FOR PHOTOVOLTAIC PROJECTS.

In 2023, **16.2 GW of renewable energy PPA contracts were awarded**, marking a 41% increase compared to the previous year. Of this total, **10.5 GW are PV contracts**, meaning that the PV sector accounts for 65% of all contracts, making it the most popular sector in the PPA market.

SPAIN REMAINS THE LEADER IN PPA CONTRACTS.

For the fifth year in a row, **Spain leads the PPA market with 4.67 GW of renewable capacity** out of the total 16.2 GW allocated through these contracts. Germany is in second place with 3.73 GW. Together, these two countries account for 50% of the total capacity awarded through PPAs.

2.2. New European legislation

Green Deal Industrial Plan

In January 2023, the European Commission introduced the Green Deal Industrial Plan, designed to strengthen and advance the European zero-emission technology industry and support the energy transition. This plan rests on four pillars: simplifying the regulatory framework to accelerate the development of this industry; facilitating and expediting access to investment and financing for European manufacturing projects; enhancing and expanding worker training; and promoting fair and open trade for the energy transition.

Net Zero Emissions Industry Act

Proposed in March 2023, this legislation aims to foster the growth of the European zero-emission technology industry, including photovoltaic energy.

The proposal includes measures to prioritise manufacturing projects for zero-emission technologies by simplifying procedures and ensuring investment security. It also seeks to facilitate market access through public procurement and auctions, support private demand and promote innovation through controlled testing. The Act aims to enhance job skills by creating academies and supporting carbon capture and storage projects. Additionally, it proposes establishing a European Net Zero Emissions Platform to coordinate and provide guidance on these initiatives, encouraging collaboration with companies through industrial partnerships.

The European Parliament adopted its position in November 2023 and the European Council followed suit in December. In February 2024, the Council and Parliament reached a provisional agreement on the Net Zero Emissions Industry Act, which is still pending approval, though it is expected to be finalised in the coming months.

The agreement covers the main objectives of the initially proposed legislation and stipulates that **projects over 1 GW must receive construction permits within a maximum of 18 months, while those under 1 GW must do so in less than 12 months**. The Act will encourage the development of **net zero emission industrial hubs and sets a target for CO2 capture and storage of 50 million tonnes by 2030**. **The agreement aims to boost local manufacturing within the PV value chain**, with a goal for **at least 40% of production to occur in Europe**. This will be supported through procurement, auctions and other public interventions based on criteria of sustainability and resilience. In these auctions, at least 30% or 6 GW of capacity must meet these criteria, which will be enforced through pre-qualifications or special incentives. Criteria include responsible business conduct, cybersecurity, on-time project delivery, contributions to innovation, environmental sustainability, energy system integration and ensuring that 50% of components are manufactured within the EU.

European Critical Raw Materials Act

The law, introduced in March 2023, is designed to reinforce the European raw materials value chain, boost resilience against supply chain risks and disruptions, and ensure a free, circular and sustainable market for raw materials. To support these objectives, the law sets out that 10% of the raw materials needed annually should be extracted within Europe, 40% should come from processing and 15% from recycling. To diversify imports and reduce strategic dependencies, it also stipulates that no more than 65% of raw materials should originate from a single third country. Efforts to enhance the value chain include promoting national exploration programmes, reducing permit approval times to a maximum of 24 months for extraction and 12 months for processing and recycling, and improving access to funding. Additionally, measures for risk monitoring and preparedness are put in place. On the international trade front, the EU plans to establish a Critical Raw Materials Club and form mutually beneficial partnerships with third countries, adhering to principles of fair and sustainable trade.

In November 2023, the European Commission successfully reached an agreement with both the Parliament and the Council.

Electricity market reform

The fluctuation of electricity prices and their heavy reliance on fossil fuels have led the European Commission to undertake a review and reform of the electricity market. In December 2023, a provisional agreement on this market reform was reached. The reform aims to promote renewable energy by enhancing access to more stable long-term contracts, such as Power Purchase Agreements (PPAs), and requires public investment in renewable capacity to be made through Contracts for Difference (CFDs). Member States are encouraged to evaluate the flexibility requirements of their renewable energy generation systems and to propose measures to address these needs. Furthermore, the integration of renewable energy into the grid will be bolstered through increased transparency regarding the availability of grid connection capacity.

This agreement underscores the EU's commitment to achieving 45% renewable energy by 2030.

Regulation to accelerate the deployment of renewable energies

At the end of 2022, the proposal for a regulation to expedite the deployment of renewable energies was approved. It introduces urgent measures to enable this acceleration, particularly in the short term.

Member States are required to streamline, simplify and speed up the permitting process for renewable energy projects. These projects are now considered to be of paramount public interest under EU environmental legislation, allowing them to bypass certain environmental assessment requirements. Solar projects are given priority, with a maximum permitting timeframe of three months, and projects involving installations on artificial structures are also prioritised for permits. In addition, the regulation facilitates the quicker rollout of heat pumps that

utilise underused renewable sources.

These measures, among others, specifically target projects that can be rapidly deployed to help stabilise prices and reduce natural gas demand in the short term.

The regulation applies to authorisation processes initiated during its validity period, as well as to ongoing processes where no final decision has been made.

It will remain in effect for eighteen months from its implementation, although the Commission can extend this period if necessary. The regulation is designed to cover the timeframe required for the implementation of the new **Renewable Energy Directive (EU) 2023/2413**, adopted in November 2023, which allows for an 18-month transposition period into national law. The directive aims to increase the EU's renewable capacity target to 42.5% by 2030, with Member States encouraged to aim for 45%, in line with the REPowerEU plan. **Member States have until February 2026 to develop plans that designate renewable acceleration areas**. These are areas where significant environmental impact is not anticipated, priority is given to artificial surfaces and protection zones are excluded. Projects located within these designated areas will benefit from certain advantages, such as a maximum of 12 months for the issuance of authorisations and exemption from the requirement to conduct a specific environmental impact assessment.

Regulation 2023/956: Carbon border adjustment mechanism

Regulation (EU) 2023/956 establishes a Carbon Border Adjustment Mechanism (CBAM) to address embedded greenhouse gas emissions in goods imported into the European Union. This aims to prevent carbon leakage and support the objectives of the Paris Agreement.

The mechanism complements the EU Emissions Trading Scheme (EU ETS) and **focuses on products such as steel, cement, fertilisers, aluminium and electricity**. The regulation outlines a gradual phase-out of free allowances, currently part of the EU ETS, to create a more effective and fair system for carbon pricing.

For imports, the regulation requires importers to purchase **carbon certificates that reflect the greenhouse gas emissions linked to the production** of the imported goods. This ensures that both domestic and imported products face an equivalent carbon cost. **Exemptions are available for countries meeting specific emission reduction conditions** and for goods with low intrinsic value. This includes nations with binding agreements with the EU on carbon pricing and emissions reductions.

The regulation also introduces a **transitional period** for data collection. During this time, importers must submit quarterly reports on the emissions of imported goods, facilitating a gradual adjustment for the parties involved and gathering necessary information for the full implementation of the mechanism.

Rooftop Solar Standard

The EU's Energy Performance of Buildings Directive was officially implemented on 8 May and published in the EU's Official Journal, allowing member states two years to incorporate it into national law. The directive includes the Rooftop Solar Standard which, according to SolarPower Europe, has the potential to supply solar energy to 56 million European homes. It is expected to lead to the installation of 150-200 GW of rooftop solar panels, starting with public and non-residential buildings in 2027 and 2028, respectively, and new residential buildings from 2030. By the end of 2027, Europe's rooftop solar capacity could reach 355 GW.

EU Grid Action Act

The EU Grid Action Act, announced at the end of 2023, is designed to adapt the grid to support a decentralised and flexible electricity system. This includes integrating renewables in power plants, on rooftops and within local energy communities. Distribution grids are required to expand, evolve into smart grids and undergo modernisation, as 40% of them are over 40 years old. The legislation also seeks to shorten waiting times for connection rights. The act anticipates an investment ranging from €375 to €425 billion by 2030, while the Commission estimates a total mobilisation of €584 billion.

Nature Restoration Act

This law, proposed by the European Commission in June 2022, was delayed for years due to concerns from the agricultural sector that it would impose additional burdens and potentially impact prices and production. Finally, on 18 June 2024, the law was approved by a vote of the EU Environment Ministers, marking the final step for one of the most controversial measures of the European Green Deal to reach the goals of the European Biodiversity Strategy for 2030. The law focuses on dialogue for rebuilding ecosystems, allowing economic activities to continue. It requires Member States to commit, particularly in addressing factors that degrade environmental quality, such as agriculture, which involves a significant commitment to the primary sector.

The Nature Restoration Act **aims to restore at least 20% of the EU's land and sea areas by 2030 and all degraded ecosystems by 2050**. It mandates that at least 30% of degraded areas be restored by 2030, increasing to 60% by 2040 and 90% by 2050. It imposes binding obligations to rehabilitate natural habitats, 80% of which are currently in poor condition, focusing particularly on those with the highest potential for carbon sequestration and storage, such as wetlands, rivers, forests, grasslands, and urban and marine ecosystems. Specific measures include the restoration of pollinator populations, protection of butterfly and bird species, and the planting of at least 3 billion new trees by 2030. Member countries will have the flexibility to develop national plans when implementing the directive.

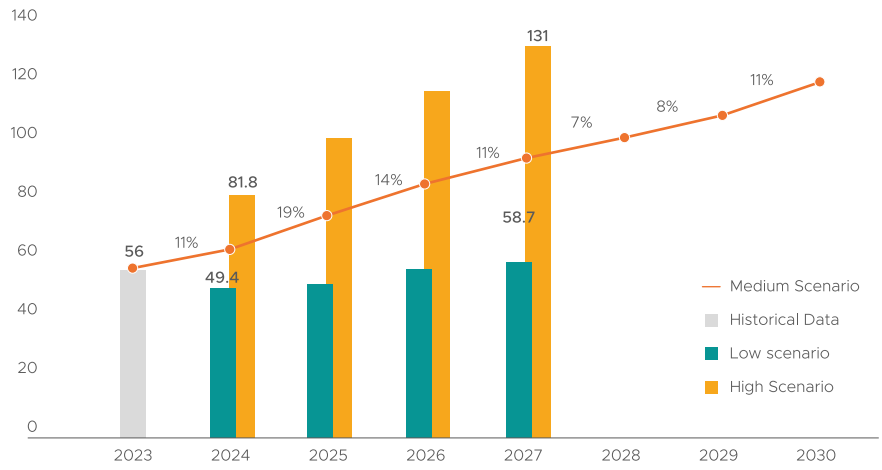
2.3. Outlook

In 2023, the **National Energy and Climate Plans (NECPs) underwent a review**. By the end of the year, 22 Member States had published their draft NECP. Several countries have set more ambitious targets for 2030, with Lithuania increasing its target fivefold to 5.1 GW, Spain aiming for 76 GW compared to the previous target of 36.8 GW and Germany planning to reach 215 GW. SolarPower Europe (SPE) estimates that, among the Member States that have published their updated NECPs, five will achieve their targets by 2025 and twelve by 2027.

SOLARPOWER EUROPE PREDICTS THAT 17 MEMBER STATES WILL ACHIEVE THEIR NECP TARGETS BY 2027.

Photovoltaic growth is expected to continue in the coming years. According to the average scenario forecast by SPE, it is estimated that the EU will install 61 GW of new capacity in 2024 and 93.1 GW in 2027, marking a 67% increase compared to installations in 2023. Beyond 2027, **119 GW is expected to be installed by 2030**.

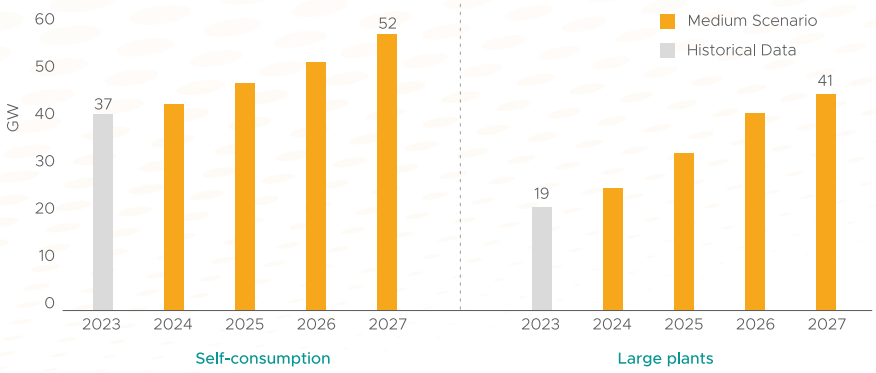
Figure 20: Growth of installed PV capacity annually between 2023-2030



Source: SolarPower Europe

Regarding the segmentation of the photovoltaic sector, significant growth is expected for both ground-mounted and rooftop solar systems between 2024 and 2027, according to Solar Power's EU Market Outlook. Ground-mounted systems are projected to expand their cumulative capacity to 222 GW by 2027, while rooftop systems are expected to reach 355 GW.

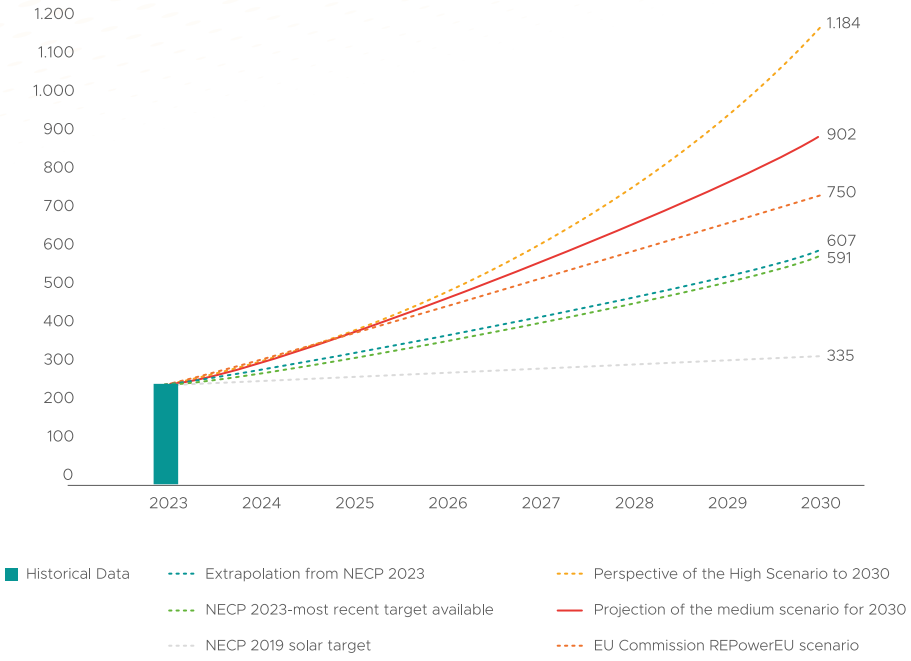
Figure 21: Segmentation of solar systems between 2023-2027



Source: SolarPower Europe

Based on the draft NECP-2023 from Member States, the total target is set at 607 GW by 2030. Although this is higher than the NECP-2019 target of 335 GW, it falls short compared to the REPowerEU target of 750 GW.

Figure 22: Cumulative PV capacity between 2023-2030 under various scenarios



Source: SolarPower Europe

In both medium and high scenarios projected by SolarPower Europe, the targets set by the NECP and REPowerEU are expected to be greatly exceeded. The medium scenario anticipates **reaching 902 GW of cumulative photovoltaic capacity by 2030**.

The 2023 review of the NECP has been crucial for understanding the future trajectory of the photovoltaic sector. Therefore, it is important for the remaining five Member States to submit their drafts as soon as possible.

3

NATIONAL FRAMEWORK

3.1. The photovoltaic sector in Spain

The photovoltaic sector in Spain has seen remarkable growth in 2023, surpassing the installation record set in 2022. With more than 7,489 MW of new capacity added this year, the sector continues to demonstrate sustained growth and consolidation. **Spain's total photovoltaic capacity now stands at 32,488 MW**, including both ground-mounted plants and self-consumption installations. This achievement **positions photovoltaic technology as the leading energy source in terms of installed capacity within the country's energy mix**.

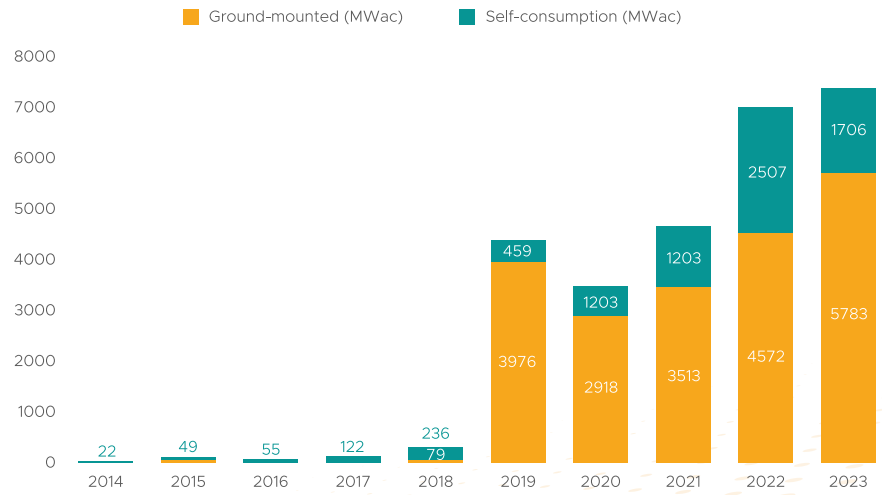
IN 2023, SPAIN INSTALLED 5,783 MW OF GROUND-MOUNTED PHOTOVOLTAIC PLANTS.

In 2023, 5,783 MW were installed in ground-mounted plants, marking a 26.5% increase from the previous year. As in previous year, this expansion has been achieved without the need for subsidies, auctions or remuneration schemes.

IN 2023, SPAIN INSTALLED 1,706 MW OF PHOTOVOLTAIC SELF-CONSUMPTION.

Meanwhile, self-consumption installations reached a total of 1,706 MW, a decrease of 32% compared to 2022. This slowdown is thought to reflect the low electricity prices in the wholesale market, along with high inflation and interest rates impacting household finances.

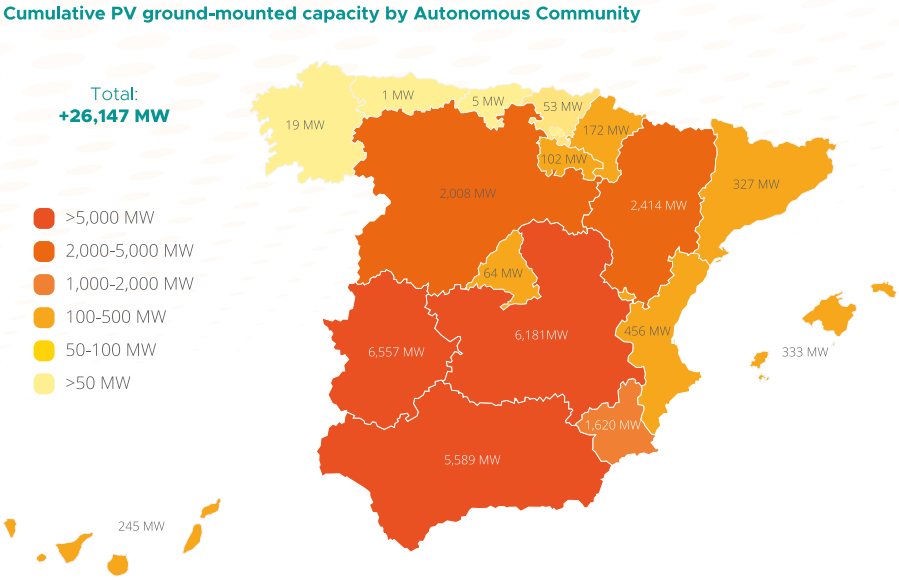
Figure 23: Trend in photovoltaic solar power capacity in Spain



Source: Red Eléctrica de España and UNEF

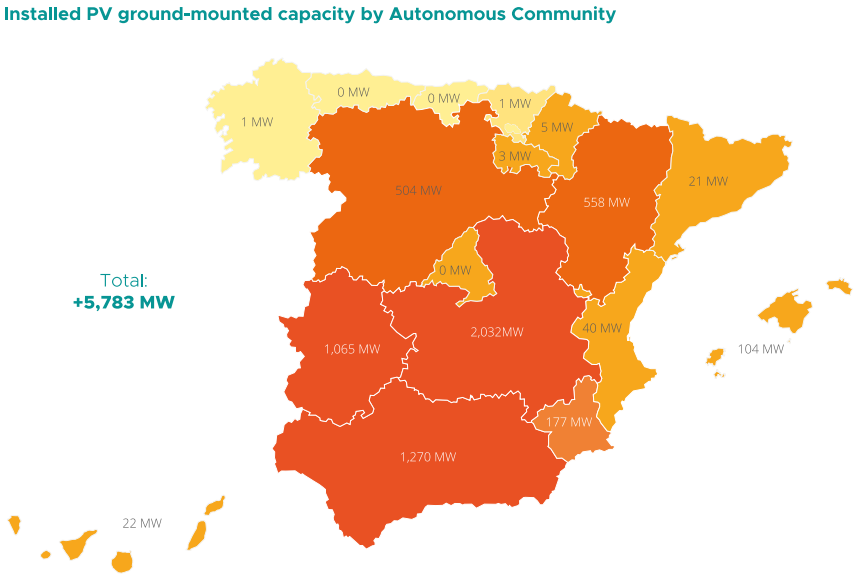
A map by Autonomous Community illustrates the distribution of photovoltaic capacity, focusing solely on ground-mounted plants as the registry for self-consumption is not yet fully operational. In 2023, Extremadura, Castile-La Mancha and Andalusia emerged as the leading Autonomous Communities in photovoltaic development. Together, they account for 18,327 MW, representing more than 56% of the nationally installed capacity.

Figure 24. Photovoltaic capacity in ground-mounted plants (including self-consumption as estimated by REE) by Autonomous Community up to April 2024.



Source: REE

Figure 25. Photovoltaic capacity installed during 2023 in ground-mounted plants (including self-consumption as estimated by REE) by Autonomous Community



CASTILE-LA MANCHA LED PHOTOVOLTAIC DEVELOPMENT IN 2023 WITH 2,032 MW OF NEW GROUND-MOUNTED PLANT CAPACITY.

As in previous years, new ground-mounted plant capacity was established without the need for public subsidies or regulated remuneration systems. This was made possible through PPAs (bilateral contracts with retail suppliers or consumers) and participation in the electricity pool. Notably, no energy auctions for photovoltaics were held in 2023.

We are your most committed decarbonisation partner in the market.

For an energy transition with cleaner and more efficient energy solutions.

More than 15 years of experience

Global with presence in more than 11 countries

We offer: Development, EPC, O&M, IPP or PPA

Biogas/Biomethane Solar, Wind & Storage

ID Energy Group

Beyond —— Solar Power

www.idenergy.group

PHOTOVOLTAICS WAS THE FOURTH LARGEST SOURCE OF ENERGY GENERATION IN 2023, MAKING UP 13.6% OF THE NATIONAL MIX.

IN TERMS OF RENEWABLE GENERATION, PHOTOVOLTAICS ACCOUNTED FOR 27.8%.

That year also saw a significant increase in photovoltaic contribution to the electricity mix, reaching 13.6% of total electricity production. This marks a steady rise from 6.9% in 2020, 8.1% in 2021 and 10% in 2022. With regard to overall renewable energy generation, photovoltaics achieved a 27.8% share in 2023.

3.1.1. Economic footprint

In 2023, the **total economic footprint** of the photovoltaic sector, combining direct, indirect and induced GDP generation both domestically and internationally, reached **€18.02 billion. This represents a 4% increase compared to the 2022** figure of €17.38 billion.

Table 1. Economic footprint (GDP) of the Spanish PV sector. Millions of euros.

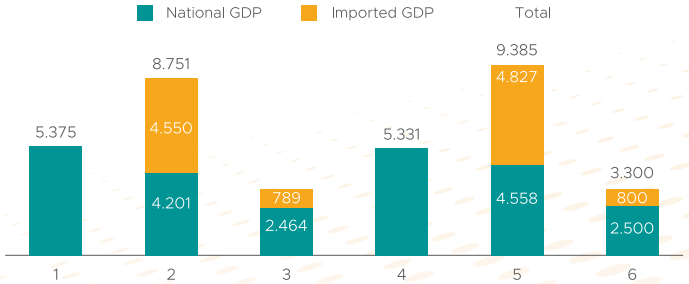
	2022	2023p	Growth rate
Direct footprint	5,375	5,331	-1%
Indirect footprint	8,751	9,385	7%
Induced footprint	3,252	3,300	1%
Total footprint	17,378	18,015	4%

The direct economic footprint of the photovoltaic sector on national GDP amounted to €5.33 billion in 2023, as shown in Table 1. The reported figures also detail the sector's indirect and induced economic contributions, capturing the knock-on effects from purchasing materials, both domestic and imported, and the consumption of goods and services resulting from wage incomes in the sector.

THE SECTOR CONTRIBUTED €17.38 BILLION TO GDP, ENCOMPASSING DIRECT, INDIRECT AND INDUCED IMPACTS, BOTH DOMESTICALLY AND INTERNATIONALLY IN 2023.

Regarding the indirect impact, €4.56 billion was mobilised across national territory, with an additional €4.74 billion mobilised abroad, resulting in a total indirect footprint of €9.39 billion. This represents a 7% increase compared to the previous year, highlighting the potential market size for expanding the value chain in the domestic PV industry. Additionally, an induced footprint of €2.5 billion was mobilised domestically, with a further €800 million related to imported GDP, bringing the total induced footprint to €3.3 billion.

Figure 26. Domestic and imported economic footprint of the Spanish PV sector. Millions of euros.



Source: UCLM

While the direct economic footprint amounted to €5.33 billion in 2023, impacting national GDP, it is the indirect footprint that has again had the greatest absolute impact, as seen in previous years. The indirect economic footprint reached €9.39 billion in 2023, reflecting its effect on both national and imported GDP. Developing the domestic equipment and components industry will help ensure these contributions continue to bolster national GDP figures.

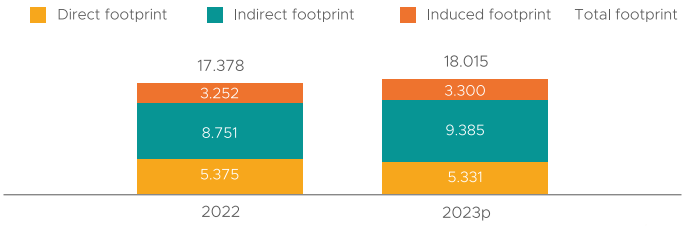
Table 2. Economic footprint (GDP) by activity group Millions of euros.

2023p	Producers	Manufacturers	Engineering and Installers	Mixed + Distributors	Total
Direct footprint	3,098	909	932	392	5,331
Indirect footprint	2,381	2,724	2,234	2,046	9,385
Induced footprint	1,319	760	887	334	3,300
Total footprint	6,798	4,393	4,053	2,772	18,015

Source: UCLM

In terms of the **sector's direct contribution to GDP by activity**, the most significant contribution came from energy production, which added almost €6.8 billion, 37.7% of the direct contribution. This was followed by the manufacturers sector, contributing close to €4.4 billion and accounting for 24.3%. The engineering and installation sector made up 22.5%, while the mixed section and distributors contributed another 15.3% of the direct GDP contribution.

Figure 27. Contribution of the photovoltaic sector to national GDP. Millions of euros.



Source: UCLM

Overall, when the total footprint of the photovoltaic sector in the country is considered, it generated €18.02 billion, marking a 3.6% increase compared to 2022 (Table 1). This continues the upward trend from the previous year despite challenges in the self-consumption segment.

Table 3 Imports, exports by activity. Millions of euros.

		Producers	Manufacturers	Engineers and Installers	Mixed + Distributors	TOTAL
2022	Major Exports	938	2,104	241	420	3,704
		496	974	389	846	2,705

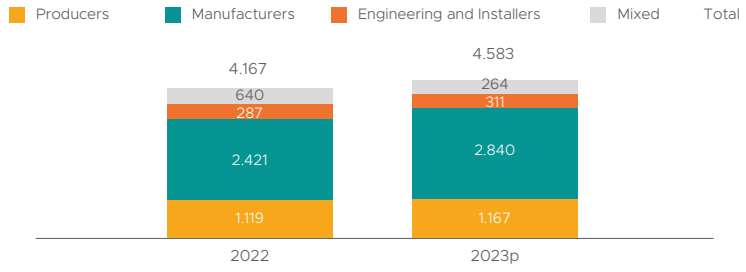
		Producers	Manufacturers	Engineers and Installers	Mixed + Distributors	TOTAL
2023	Exports	998	2,479	262	343	4,082
	Imports	620	1,149	423	632	2,823

Note: Mixed includes Distributors. Producers include Developers.

Source: UCLM

In terms of the trade balance, exports rose by 10% in 2023, highlighting Spain's exporting strength. This marks a continuation of the upward trend in exports seen since 2021, with an increase of €378 million compared to 2022. While the trade balance remains positive due to exports, imports have stabilised at a level very close to their 2022 value.

Figure 28: Total impact of exports in terms of GDP generated by activity.



Source: UCLM

Manufacturers continue to lead the export segment, mobilising €2.84 billion, marking a 17% increase over 2022. The producers' sector follows with exports of €1.17 billion in 2023, reflecting a modest 4% rise. Engineering and installation companies, though not leading in capital mobilisation, have grown by 8%, making them the second fastest-growing segment in 2022. The mixed section, which includes distributors, saw a decrease of 22% compared to 2022 values.

Among national photovoltaic **companies** operating abroad, those showing the highest levels of international activity over the past two years stand out in particular categories.

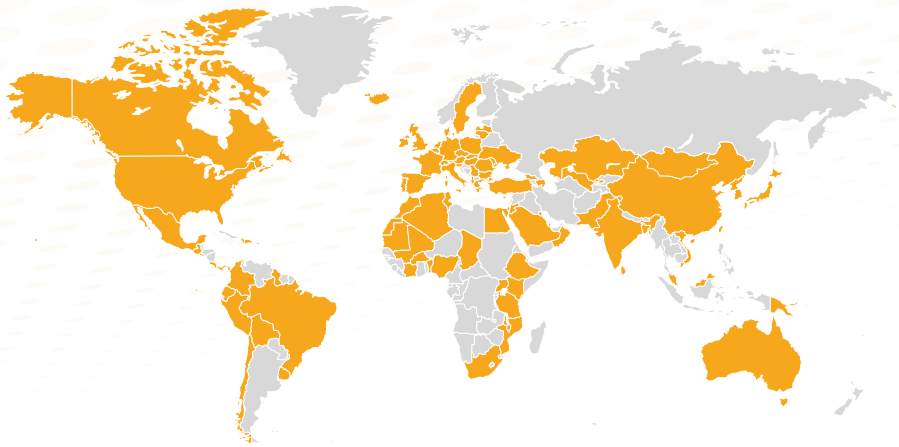
Table 4. List of the main companies operating abroad

PRODUCERS (8 COMPANIES)	DEVELOPERS (20 COMPANIES)	INSTALLERS AND ENGINEERING COMPANIES (24 COMPANIES)	MANUFACTURERS (19 COMPANIES)	DISTRIBUTORS AND MIXED (40 COMPANIES)
ALTEN ENERGY	BAYWA R.E. ESPAÑA	ABAITUA	ALUSIN SOLAR, S.L.U.	AGERE INFRAESTRUCTURE
ENDESA, S.A.	DISA RENOVABLES,S.L.	ALINEA SOLAR ALTERNAS, S.L.	APLICACIONES TÉCNICAS DE	PARTNERS, S.L.
Eni Plenitude Iberia, SL	DIVERXIA INSFRAESTRUCTURAS, S.L.	ECOOO ENERGÍA CIUDADANAS	LA ENERGÍA, S.L.	AMARA SOLAR RENOVABLES, S.L.
R. POWER ESPAÑA, S.L.	EDP RENOVABLES ESPAÑA, S.L.U.	S. COOP.	EXPERIENCE SNOWLEDGE	AXPO IBERIA, S.L.U.
RWE RENEWABLES IBERIA	ENERLAND 2007	EIFFAGE, S.A.	STRATEGY. S.L.	CANADIAN SOLAR
S.A.U.	FOTOVOLTAICA, S.L.	EKS ENERGY	EXTRUIDOS DEL ALUMINIO S.A.U.	CONSTRUCTION, S.R.L.
SHELL ESPAÑA, S.A.	ESTRUCTURAS METÁLICAS	ENGINEERING AND	GONVARRI SOLAR STEEL, S.L.	EFORA TECHNOLOGIES, S.L.
SOTO SOLAR 26,SL	JOYBE,S.L.	TECHNOLOGY FOR LIFE, S.L.	INGETEAM POWER	ENERSIDE ENERGY, S.L.
	EUDER ENERGY, S.L.	GESTIÓN DE RECURSOS Y	TECHNOLOGY, S.A.	FUNDACIÓN CIRCE
	ID ENERGY GORUP, S.L.	SOLUCIONES EMPRESARIALES	ISIGENERE, S.L	FUNDACIÓN TECNALIA
	IGNIS DESARROLLO, S.L.	GESTIÓN Y PRODUCTIVIDAD	MONDRAGON	RESEARCH & INNOVATION
	NARA SOLAR, S.L.	ENERGÉTICA, S.L.	ASSEMBLYSCOOP	INSTITUTO DE SISTEMAS
	PLENITUDE RENEWABLES	GRUPO GRANSOLAR, S.L.	ORMAZABAL MEDIA TENSION, S.L.U.	FOTOVOLTAICOS DE CON
	SPAIN, S.L.U	GRUPOTEC SERVICIOS	PRAXIA ENERGY, S.L.	ISOTROL, S.A.
	PROKON NW ENERGY SPAIN, S.L.U.	AVANZADOS, S.A.	PROTECCIONES ELÉCTRICAS	JONES LANG LASALLE
	RENOVALIA ENERGY GROUP, S.L.	INGENIERIA SOLARFAM, S.L.	DE ALTA TENSIÓN, S.L	ESPAÑA, S.A.
	RIC ENERGY	INGENIERÍA Y APLICACIONES	SALICRU, S.A.	ARIES MARKETS
	SOLARPACK CORPORACION	SOLARES S.L-IASO	SOLTEC ENERGIES	INTERNATIONAL, S.A.
	TECNOLOGICA, S.A.	INNOVER INSTALACIONES DE	RENOVABLES, S.L.	MICROSEGUR, S.L.
	SOLEK	NUEVAS ENERGÍAS	SOLUCIONES TÉCNICAS	NATEC SUNERGY B.V
	TSK, ELECTRONICA Y	IQONY SOLAR ENERGY	INTEGRALES NORLAND, S.L.	NETWORK BACKUP, S.L.
	ELECTRICIDAD, S.A.	SOLUTIONS IBÉRICA, S.L.U	SONNEN SPAIN, S.L.	NEXUS ENERGÍA, S.A.
	UNIVERGY INTERNATIONAL, S.L.	IRRADIA INGENIERÍA SOLAR, S.L.	STANSOL ENERGY	ONTIER ESPAÑA, S.L.
	VOLTALIA RENOVABLES	KISHOA, S.L.	SUNPOWER ENERGY SYSTEM	OSBORNE CLARKE, S.L.P
	ESPAÑA SAU	KENERY EFICIENCIA	SAPIN, S,L.	OVE ARUP AND PARTNERS, S.A.U.
	X-ELIO	ENERGETICA, S.L	TRACTEL IBÉRICA, S.A.	P4Q SUNTRACK SERVICES S.L.
		NORSOL ELECTRICA S.L.	ZIGOR SORPORACION, S.A.	PARAGON SOLAR SL
		POLAR DEVELOPMENTS, S.L.		PINSENT MASONS ESPAÑA, S.L.P.
		PRONOR,S.L.		RATED POWER, S.L.
		RIOGLASS SOLAR SCH, S.L.		SCHLAICH DAUSS, S.L.P.
		RIOS RENOVABLES, S.L.		SGS TECNOS, S.A.U.
		SOLARDRONE		SMA IBÉRICA TECHNOLOGY
		SUNKE INSTALACIONES, S.L		SOLAR, S.L.
				STAUBLI ESPAÑOLA, S.A.U.
				SUMINISTROS ORDUÑA, S.L.
				SUNGROW IBERICA, S.L.U.
				TRAMA TECNOAMBIENTAL, S.L.
				URÍA MENÉNDEZ ABOGADOS S.L.P.
				VALFORTEC, S.L.
				VALK SOLAR SYSTEMS
				IBERIA, S.L.
				MOTOR CONTROL VECTOR
				IBERICA SL (VMC)
				VITA CAPITAL MANAGEMENT, S.L.
				WIND TO MARKET, S.A.
				WORLDWIDE RECRUITMENT
				WORLEYPARSONS ESPAÑA, S.L.U.
				WSP SPAIN (APIA XXI)
				YINGLI GREEN ENERGY
				EUROPE, S.L.

Source: UCLM

These companies have been identified as operating in more than **92 countries**. As shown in figure 29.4, besides Europe, businesses in the sector are present across almost the entire American continent, much of Asia, several African countries and Australia. However, since the war in Ukraine, company operations in Asia have decreased due to trade restrictions with Russia.

Figure 29. International presence of Spanish companies in the solar photovoltaic sector. 2023



Source: Prepared by UCLM based on data from SABI, Spanish Ministry of Foreign Affairs and ICEX.

THE ECONOMIC IMPACT OF EXPORTS FROM THE PHOTOVOLTAIC SECTOR REACHED €4.58 BILLION IN 2023

In 2023, the protectionist industrial development programmes of the USA, India and China started to affect the slowing growth rate of exports. Further changes may arise due to these plans and specific geopolitical factors.

Table 5 Economic impact (GDP) of Spanish PV exports. Millions of euros.

	2022	2023p	Growth rate
Direct footprint	1,135	1,229	8%
Indirect footprint	2,272	2,522	11%
Induced footprint	760	775	2%
Total footprint	4,167	4,526	9%

Source: UCLM

The data indicate a positive trend in the foreign trade balance. The economic impact of the Spanish photovoltaic sector is significant, thanks to notable growth in both direct and indirect contributions to GDP. In terms of GDP generated, **exports** rose from €4.17 billion in 2022 to €4.53 billion in 2023, marking a 9% increase. Analysing the direct, indirect and induced effects of exports reveals that the indirect impact is particularly significant, reaching €2.52 billion in 2023. This accounts for 55.7% of the total economic impact related to imports.

Table 6. Technological innovation activities: Innovation intensity (%) and R&D&I spending. Millions of euros.

	Innovation intensity (%)	R&D&I spending 2022	R&D&I spending 2023p
Producers	3.09	182	176
Manufacturers	5.80	186	211
Engineering and installers	3.36	106	115
Mixed + Distributors	4.62	104	109
TOTAL 2022	3.65	578	610
TOTAL 2023 (p)	3.66		
TOTAL Spanish companies	1.61		
TOTAL Spanish industry	1.36		

Source: UCLM

Spending on R&D&I by sector companies has shown steady growth to date. In 2023, investment in Research, Development and Innovation reached €610 million, marking a 5% increase over the €578 million spent in 2022. By sector, manufacturers allocated the highest percentage of their revenues to technological innovation activities, with a 5.8% increase over 2022, amounting to €211 million in 2023.

The photovoltaic energy sector's overall innovation intensity (3.66%) notably surpasses the average for Spanish companies (1.6%) and is well above the national industry average (1.36%).

3.1.2. Social footprint

Rising photovoltaic activity is not only bringing climate and economic benefits but is also having a positive impact on national employment. By 2023, a total of 162,396 people were employed in the sector, including direct, indirect and induced jobs.

THE SECTOR CREATED 34,037 DIRECT JOBS NATIONALLY.

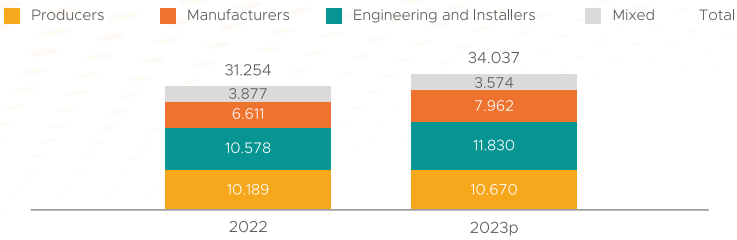
Table 7. Employment footprint of the photovoltaic sector by activity. Persons employed

2023p		Producers	Manufacturers	Engineering and Installers	Mixed + Distributors	Total
Direct footprint	Spain	10,670	7,962	11,830	3,574	34,037
Indirect footprint	Spain	33,181	11,705	19,347	22,735	86,968
Induced footprint	Spain	16,547	9,528	11,127	4,189	41,391
Total domestic footprint		60,398	29,196	42,305	30,499	162,396

Source: UCLM

The Producers section employed the most people, reaching a total of 60,398, making it the top job-creating segment in Spain. Meanwhile, the engineering and installers section employed 11,830 people, leading in direct job creation in the country. **Direct employment saw a 9% increase, rising from 31,254 to 34,037 jobs**.

Figure 30. Direct employment by type of activity



Source: UCLM

When examining the **direct employment** generated by different activities, the most significant growth is found in the manufacturers segment. This area, which employs a large number of skilled workers, saw a 20% increase, underscoring the development of Spain's photovoltaic solar industry. Conversely, the mixed section experienced an 8% decline, decreasing from 3,877 to 3,574 people this year.

Indirect employment in the sector rose by 8%, reaching a total of 86,968 jobs. The producer section created the most indirect jobs, accounting for 38% of total indirect employment generated by photovoltaics in Spain.

Finally, the number of induced jobs reached 41,391, showing a slight increase compared to 2022. The manufacturers segment saw the most considerable growth, employing 9,582 people nationally.

Table 8. Fiscal balance. Millions of euros

	2022	2023p
TAX REVENUE		
National taxes	1656.8	1490.0
Local taxes	242.4	257.9
National insurance contributions	389.5	395.2
Total tax revenue	2288.8	2143.1
TAX BENEFITS		
Investment grants	164.5	175.7
Tax rebates (ICIO and IBI)	24.9	17.0
Total tax benefits	189.5	192.7
TAX BALANCE	**2099.3**	**1950.4**

Source: UCLM and data from the State Tax Agency (Agencia Estatal de la Administración Tributaria)

The **fiscal balance** perspective reveals a significant surplus for the photovoltaic solar sector. Notably, the amounts received under the specific remuneration regime are not classified as subsidies since they originate from electricity sector regulations rather than the General State Budget.

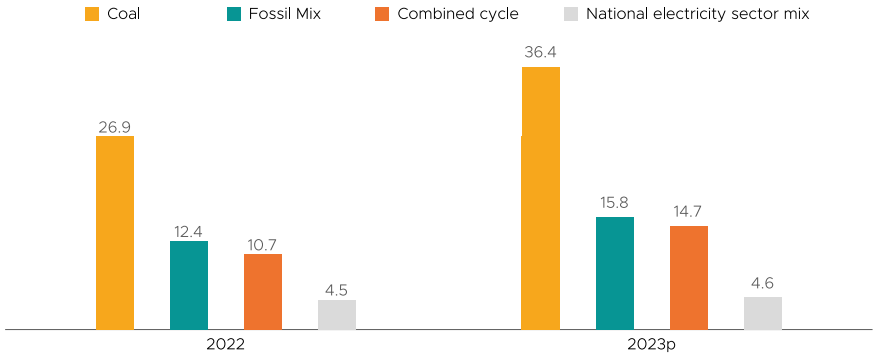
Fiscal balance indicates that total tax revenues in 2023 were €2.14 billion, marking a 6% decrease from 2022.

The sector benefits from economic support, including tax discounts applied by some local administrations on Property Tax (IBI) and the Tax on Construction, Installations and Works (ICIO). It also receives direct aid, such as that provided through the ERDF programme. In recent years, these forms of support have not only increased in amount but have also been extended to several autonomous communities.

3.1.3. Environmental footprint

Renewable energies are undoubtedly the best tools we have to reduce CO2 emissions, decrease reliance on fossil fuels and decarbonise the economy. Solar photovoltaic energy plays a crucial role in cutting emissions within the electricity sector. Its significance lies not only in its potential to combat climate change but also in its ability to help stabilise biodiversity in areas affected by human activity.

Figure 31: Emissions avoided by type of primary source (MtCO2 eq)



Source: UCLM

In 2022, the use of solar photovoltaic energy in Spain led to a reduction of **14.7 megatonnes of CO2 equivalent emissions**, effectively replacing combined cycle power generation.

A national analysis of the Spanish electricity system reveals a significant drop in emissions due to the shift from fossil fuel generation to renewable energy sources. Generating electricity from fossil fuels results in the release of substantial amounts of carbon dioxide and other atmospheric pollutants. In contrast, photovoltaic systems do not emit greenhouse gases during their operation, playing a critical role in reducing the carbon footprint and improving air quality. **A photovoltaic panel can offset the emissions from its production within 6 to 9 months of renewable energy generation** and has a lifespan of 25 to 30 years.

IN SPAIN ALONE, PHOTOVOLTAIC SOLAR ENERGY PREVENTED 14.7 MILLION TONNES OF CO2 EQUIVALENT EMISSIONS.

3.2. New national regulation

3.2.1. Sectoral framework

In 2023, the **regulatory environment** has been relatively stable, with less intense activity compared to the past three years. However, work continued on various consultations, including those related to **reforming the electricity market** in line with European changes and setting the objectives for the new **integrated National Energy and Climate Plan (NECP)**.

The legislative landscape of 2023 has been influenced by several Royal Decree-Laws impacting the electricity market, such as **extensions to administrative milestones**, changes in the PVPC and revised criteria for environmental assessments.

UPDATE OF NECP OBJECTIVES

In June 2023, the Ministry for Ecological Transition initiated a public consultation to update the objectives of the NECP. This plan, which is part of Law 17/2021 on Climate Change and Energy Transition, outlines Spain's policies for decarbonisation and energy planning.

This year, targets have been revised upwards through a draft that is set to be finalised and approved in Brussels by the summer of 2024. The draft includes the following targets:

- 32% reduction in greenhouse gas emissions compared to 1990 levels
- 48% of energy end use from renewable sources
- 44% improvement in energy efficiency in terms of final energy use
- 81% of electricity generation from renewable energy
- Reduction of energy dependence to 51%

These targets reflect **increased ambition in expanding solar photovoltaic (PV), storage and hydrogen technologies by 2030**.

- **PV capacity targets have risen from 36 GW in the 2021 NECP to 76 GW** in the current draft, aligning with UNEF's proposal of 70-80 GW.
- The 2021 NECP did not specify a target for self-consumption, but the subsequent Self-consumption Roadmap suggested an installed capacity between 9 GW and 14 GW. **The current draft sets a target of 19 GW for self-consumption**, surpassing UNEF's proposal of 15 GW.

- For storage, the 2021 NECP originally set a target of 17.6 GW across pumped storage, thermoelectric and electrochemical methods. This was later increased to 20 GW by the Storage Strategy, which also included the potential storage capacity from electric vehicles (V2G). **The draft NECP raises the storage target to 22 GW**, slightly below UNEF's proposal of 24.5 GW.

- The 2021 NECP did not specify targets for the capacity of electrolysers used in hydrogen production. However, the subsequent Hydrogen Roadmap set a target of 4 GW. In contrast, **the new draft NECP increases this target to 11 GW**, aligning with UNEF's proposed range of 5.8 GW to 15 GW for electrolysers.

Figure 9: Targets to 2030

	MITECO - NECP 2021-2030 (GW)	Other documents: Roadmaps / Strategies (GW)	UNEF Proposal 2023 (GW)	Draft NECP 2023-2030 (GW)
Photovoltaic	39		70-80	76
Ground-mounted			55-65	57
Self-consumption		9-14*	15	19
Storage	17.6	20**(including EVs)	24.5	22
Pumping (pure + mixed)	9.5		15.1	
Electrochemical			8	18.5
Behind-the-Meter	2.5	0.4	1.4	
Thermoelectric	5.6			3.5
Hydrogen		4***	5.8-15	11

* Self-consumption Roadmap (2021)

** Storage Strategy (2020)

*** Hydrogen Roadmap (2020)

Source: UNEF

The updated objectives of the NECP are currently under review by European institutions, with the final plan expected to be submitted to the European Commission by June 2024.

Royal Decree-Law 5/2023

In June 2023, the Council of Ministers approved Royal Decree-Law 5/2023, dated 28 June. This decree introduces significant measures, including **a six-month extension** of administrative milestones related to access permits for electricity generation and storage facilities. This extension applies to projects that obtained access permits from 31 December 2017 and before this decree came into effect.

The decree also **governs the use of surplus toll revenue from the electricity sector to enhance the competitiveness of energy-intensive industries** and address temporary imbalances between revenues and costs for the 2023 financial year. It establishes a legal mechanism to utilise the surplus from tolls and charges, applying this surplus in the pro-

visional settlements or for the 2023 financial year. This approach provides liquidity to entities subject to settlement and reduces the need for additional financing to manage the mismatches in the electricity system. The surplus from 2022, which is nearly €6.2 billion, will be used to cover temporary imbalances and transitory deviations between revenues and costs in 2023.

In addition, the Royal Decree-Law updates the specific remuneration scheme for power generation, making adjustments to electricity market prices and fuel costs. It stipulates that, exceptionally, for the regulatory period from 1 January 2023 to 31 December 2025, the electricity market price estimate for 2023 will be based on daily market values from 1 January to 31 May 2023, along with futures values traded during that period for energy delivered between 1 June and 31 December 2023. For 2024 and beyond, the estimate will rely on futures markets. These measures are expected to increase the remuneration for renewable technologies by €180 million in 2023, and for cogeneration by €20 million for the first half of 2023.

The decree also progresses the regulation of energy communities by incorporating the regulatory principles for renewable energy communities and citizen energy communities, in line with Directives (EU) 2018/2001 and 2019/944. The Royal Decree-Law grants these communities rights to produce, consume, store and sell renewable energy. Moreover, it eliminates certain constraints from the previously published draft Royal Decree, such as distance limits for renewable energy projects and restrictions on access to specific auctions for energy communities.

Royal Decree-Law 8/2023: Extension of Administrative Milestones.

At the end of December 2023, significant measures were approved for the photovoltaic sector. These measures are an important step forward in the ecological transition and in meeting the objectives of the NECP.

RDL 8/2023 extended two milestones originally set by RDL 23/2020 that were still pending. firstly, a **6-month extension for the Connection Access Authorisation (AAC)**, which was due to expire on 25 January 2024, now allowing up to 49 months in total. Secondly, an extension of up to **8 years for the Administrative Operating Authorisation (AAE)**, requiring projects only to specify the semester in which they expect the installation to become operational, with this timeline being binding.

The extension of the final milestone for the AAE has **provided legal certainty for ongoing projects**, creating a necessary framework to ensure the achievement of 2030 targets. This measure demonstrated to both national and international investors the Government's strong commitment to these objectives and the substantial efforts made by the sector and all public administrations to progress in decarbonisation.

As anticipated by UNEF, the extension helped to avoid technological bottlenecks and reduce inflationary pressure in construction processes by extending the timelines for plant construction. It also made it easier to secure financing for all projects and within the financial sector, preventing the concentration of large financial demands within short time frames.

Regarding self-consumption, **RDL 8/2023 increased grid capacity** by allocating 10% of the capacity of all nodes in the electricity transmission grid for access tenders. This also helped to ensure the efficient evacuation of surpluses from self-consumption facilities, thus maximising the potential of self-consumption, with a particular benefit for large-scale installations linked to industrial activities.

Additionally, this royal decree introduced tax changes related to electricity, **setting Value Added Tax (VAT) at 10% for the entirety of 2024**. The Special Electricity Tax (IEE) was set at 2.5% for the first quarter of the year and 3.8% for the second quarter, subject to certain conditions. Additionally, the Tax on the Value of Electricity Production (IVPEE) was adjusted to a rate of 3.5% until March and then increased to 5.25% until June. Changes introduced by this RDL mean that **IVPEE** will be calculated on **50% of the energy discharged in the first quarter and 75% in the second quarter, with a 7% tax rate applied**.

THE IVPEE WILL BE CALCULATED ON 50% OF THE ENERGY DISCHARGED IN THE FIRST QUARTER AND ON 75% IN THE SECOND QUARTER.

For natural gas supplies, the VAT was maintained at 10% for the initial three months of 2024, and this same rate was applied to biomass fuels for the entirety of the year.

Regarding energy storage, which is crucial for integrating substantial renewable energy production and accelerating the electrification of the economy, the government has prioritised storage among water uses.

It is now third in order of importance, after supplying towns and cities and agricultural use, but before electricity production and other industrial uses. The government has also modified the concessions for pumped-storage hydroelectric power stations to categorise them as hydraulic energy storage facilities, thereby encouraging their enhancement.

RD 444/2023: Electro-intensive consumers

Published on 13 June, Royal Decree 444/2023 amends Royal Decree 1106/2020 to update the Statute for electro-intensive consumers, aligning it with the European Commission's 2022 'Guidelines on State Aid for Climate, Environmental Protection and Energy'. This update broadens the Statute's scope to include extractive industries, reflecting the EU's goal of enhancing the availability of essential raw materials for industry.

Key modifications include new criteria for obtaining certification as an electro-intensive consumer, which involve assessing factors such as energy consumption, gross value added and ensuring a monthly consumption forecast accuracy of 75%. The decree distinguishes between aid intensities for sectors that are 'at significant risk' and those simply 'at risk' of relocation, providing aid levels of 85% and 75%, respectively.

It also revises the calculation methodology for aid by introducing requirements such as investment in energy efficiency and the consumption of renewable energy. Beneficiaries are required to demonstrate that at least 50% of their electricity consumption is sourced from renewables and must have committed to long-term contracts covering at least 10% of their annual electricity use. New obligations regarding transparency and control have been introduced, necessitating annual reports on energy efficiency measures and verification of compliance by accredited entities.

RD 445/2023: Amendment of the Environmental Assessment Act

In June 2023, the Ministry for Ecological Transition and the Demographic Challenge introduced a Royal Decree that **amended Annexes I, II and III of the Environmental Assessment Act** (Law 21/2013, dated 9 December). The amendment incorporates changes from Directive 2014/52/EU, specifying which projects require either an ordinary or simplified environmental assessment.

Key modifications include detailing project characteristics, their accumulation with existing projects, the use of natural resources, waste generation and pollution. The decree also places special emphasis on the location of projects and their impact on sensitive areas, such as wetlands, coastal zones and nature reserves. Furthermore, new criteria have been introduced in Annex III to ensure that any project with significant impacts is thoroughly assessed, even if it falls below the thresholds established in Annex II. This includes projects located in environmentally sensitive areas or those that particularly affect water resources, thereby ensuring enhanced environmental protection and sustainable development.

The criteria determining whether a project is subject to ordinary or simplified environmental assessment are summarised in the following tables:

Table 10: Ordinary environmental assessment:

	Ordinary environmental assessment
Project characteristics	Overall size and design of the project.
	Integration with other existing and/or approved projects.
	Use of natural resources, specifically land, soil, water and biodiversity.
	Waste production.
	Pollution and other disruptions.
	Risks of major accidents and/or disasters relevant to the project, including those associated with climate change, based on scientific understanding.
	Risks to human health, such as those arising from water, air or electromagnetic pollution.
Project location	Current and approved land use.
	The relative abundance, availability, quality and regenerative capacity of the area's natural resources and subsoil, including soil, land, water and biodiversity.
	The natural environment's absorption capacity, with special attention to: • Wetlands, riparian zones and river mouths. • Coastal areas and the marine environment. • Mountain and forest areas. • Nature reserves and parks. • Areas classified or protected by state or regional legislation, as well as Natura 2000 Network sites. • Areas where environmental quality objectives have been exceeded according to relevant legislation, or where compliance with these standards is in question. • Densely populated areas. • Landscapes and sites of historical, cultural and/or archaeological significance. • Areas that could impact cultural heritage. • Surface and groundwater bodies listed in hydrological planning with their environmental objectives.
Characteristics of potential impact	Scale and geographic scope of the impact, including the area and population likely to be affected.
	Scale and geographic scope of the impact, including the area and population likely to be affected.
	Transborder nature of the impact.
	Intensity and complexity of the impact.
	Anticipated onset, duration, frequency and reversibility of the impact.
	Accumulation of the impact alongside other existing or approved projects.
	Potential for effectively reducing the impact.

Table 11. Simplified environmental assessment

Simplified environmental assessments apply to projects falling below the thresholds set out in Annex II	
Project characteristics	Natura 2000 network areas.
	Protected natural areas.
	Wetlands designated as being of International Importance (Ramsar sites).
	Natural sites listed as World Heritage.
	Areas protected under the Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR).
	Zones designated for marine and coastal protection in the Mediterranean (ZEPIM), as well as core and buffer zones of UNESCO Biosphere Reserves.
Project location	Surface water bodies officially classified as having poor ecological status or potential, or good status/potential where water extraction exceeds 5% of the average monthly flow at the point of abstraction, calculated using a representative series according to the Hydrological Planning Instruction criteria.
	Groundwater bodies in poor quantitative status, or good quantitative status where the annual water extraction exceeds 1% of the available resources.
	Protection perimeters for catchment areas intended for human consumption, mineral and thermal waters, as well as zones designated for the protection of habitats or species, economically important species, hydrological reserves and wetlands of international importance, such as Ramsar sites, or those included in the Spanish Inventory of Wetlands (as outlined in paragraphs 2 (a, b, c, g, and h) and 3 (a and c) of Article 24 of the Hydrological Planning Regulation, approved by Royal Decree 907/2007 of July).
Projects that, during their operational phase, discharge water potentially leading to either diffuse or point source pollution include:	Surface water bodies failing to achieve good ecological or chemical status/potential.
	Groundwater bodies with poor chemical status.
	Areas protected under Directive 2000/60/EC of the European Parliament and the Council, dated 23 October 2000.
Other projects	Projects overlapping with formally designated green infrastructure, recognised for their function as ecological corridors or connectors.
	Critical areas identified in recovery or conservation plans for endangered species, or regions crucial for the conservation of species under special protection.
	Habitats of Community interest that are in an unfavourable conservation status within their biogeographical unit.
	Areas designated by authorities for the protection of species that are fished or harvested, except where the competent authority confirms that the projects are unlikely to cause adverse effects.

Royal Decree 446/2023 on the modification of the PVPC calculation methodology

Royal Decree 446/2023 introduced a new method for calculating Voluntary Prices for Small Consumers (PVPC), amending the provisions in RD 216/2014. This methodological shift adopts a protectionist approach aimed at stabilising prices by linking them to forward market signals. It also broadens eligibility criteria for the PVPC, now including micro-enterprises as beneficiaries.

The new calculation method brings substantial changes by integrating a mix of forward products—available monthly, quarterly and annually—

with the hourly prices from the daily and intraday markets. Furthermore, the impact of forward signals is set to increase progressively from 2024 through to 2026.

Regarding subsidised rate financing, **the Royal Decree incorporates it into the PVPC calculation, enabling retail suppliers to recuperate the amounts they financed prior to the regulation coming into effect**. The decree also revises energy production costs, introducing an adjustment for island territories and permitting references to infra-marginal energy auction prices. Additionally, it alters remuneration for variable generation costs and adjusts the cost of dispatch emission rights.

3.2.2. Regional regulations

Andalusia

In March 2023, the Junta de Andalucía introduced a new **Circular Economy Law** aimed at advancing a transition to a circular economic model rooted in sustainability, innovation and job creation. The law aims to lessen reliance on external resources and promote material recycling. This legislation establishes the Andalusian Office of Circular Economy and outlines a dedicated strategy for implementation within the region. It also integrates environmental clauses into public procurement processes and introduces measures to promote reuse.

Aragon

In 2023, Aragon stood out as one of the most active autonomous communities in legislative matters concerning renewable energy. In March, the Aragonese government enacted **Decree-Law 1/2023** to regulate local, residential and productive energy consumption. The law aligns the planning of productive investments and renewable energy generation with the framework for direct lines, self-consumption, energy communities, closed distribution networks and aspects of hybridised plants in the region.

By September 2023, the **draft bill proposing environmental taxes** on wind farms and photovoltaic plants in Aragon was put forward for consultation and subsequently approved in May 2024. This legislation establishes a special tax for installations on land exceeding 5 hectares, based on the proposal from the Spanish Photovoltaic Union (UNEF). It exempts certain types of self-consumption with surpluses and offers incentives for others. Tax deductions are also available for developers investing in targeted programmes and initiatives aimed at enhancing socio-economic welfare and combating depopulation, in accordance with UNEF's recommendations.

Asturias

In 2023, Asturias did not introduce any specific legislation on renewable energy or the environment. However, it has continued to advance its Just Energy Transition Strategy, which began in early 2021. This strategy outlines the transformation of the region's energy sector, targeting a decarbonised, decentralised, digitalised and sustainable energy model by 2050, with interim goals to increase the share of renewable energy in electricity generation to 55% by 2025 and 72% by 2030. Furthermore, in 2022, As-

turias launched the Asume Plan (Plan Asturias Suma), which includes a measure to rapidly expand self-consumption in public buildings. It involves a three-month initiative to inventory rooftops and available spaces and to plan the installation of self-consumption systems over the next five years. These efforts demonstrate Asturias' commitment to energy transition and sustainability.

Balearic and Canary Islands

In May 2023, the Ministry for Ecological Transition issued Order TED/448/2023, which set out the regulatory framework for granting aid to electricity generation projects using innovative renewable energy sources. This includes repowering or technologically updating obsolete facilities nearing the end of their useful life, as well as integrating storage systems into generation facilities. This order targets the Balearic and Canary Islands, providing support for renewable generation installations, including renewable hydrogen production, and investments aimed at improving management and optimising production. It also facilitates self-consumption and the integration of energy into local markets. The aid covers modifications, repowering and renovation of existing renewable energy generation facilities.

Finally, in May 2023, the Canary Islands Government approved the **Canary Islands Climate Action Strategy**, with the goal of achieving climate neutrality and resilience by 2040. Its five strategic objectives include reducing greenhouse gas emissions and promoting carbon sequestration, improving energy efficiency, implementing renewable energy sources, encouraging sustainable mobility and zero-emission transport, and enhancing adaptation and resilience.

Cantabria

In March 2023, Cantabria's Ministry of Industry approved an aid package amounting to €754,594 to support self-consumption and storage of renewable energies for the self-employed, families and non-profit organisations. This initiative is part of a broader regional programme aiming to install at least 9.6 MW of new renewable energy generation capacity and 3.2 MWh of storage capacity within Cantabria.

Also, in March 2024, the Regional Ministry of Rural Development, Livestock, Fisheries and Food announced funding for investments in renewable energy for agricultural buildings in rural areas. This assistance targets farmers and livestock owners who undertake eligible projects in agricultural buildings located in rural settings.

Castile-La Mancha

The Ministry of Sustainable Development in Castile-La Mancha has opened the revision of the Recovery Plan for the Iberian Imperial Eagle for public consultation. The plan aims to prevent the species from becoming extinct by 2034 by increasing the number of pairs to over 600, thereby reclassifying it as vulnerable. The draft plan includes proposed restrictions on photovoltaic plants, sparking debate about the impact of these projects on the eagle population.

Castile and León

On 17 July 2023, Order IEM/916/2023 was published, setting out the regulatory framework for subsidies intended for acquiring new industrial machinery in Castile and León. This regulation is designed to encourage modernisation and energy efficiency in the region's industrial sector. The aid aims to enhance industry competitiveness while fostering innovation and a shift towards more sustainable and efficient energy use. The order also includes funding for projects that aim to reduce carbon emissions and incorporate renewable energy in industrial processes.

Catalonia

In 2022, the Government introduced the **Energy Outlook for Catalonia 2050** (Prospectiva energética de Catalunya al horizonte 2050, PROENCAT). PROENCAT 2050 outlines strategies necessary to achieve the energy transition. It estimates that an additional 12 GW of renewable energy capacity will need to be installed by 2030, with 7 GW of that coming from photovoltaic sources. By 2050, this figure is expected to rise to nearly 62 GW, which is 18 times the current capacity. By 2050, photovoltaics are projected to comprise 43% of the energy generation mix, supported by over 500,000 rooftop photovoltaic installations.

In 2023, the Generalitat de Catalunya initiated a public consultation on the **Territorial Sector Plan** for the implementation of renewable energies (PLATER). This plan focuses on three key areas affecting renewable energy deployment: land use planning, Strategic Environmental Assessment and the actual rollout of renewable energy projects.

Community of Madrid

In October 2023, the Community of Madrid initiated a public consultation on the **Draft Decree for its Energy, Climate and Air Strategy**, Horizonte 2030. This strategy aligns with the 'Blue Plan Plus' and the Decarbonisation Plan of the Autonomous Community of Madrid (CAM), proposing measures to enhance air quality, reduce greenhouse gas emissions and transform the region's energy framework.

The draft focuses on increasing energy efficiency, promoting self-consumption from renewable sources and supporting the expansion of electricity and thermal energy production from renewables. By 2030, the CAM aims to achieve an installed renewable capacity of 5 GW, with 84% of electricity generation coming from renewable sources. The strategy also aims for a 23% reduction in emissions compared to 1990 levels, and a 50% reduction from 2018 levels.

Valencian Community

In February 2023, **Law 6/2022, dated 5 December, concerning Climate Change and Ecological Transition in the Valencian Community**, was published in the Official State Gazette (BOE). This law aims to create a regulatory framework for climate change mitigation and adaptation measures in the region. The law outlines plans for renewable energy installations, evacuation facilities and necessary grid reinforcements to ensure proper connection to the electricity system. This involves designating areas suitable for environmental and territorial purposes and promoting agrivoltaic installations.

It includes priority development areas, which are urban and territorially defined regions that extend beyond municipal boundaries, and introduces surface rights to encourage energy communities. Furthermore, the law requires all buildings to gradually implement renewable energy sources, regardless of ownership.

The Climate Change and Ecological Transition law also aims to simplify the process for self-consumption and its connection to the grid. It eliminates the need for prior administrative approvals and construction permits for installations below 100kW. Additionally, it establishes the Administrative Register of Self-consumption and promotes better integration of storage systems.

Extremadura

The Regional Ministry for Ecological and Sustainable Transition of the Regional Government of Extremadura has issued a **Decree-Law, dated 11 January, which declares the production of hydrogen from electricity generated by isolated renewable energy facilities in Extremadura to be of general interest**. This Decree-Law designates the land as being of general interest for the development of green hydrogen projects. As a result, projects related to the production of renewable hydrogen, including the construction, modification, expansion and operation of facilities, will not require any substantive administrative authorisations. These projects will, however, need to comply with regulations regarding industrial safety, environmental protection, urban planning and other relevant areas.

Galicia

In May 2023, the First Vice-Presidency and Regional Ministry of Industry, Economy and Innovation of the Regional Government of Galicia opened a **draft bill for public consultation. This legislation focuses on enhancing the social and economic benefits of projects that utilise natural resources in Galicia**. The draft bill is relevant to owners and operators of distribution and transmission networks, consumers and owners of electricity generation facilities connected to these networks, as well as their suppliers and representatives. Its primary goal is to maximise the advantages that such projects bring to society and the economy. The law also requires that the social and economic impacts of these projects be evaluated as part of the environmental impact assessment.

La Rioja

On 24 January 2024, the Parliament of La Rioja approved **Law 1/2024, which introduces urgent temporary measures for protecting the region's landscape**. This law states that once the goals set in the Integrated Energy and Climate Plan of La Rioja (PRIEC) for renewable energy deployment are met, the declaration of public utility for renewable energy installations is no longer supported by the Electricity Sector Act.

Additionally, the law reinforces commitment to the European Landscape Convention by legally recognising landscapes included in land use and urban planning policies, as highlighted in La Rioja's Land Use and Urban Planning Law 5/2006, dated 2 May. The law also imposes a suspension on administrative procedures for recognising public utility that

fall under the jurisdiction of the Autonomous Community of La Rioja. It **halts all administrative processes for granting permits for activities and uses on undeveloped land related to electricity generation facilities and their infrastructure**.

The law does not apply to self-consumption facilities without surplus generation or to public utility recognition procedures that have completed the public consultation stage and received reports from the relevant bodies before the law's enactment.

Murcia

In 2023, the regional government of Murcia enhanced the **General Action Protocol for the Protection of the Mar Menor and Sustainable Development**. The protocol sets out specific guidelines to ensure that renewable energy projects do not damage the fragile ecosystem of the Mar Menor. To safeguard critical areas of the ecosystem, exclusion zones have been designated where renewable energy infrastructure is prohibited.

Additionally, the **Territorial Planning and Environmental Sustainability Plan** has been revised to incorporate criteria directly impacting renewable energy developments. New projects, particularly those near the Mar Menor, are subject to more stringent environmental impact assessments.

Furthermore, **grants and subsidies** for renewable energy initiatives in Murcia are now contingent upon adherence to specific environmental standards. These include reducing the visual and ecological footprint of projects and implementing measures to protect local biodiversity.

Priority Development Zones have been identified and designated within the Murcia region as key areas for renewable energy projects. These zones were chosen because they have a minimal environmental footprint and offer significant potential for solar and wind energy production.

In 2023, the **Environmental Impact Regulations** were revised and strengthened to ensure that all renewable energy projects in the region are sustainable and do not jeopardise the health of the Mar Menor. Updated assessments now require more detailed studies on the effects on wildlife, plant life and water quality.

Furthermore, new measures have been introduced to promote **Citizen Participation and Transparency** in the planning and development of renewable energy projects. This includes holding public consultations and enhancing transparency in the project approval process.

Navarre

In May 2023, the Chartered Community of Navarre issued Resolution 132E/2023, which **revised the guidelines for grants related to self-consumption, energy storage and renewable thermal systems in the residential sector** as part of the Recovery, Transformation and Resilience Plan. This resolution increased the budget by €9,868,897.09 for various

incentive programmes. Following this, in June 2024, the Director General for Energy, Business R&D&I and Entrepreneurship in Navarre released Resolution 180E/2024, introducing further changes to these guidelines. This amendment boosted the budget by an additional €11,789,591.03, allocated across several programmes, and extended the maximum deadline to eighteen months from notification of the grant award.

Basque Country

On 8 February 2024, the Basque Parliament enacted **Law 1/2024 on Energy Transition and Climate Change**. This law, which builds on a 2021 draft, establishes a regulatory framework for the Basque Country. It introduces governance mechanisms, promotes citizen participation and **imposes a levy on renewable energy installations to offset environmental impacts**.

The "Renewable Energy Levy" is a direct and recurring charge aimed at mitigating the environmental effects of renewable energy installations on non-developable land. The levy applies to both existing and new installations and the revenue generated will be allocated to fund the conservation and restoration of the affected environments. Owners of these installations are responsible for the **levy, which is set at €700 per hectare impacted**, adjusted proportionally for the first and last year of operation. The law provides exemptions for self-consumption facilities and those generating less than 5 MW.

3.2.3. Access and connection

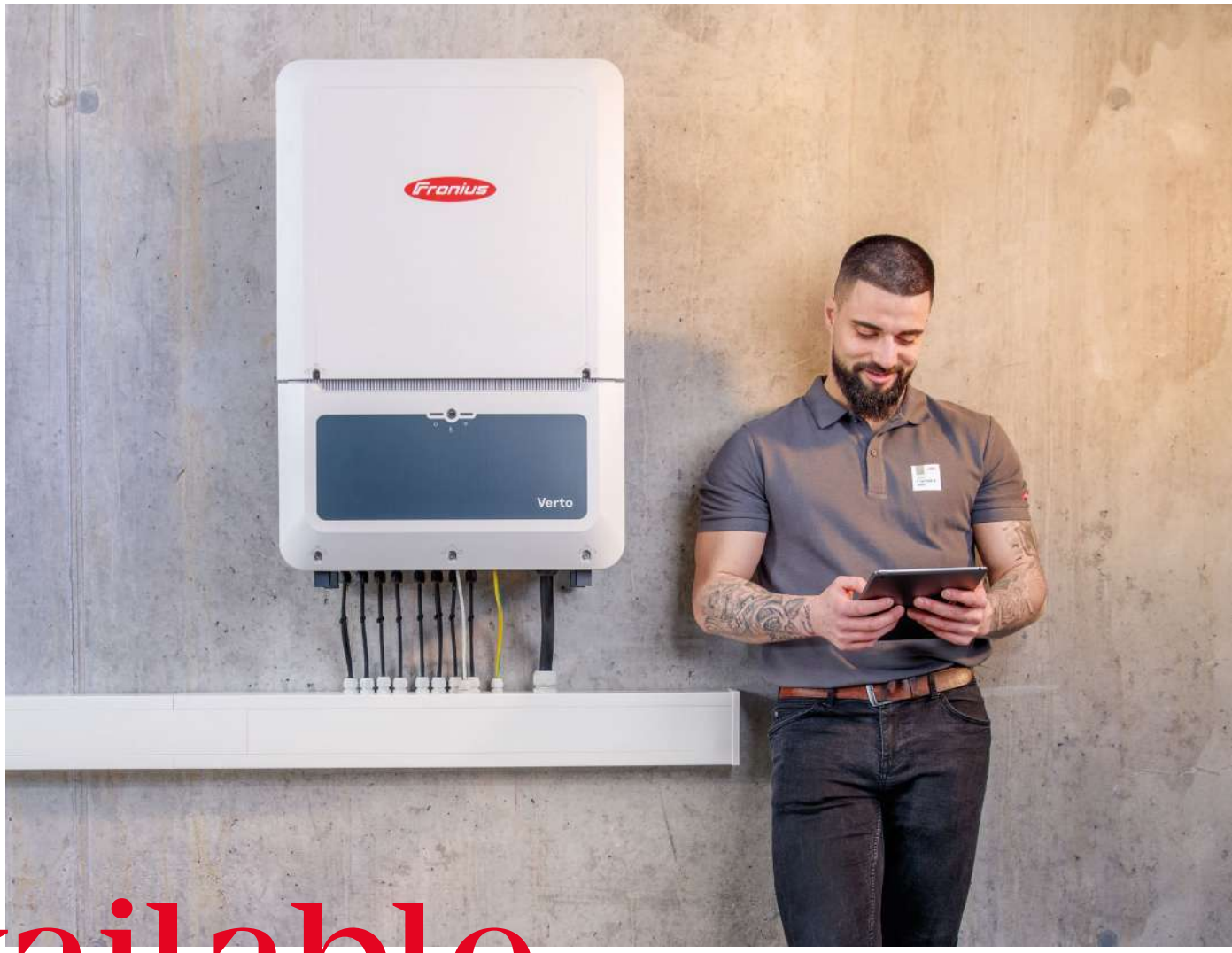
CNMC Proposal for a Circular on Electricity Demand

In May 2023, the National Securities Market Commission (CNMC) introduced a draft Circular on electricity demand. This proposal laid the groundwork for defining the **methodology and conditions for access and connection to the transmission and distribution grids for electricity demand facilities**. Highly anticipated across the sector, the proposal was revised in January 2024. The draft serves as a framework for enabling consumers and operators of distribution facilities to access the transmission and distribution networks.

The new draft outlines that there may be different types of access capacity: firm or flexible. It also requires the grid operator to consult with the upstream operator to assess access capacity. For flexible access, the capacity study must demonstrate that the demand facility can be expected to consume electricity for at least a minimum percentage of hours annually, as determined by a CNMC resolution. Proposals should incorporate specific technical and economic conditions, detailed within the framework.

The draft **strongly emphasises transparency**, suggesting the creation of a web platform to handle demand requests. This platform would distinguish between requests from downstream distributors and streamline the management of grid access applications for self-consumption and electric vehicle charging infrastructure. Additionally,

Fronius Verto



Available now

Make all your PV dreams come true: Maximum safety, optimized yields, and flexibility for every roof. Fronius Verto, the adaptable inverter for small businesses, agricultural applications, and apartment buildings, is now available in power categories 25, 27, 30, and 33.3 kW.

Fronius Verto. Designed to transform.

www.fronius.com/verto-en

the transparency measures include publishing the granting of permits for demand facilities and requiring grid operators to disclose information about network node access capacity.

Order updating remuneration parameters 2023-2025

At the end of June 2023, an order was published updating the **remuneration parameters for standard installations using renewable energy sources, cogeneration and waste**. These parameters apply to the regulatory half-period from 1 January 2023 to 31 December 2025.

The estimated electricity market prices for this period are calculated as the arithmetic mean of the annual futures contract prices traded on the electricity futures market organised by OMIP between 1 January and 31 May 2023. For **2024, the estimated market price is €108.86/MWh**, while for 2025, it is €89.37/Mwh. The 2025 figure will also be used for the years 2026 and beyond.

Figure 12. Estimated prices for the following half-years

Market price(E/MWh)	Draft	Final Proposals	Diff.
2023	207.88	109.31	-47.4%
2024	129.66	108.86	-16%
2025	78.19	89.37	14.3%
2025 onwards	78.19	89.37	14.3%

Source: UNEF

For 2023, there is a 47.4% reduction in the market prices considered, which directly improves Return on Investment (Ri) and Return on Operation (Ro) compared to the initial proposal.

Starting from 2023, and following the regulatory framework set out in RD 413/2014, remuneration is adjusted in the subsequent half-period due to the discrepancy between actual and estimated prices. However, the adjustment value for deviations will be based on the weighted average of a basket of electricity market prices, taking into account the average prices of annual, quarterly and monthly futures, rather than relying solely on daily market prices. In 2023, market prices will account for 75% of the calculation.

For photovoltaic systems, the estimated capacity factor coefficients for 2023 and beyond have been reduced by 8.32%, from the previous value of 1.0036 to the current 0.9201.

Figure 13. Capacity factor coefficient

Capacity factor coefficient			
2020	**2021**	**2022**	**Mean**
0.9555	0.9069	0.8979	0.9201

Source: UNEF

Regarding operating costs, this order does not include the Tax on the Value of Electricity Production (IVPEE) as a cost for 2023. This tax will be incorporated from 2024 onwards. Additionally, the order has introduced the cost of financing the subsidised rate as a system expense, set at €1.294768/MWh, for entities engaged in production activities.

Order TED 353/2024: Modification of calculation of upper and lower annual limits in the VADPM

Order TED 353/2024 addresses the issue related to the upper and lower annual limits. The order revises the methodology for calculating the adjustment value for deviations from market prices, as established by the previous Order TED 741/2023.

For determining the adjustment value, the order specifies the use of upper and lower annual limits tailored to each technology. These are calculated by multiplying the general limits listed in the following table by the corresponding estimated capacity factor coefficients for each year.

Figure 14. Overall annual upper and lower limits

	OVERALL ANNUAL UPPER AND LOWER LIMITS			
	2023	2024	2025	2026 onwards
UL2 (€/MWh)	117.12	116.67	97.18	97.18
UL1 (€/MWh)	113.22	112.77	93.28	93.28
Estimated Market Price (€/MWh)	109.31	108.86	89.37	89.37
LL1(€/MWh)	105.4	104.95	85.46	85.46
LL2(€/MWh)	101.5	101.05	81.56	81.56

Source: Order TED/741/2023

Order on Tolls for 2024

In December 2023, the National Securities Market Commission published a resolution that sets the access tolls for electricity transmission and distribution networks, effective from 1 January 2024.

With regard to the remuneration of **tolls** for 2024, based on the methodologies of Circulars 5/2019 and 6/2019, it establishes:

- **Contracted Power Charges:** The values for contracted power charges have been adjusted, with some periods and tariffs seeing reductions (such as periods 2 and 6), while others experience increases (like periods 1 and 3).
- **Energy Charges:** There has been a reduction in energy charges during certain periods (periods 2 and 6), with a general increase in others.

ORDER TED/353/2024 SET THE OPERATIONAL REMUNERATION VALUES FOR THE SECOND HALF OF 2023.

- **Self-consumers and Generators:** Specific pricing has been defined for energy drawn from the grid and for self-consumption.

- **Electric Vehicles:** Detailed charges have been outlined for the contracted power and energy terms related to electric vehicle charging points, for both low and medium voltage connections.

Regarding **charges**, the order extends the charges and capacity payments from the 2023 financial year. It specifies that the charges set out in Order TED/1312/2022 will remain in force until new charges are approved. The order also includes specific charges for electric vehicle charging points, aligning tariffs with the evolving realities of the electricity market.

JUST TRANSITION TENDER

The Ministry for Ecological Transition and the Demographic Challenge, via the Institute for Just Transition (ITJ), has initiated public consultations for several tenders aimed at facilitating a just transition in Spain. These tenders aim to allocate grid access rights to renewable energy projects in regions impacted by the closure of coal-fired power stations.

Lancha Just Transition Node

In June 2023, a pre-consultation was launched to establish the access procedure for the **Lancha Just Transition Node** at 220 kV, situated in the Puente Nuevo-Valle del Guadiato area, which has been affected by the closure of the Puente Nuevo power plant in Espiel (Córdoba).

The consultation intended to benefit eleven municipalities in the province of Córdoba, which are included in the Puente Nuevo-Valle del Guadiato Just Transition Agreement: Belmez, Los Blázquez, Espiel, Fuente Obejuna, La Granjuela, Obejo, Peñarroya-Pueblonuevo, Valsequillo, Villaharta, Villanueva del Rey and Villaviciosa de Córdoba.

The award criteria focused on delivering local **socio-economic benefits**, considering factors such as job creation, promotion of female employment, training for the unemployed and the involvement of local investors in the generation project. The criteria also included the promotion of self-consumption and support for local industrial, agricultural or social initiatives. Projects that minimise **environmental impact** will be given priority.

Order TED/345/2024: Allocation of access capacity in certain just transition nodes

THE PUBLIC CONSULTATION FOR THE CHA FAIR TRANSITION NODE FOCUSED ON CREATING LOCAL JOBS AND PROMOTING SELF-CONSUMPTION.

In April 2024, Order TED/345/2024, dated 9 April, was published in the Official State Gazette (BOE). This order regulates the procedures and requirements for **granting access capacity** to the electricity transmission grid for **synchronous electricity generation modules from renewable sources and synchronous storage facilities** at the **Garoña** 220 kV, **Guardo** 220 kV, **Lada** 400 kV, **Mudéjar** 400 kV and

Robla 400 kV just transition nodes.

The aim of the order is to maximise renewable energy installation potential while delivering socio-economic benefits to the affected municipalities involved in Just Transition initiatives. The municipalities and associated agreements are as follows:

- Garoña 220kV: Garoña Just Transition Agreement
- Guardo 220kV: Guardo-Velilla Just Transition Agreement
- Lada 400kV: Just Transition Agreements for the Valle Caudal-Aboño and Valle del Nalón
- Mudéjar 400kV: Aragón Just Transition Agreement
- Robla 400kV: Just Transition Agreement for Montaña Central Leonesa-La Robla

The primary criteria for prioritising access and connection permits were based on the order of application, alongside considerations of the technical and legal capacities of the applicants.

This order specified that applications must involve **facilities comprising synchronous power generating modules (SPGM) or synchronous storage systems. It excluded power park modules (PPM) equipped with synchronous compensators or those that mimic the behaviour of SPGMs**. The modules were required to be part of power generation installations utilising renewable energy sources as their primary energy. In addition, the installations needed to be situated within the municipalities specified in the Just Transition Agreements, allowing for up to 20% of the area to extend into adjacent municipalities.

Regarding socio-economic commitments, the Order specified that applications must include pledges in three areas: **promoting energy self-consumption** (at least 2 kW per MW requested), **providing professional retraining for local residents** (at least 1 recipient per MW, with a minimum of 100 hours of training), and **creating employment** (at least 1 full-time equivalent job per MW requested, in activities related to installation operation and maintenance and other local sectors).

ORDER TED/345/2024, WHICH REGULATES THE ALLOCATION OF ACCESS CAPACITY IN FAIR TRANSITION NODES, REQUIRED A GUARANTEE OF €120/KW INSTALLED TO ENSURE SOCIO-ECONOMIC COMMITMENTS.

Additionally, applicants were required to provide a **guarantee of €120/kW installed** to ensure that they meet their socio-economic development commitments. Notably, the Order stated that permit expiry would not result in the loss of this guarantee if the commitments are honoured.

New Detailed Specifications for Access and Connection for Electricity Generation

On 5 July, the Official State Gazette published new **"detailed specifications for determining the access capacity of generation to the transmission and distribution networks"**.

These rules govern how the **TSO (Electricity Grid) and DSOs (electricity distributors)** calculate the **access capacity** of nodes on the transmission and distribution grids. The guidelines for **granting or denying network access permits are also specified**.

Among the key updates are **changes to accommodate** utility-scale **storage**, **clearer guidelines concerning synchronous compensators** and the introduction of several well-established sector concepts. Additionally, the regulation now includes **less conservative and more realistic rules for simulating and determining access capacities**.

It is anticipated that this new regulation will release additional access capacity for generation.

The main changes introduced are as follows:

- Both Distribution System Operators (DSOs) and the Transmission System Operator (TSO) will be required to publish **information on available and denied access capacity**, as detailed in Article 12 of CNMC Circular 1/2021 dated 20 January, **by 8:00 am on 2 December 2024**.
- F**rom 8:00 am on 2 December 2024, specific studies** to determine access capacity must be conducted **in accordance with the annexes of this new resolution**.

Regarding the transmission grid:

- When assessing whether **an installation significantly impacts** the transmission grid, access capacity will now be considered rather than the installed power, which was used previously.
- A new concept is introduced: the **"Operational Profile** of Installations **for the Static Behaviour Criterion** in the Transmission Grid." This is defined as the pattern of power injection and/or absorption into the grid, based on statistical data, whether derived from market conditions or resource availability. This profile is utilised in study scenarios to apply the static behaviour criterion. In simpler terms, installation statistical behavioural patterns will be used to calculate the static criterion in the transmission grid. **This approach is particularly important for storage and photovoltaic systems as they generate power in very specific patterns**.
- The introduction of the **"Reference Scenario"** concept refers to the target scenario outlined in the integrated National Energy and Climate Plan (NECP).
- The concept of an **"Operating Scenario"** has been introduced, relating to the target scenario of the integrated National Energy and Climate Plan (NECP). This is defined as "the pattern of power injection and/or absorption into the grid, based on statistical data, whether derived from market conditions or resource availability. This profile is utilised in study scenarios to apply the static behaviour criterion".
- Additionally, the term **"curtailment"** is introduced, referring to energy that is not fed into the grid to ensure the system operates safely. The definition specifically excludes any unmatched energy.

- The provision that previously classified installations unable to operate by consuming and/or injecting energy into the grid as part of the Power Generating Module equipment has been removed.
- The regulation now allows the **TSO to request additional information and simulation models from storage facility operators**. These models must represent the behaviour of the storage facilities and are necessary for conducting transient stability and electromagnetic transient studies. This requirement was already in place for generation facility operators.
- The requirement for facilities with technical specificities to provide the Resolution acknowledging the exception by the competent authority, as set out in Article 62 of Regulation (EU) 2016/631, has been removed. Access requests can now be considered without needing this authorisation.
- It is specified that when **incorporating synchronous compensators (SC)** to connect to the grid, the 'effective three-phase short-circuit power' provided by the installation must be at least equal to or greater than what was evaluated when granting the access permit.

  Moreover, the SC should not negatively affect the system's oscillatory stability.

  Hybridisation with synchronous storage that can operate with synchronous compensators (SC) or generators can be considered for the purpose of assessing access capacity according to the short-circuit criterion. However, power electronics equipment will not be classified as SC for access capacity assessments. Gridforming Power Park Modules might receive special treatment once regulations defining the gridforming concept and its requirements are established.

  If access requests involving SC impact the system's operation, the TSO will publish a list of nodes where this occurs. This will either cancel or limit the available capacity for SC.

  When a PPM with SC is connected to the distribution network and significantly affects the transmission network, the same conditions and considerations will apply as PPM with SC connection requests to the transmission network.

- The **Automatic Power Reduction System (APRS) will now be factored into the calculation of access capacity based on static behaviour**; previously, its consideration was optional.
- When **defining the static criterion, the simulation process will be characterised by demand values**, installed generation and storage capacity, and their hourly operational profiles. These operational profiles will be determined based on resource availability, market criteria and system optimisation results, all aligned with the reference scenario used during the planning process or any updates that follow. Selected cases will be representative of operations over an entire year.
- The previous requirement for access capacity to ensure a 90% injection rate is removed. Instead, it now relies on:
  - **Ensuring, at global system level, a maximum energy curtailment of 5%**, which theoretically corresponds to a 90% probability of renewable energy injection.

- Allowing generation to be dispatched in the analysed cases with an estimated 90% probability. This shifts from a guarantee to an estimation. For storage facilities, this figure may be further reduced to an estimated 70% probability. In the future, the 90% target may be adjusted to remain consistent with the overall 5% curtailment.

Concerning the distribution network,

- The term **"Access capacity at a connection point to the distribution network"** is introduced. It is defined as: "The maximum active power that can be injected at that point while complying with the access capacity assessment criteria outlined in Circular 1/2021, these Detailed Specifications and applicable regulations."

- The term **"Access capacity at a connection point to the distribution network"** is introduced. It is defined as: "the contribution factor of a node i on a branch j (such as a line or transformer) is defined as the increase in flow in branch j relative to the increase in generation at node i."

- The concept of **"Direct Impact"** is introduced and defined as follows: "In a given study scenario (section 3.2), a node is considered to be directly impacted by a zonal constraint on a branch of the distribution network when the Contribution Factor of that node on the limiting branch exceeds a 10% threshold."

- Additionally, any application to a different distribution network connected to the first one, which does not meet the criteria outlined in Annex III of Circular 1/2021, will not be considered directly impacted by a limitation in the distribution network for the purpose of determining the need for the corresponding acceptability report.

- For **storage facilities, access capacity assessments will be conducted based on studies** that consider criteria relevant to both demand and generation conditions. These studies will **account for the operational regime of the facilities, particularly their typical patterns of injecting and/or absorbing power from the grid**.

- The **DSO may implement as many systems as necessary** to optimise network capacity and promote **greater integration of generation and storage**.

- In access capacity determination studies, **applications for access and connection permits that have priority over the application under evaluation will be considered**, in accordance with the criteria outlined in Royal Decree 1183/2020, of 29 December.

- The **CNMC will establish specific standards for storage facilities through a resolution**.

- Regarding access capacity **during unavailability in interconnected networks with effective support (N-1), the evaluation of an application may incorporate a reasonableness criterion, allowing a certain level of overload that does not exceed a specified number of hours annually**. More specifically:

  - Applications may be approved in the N-1 scenario if they

result in no more than a 1% increase in saturation of the network elements that are directly impacted, at a voltage level higher than their connection point, provided the estimated hours of overload above 100% do not exceed 2% of the total hours in a year.

- Requests may also be accepted if the worst-case N-1 scenario could see a maximum saturation threshold of 120%.

This is in line with Article 7 of Royal Decree 413/2014, dated 6 June.

- When **evaluating access capacity for power park modules (PPM) based on short-circuit power**, **applications for access and connection permits with priority over the one being assessed will be considered**. It is important to note that in the distribution network, WS CR equals SCR.

- Furthermore, in cases involving SC, access depends on the final solution being equal to or better than the one evaluated.

- For **assessing access capacity by the maximum power injection at a given point, applications for access and connection permits with priority** over the one being evaluated will also be considered.

- Regarding capacity maps:

  - Each **distribution company may publish nodes marked as '0* MW'**, indicating nodes without current capacity at the time of the capacity map's publication. However, these nodes could **potentially gain capacity, contingent upon the applicant funding reinforcements in the distribution network**.

  - **Capacity maps will be updated at least once a month** and will include, among other details, an identification of nodes limited by short-circuit capacity (Scc). These are the only nodes where a Synchronous Compensator could enhance capacity.

  - The published information reflects the values at the time of the system operator's capacity calculation.

  - Capacities shown on the maps are intended for information purposes only.

  - Due to the interdependence of nodes within the distribution network, the **total available capacity for an area (comprising multiple nodes) should not be viewed as the sum total of individual node capacities**. Similarly, the available capacity at a substation should not be calculated by simply adding the capacities published at its various voltage levels.

Other developments related to the electricity grid:

Royal Decree 314/2023, enacted on 25 April, sets out the procedures and requirements for granting administrative authorisation for **closed electricity distribution networks**.

This decree defines a "network" as the **distribution of electricity to industrial consumers within an industrial area not exceeding 8 km², using its own distribution infrastructure**. Applicants for these networks must meet at least one of the following criteria: provide a technical or safety report concerning the operation or production processes of the network's connected users, prepared by an independent third party and accounting for at least 50% of the network's total annual consumption; or primarily distribute electricity to the network's owner or manager or their associated companies.

Furthermore, **these networks cannot interconnect with one another** but can only connect with electricity distribution or transmission companies and the consumers linked to their networks. Networks may connect to one or more points within transmission or distribution networks. However, if the network connects at multiple points, these must be at the same voltage level and managed by the same transmission or distribution company.

Companies seeking authorisation to operate as grid operators must provide certifications verifying their legal, technical and financial capacity. This entails that these companies must have the sole corporate purpose of distributing electricity through a grid. They must also submit a document demonstrating the estimated useful and residual life of their assets, as well as proof of ownership of a minimum amount of tangible fixed assets.

Additionally, they must possess the necessary administrative authorisations for the grid installations they own. Lastly, they must secure authorisation from the Directorate General for Energy Policy and Mines within the Ministry for Ecological Transition and the Demographic Challenge to function as a grid operator.

To establish a network, **authorisation** must be obtained from the Directorate General for Energy Policy and Mines within the Ministry for Ecological Transition and the Demographic Challenge.

The Royal Decree allows for a maximum of 100 non-industrial consumers to connect to a closed distribution network, provided they meet certain criteria: they must be in the same geographical area, have or have previously had employment or commercial relations with the network's owners or partners, or with other connected industrial consumers. Additionally, these non-industrial consumers must account for less than 2% of the network's total annual consumption and be situated on land adjacent to industrial consumers, or separated only by natural or infrastructure barriers like rivers, streams, railways or roads.

The network operator is responsible for metering connected customers and must also ensure metering at its connection points with transmission or distribution networks, paying the necessary tolls and charges. **Retail suppliers will bill customers only for energy, while the closed network operator will invoice for tolls, charges and other network-related costs.**

Other developments related to Access and Connection:

By the end of 2023, the Ministry for Ecological Transition and the Demographic Challenge (MITECO) will begin **targeted modifications** to the current Electricity Planning, aiming for a 2026 horizon, and will prepare a **new plan for the period 2025-2030**.

- The changes to the existing plan involve **64 initiatives**, with **an investment of €321 million**, designed to implement **strategic projects for the energy transition** and the industrial value chain.
- A new electricity **planning process for 2025-2030 will be launched shortly**.
- Additionally, the addendum to the **Recovery Plan includes an allocation of €931 million** to fund the planning activities.

3.3. Photovoltaic self-consumption and energy communities

The installation of **photovoltaic systems for self-consumption** has levelled off in 2023. Overall, installations have decreased by about 32% compared to 2022.

IN 2023, SPAIN INSTALLED 1,706 MW OF SELF-CONSUMPTION CAPACITY.

Factors such as the perception of low energy prices, inflation and high interest rates are believed to have impacted household finances. Additionally, delays of over two years in the disbursement of Next Generation subsidies have contributed to a slowdown in the sector.
In 2023, Spain **achieved a total of 6,955 MW in installed self-consumption capacity**.

THE REGULATORY FRAMEWORK FOR SELF-CONSUMPTION WAS ALSO STRENGTHENED IN 2023, PROVIDING GREATER CLARITY AND LEGAL CERTAINTY.

The residential sector has been the hardest hit, followed by the commercial sector, which experienced a 72% decline compared to 2022 installations.

3.3.1. Regulatory developments

This year, a Royal Decree has been enacted to strengthen the regulatory framework for self-consumption, offering greater clarity and legal certainty. Additionally, the Institute for Energy Diversification and Saving (IDAE) has published a guide on Collective Self-consumption. This guide provides information on various modalities, energy distribution, administrative procedures and connections. The guide introduces the role of the Self-consumption Manager to facilitate the management and representation of associated consumers. It is designed for both the general public and professionals and is part of the Self-consumption Roadmap to boost the deployment of renewable energy sources in Spain.

Royal Decree-Law 8/2023

Royal Decree-Law 8/2023 extended the provisions of additional provision 17 of Law 27/2014, dated 27 November, concerning Corporate Income Tax. This clause **permits the accelerated depreciation of investments made in facilities for electricity self-consumption**.

ROYAL DECREE 8/2023 ALLOWS FOR THE FREE AMORTISATION OF INVESTMENTS IN SELF-CONSUMPTION INSTALLATIONS FOR ELECTRICITY.

The decree also advanced the framework for self-consumption, especially in the industrial sector, by facilitating access and connection. It built upon the measures outlined in Article 8 of Royal Decree-Law 6/2022. This article released some of the transmission grid capacity previously reserved for access tenders, aiming to lower energy costs, enhance the competitiveness of Spanish industry and support its move towards decarbonisation. **Royal Decree 8/2023 expands the measure to include all nodes reserved since the enforcement of Royal Decree-Law 6/2022** on 29 March, as well as those that will be reserved for future tenders. In addition, to manage the allocation of new access capacity for electricity generation, the decree stipulates that any **capacity not assigned for self-consumption will revert to being reserved for tendering**, should a tender not have taken place.

Guide to collective self-consumption

In April 2024, the Institute for Energy Diversification and Saving (IDAE) released a Guide to Collective Self-consumption, focusing on the implementation and management of collective self-consumption in Spain. The guide defines collective self-consumption as per Royal Decree 244/2019 and emphasises its importance for multi-family dwellings, which account for 71.8% of all housing in Spain.

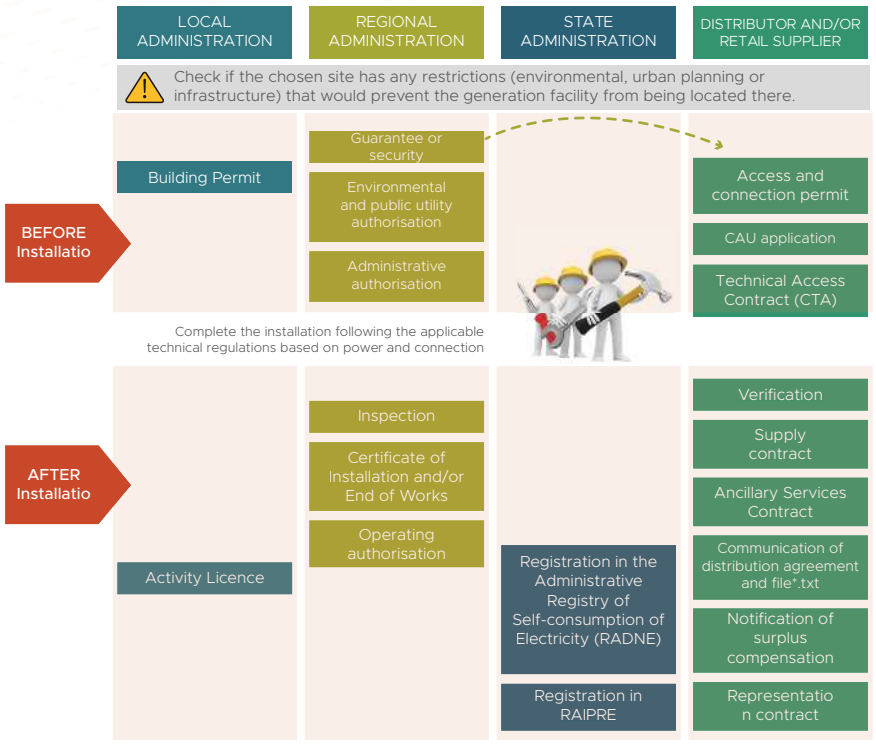
It provides an in-depth overview of every stage in the **administrative process for collective self-consumption**. This includes details on the installation design, permits and guarantees for access and connection, the application process for the Single Self-consumption Code (CAU), obtaining environmental and preliminary construction authorisations, coordination with electricity companies, energy distribution and more.

The guide outlines two models of collective self-consumption that qualify for simplified surplus compensation:

- **Without surplus eligible for compensation:** Energy generated is shared among users without being fed into the grid, but there is compensation for any energy not used immediately.
- **With surplus eligible for compensation:** Unused energy is fed back into the grid and individual consumers receive compensation.

The guide emphasises the necessity of installing metering equipment to record the system's net generation. It specifies that each consumer must maintain their own consumption meter and an additional net generation meter should be installed to measure total production.

Figure 32. Summary of the processing stages along with the bodies and entities involved



Source: Guide to Collective Self-consumption. IDAE

The guide also provides details about the role of the **Self-consumption manager**, who acts as a representative and handles all procedures related to self-consumption. This manager can be a renewable energy community or another authorised entity.

THE GUIDE TO COLLECTIVE SELF-CONSUMPTION PUBLISHED BY THE IDAE PROVIDES DETAILS ON THE VARIOUS MODALITIES, ENERGY DISTRIBUTION AND ADMINISTRATIVE PROCEDURES FOR COLLECTIVE SELF-CONSUMPTION.

Collective self-consumption systems may incorporate storage solutions, such as batteries, which are directly connected to the generation process. Stored energy is distributed among consumers following the same agreement used for the distribution of energy generated in real-time.

Regarding grid connections and requirements, the guide outlines three connection methods for collective self-consumption systems:

1. **Internal network:** Connection within the building or community's own network.
2. **Direct lines:** A direct link from the generation installation to the consumers.
3. **Through the public grid:** Using the public electricity grid, provided that certain conditions are met, such as:
   - Connection to the low voltage (LV) grid from the same transformation centre.
   - A distance of less than 500 metres between metering equipment (or up to 2,000 metres for photovoltaic systems under specific conditions).
   - Location within the same cadastral reference, with the first 14 digits matching.

3.3.2. Self-consumption and behind-the-meter storage

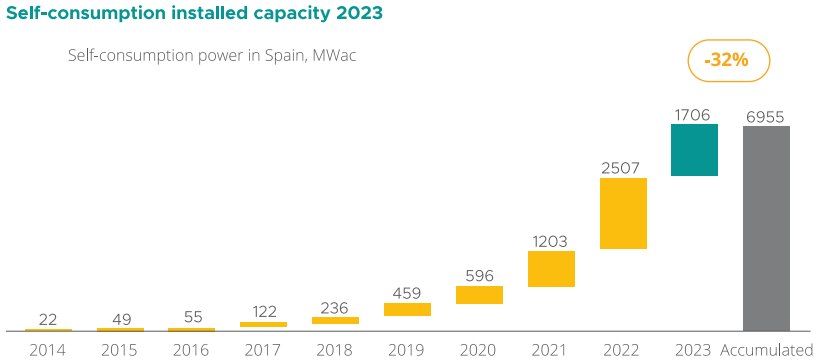
In 2023, a total of 1,706 MW of new solar power capacity was installed in self-consumption setups. This marked a slowdown compared to 2021, when 2,507 MW were installed.

THE INDUSTRIAL SEGMENT HAS ACCOUNTED FOR 60% OF NEW SELF-CONSUMPTION CAPACITY.

By the end of 2023, Spain had accumulated 6,955 MW of self-consumption capacity. Regarding sectoral distribution, the majority of new capacity in 2023 was in the industrial sector, which comprised 60% of the total. The residential sector followed with 22% of the installations and the commercial sector contributed 17% of the total capacity. Isolated self-consumption made up 1% of the total, consistent with 2022 figures.

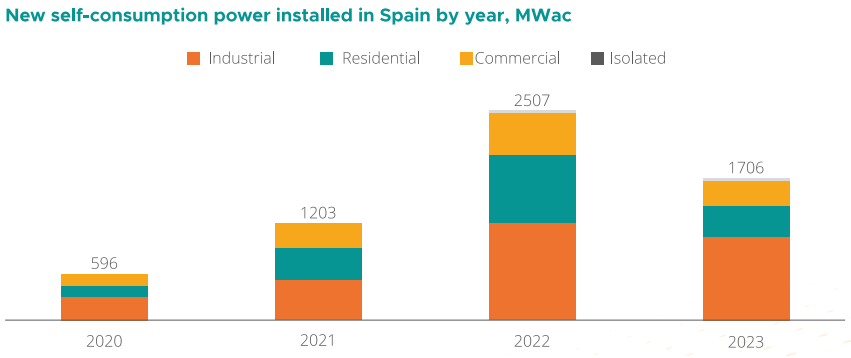
The industrial sector saw the largest increase in its share of installations in 2023, rising from 47% to 60%. This growth underscores the increasing significance of the industrial sector in the overall number of installations, continuing an upward trend for the third consecutive year.

Figure 33: Estimated installed capacity of photovoltaic self-consumption



Source: UNEF analysis

Figure 34: Segmentation of self-consumption installed capacity in 2022



Source: UNEF analysis

3.3.3. Energy Communities

In 2023, Spain fulfilled the transposition requirements of EU Directives 2018/2001 and 2019/944. Royal Decree-Law 5/2023 introduced renewable energy communities and citizen energy communities into the Spanish legal framework.

Royal Decree-Law 5/2023:

1. Royal Decree-Law 5/2023 amended Law 24/2013 on the Electricity Sector to include Citizen Energy Communities (CECs) as an entity within the sector. These are defined as "legal entities based on voluntary and open participation, effectively controlled by members who can be individuals, local authorities, including municipalities, or small businesses. The primary aim of these communities is to provide environmental, economic or social benefits to their members or the local area where they operate, rather than focusing on financial profit".

   Renewable Energy Communities (RECs) were initially introduced via RDL 23/2020. These are defined as "legal entities based on open and voluntary participation, autonomous and effectively controlled by members who are located near renewable energy projects owned and developed by these entities. The members can be individuals, SMEs or local authorities, including municipalities, and the primary aim is to deliver environmental, economic or social benefits to their members or local areas, rather than seeking financial profit".

2. An Article 12 bis has been added to the Electricity Sector Act to regulate various aspects of Renewable Energy Communities (RECs), such as:

   - End consumers have the right to join a renewable energy community while retaining their rights and obligations as consumers. They should not face any unjustified or discriminatory conditions. For private companies, participation in an REC should not become their main business or professional activity.

   - The rights of Renewable Energy Communities (RECs) include the ability to produce, consume, store and sell renewable energy, particularly through contracts for the purchase of renewable electricity. They can share the renewable energy generated by their projects within the community and access all energy markets, either directly or through demand aggregation.

   - Public administrations must ensure the following:

     - The removal of unjustified administrative barriers for RECs.
     - Cooperation from grid operators with RECs to facilitate internal energy transfer.
     - RECs are subject to fair and transparent administrative procedures, as well as network charges and relevant fees, ensuring an appropriate, fair and balanced contribution to overall system cost sharing.
     - Availability of tools to facilitate financing and access to infor-

mation.

- Provision of regulatory support for establishing RECs.
- Accessibility and participation are available to all consumers.

The support systems designed for Renewable Energy Communities (RECs) must consider their specific characteristics to enable them to compete fairly with other market participants.

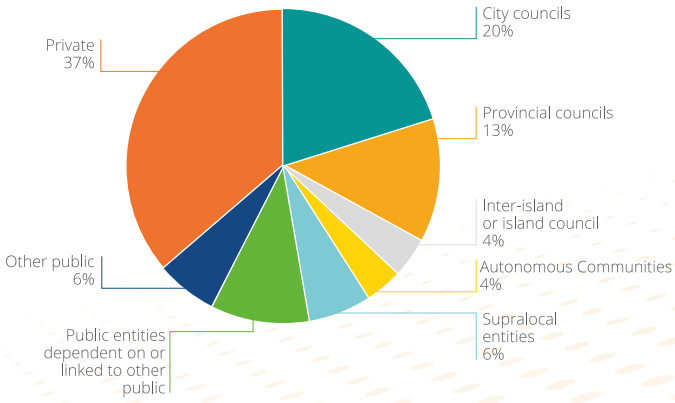
3. A new article in the Electricity Sector Act establishes a supportive legal framework for Citizen Energy Communities (CECs), ensuring:
   - Open and voluntary participation, along with the right to leave the community.
   - Access to all electricity markets, either directly or through aggregation.
   - Non-discriminatory and proportionate treatment regarding their activities, rights and obligations.
   - Fair procedures and fees, alongside transparent and non-discriminatory network access tariffs.
   - The ability for CECs to act as representatives for consumers in collective self-consumption initiatives.

Community Transformation Offices (CTOs)

In October 2022, Order TED/1021/2022 was issued, establishing the regulatory framework for **granting funding to Community Transformation Offices (CTOs)** as part of the EC Offices Programme, which aims to promote and invigorate energy communities under the Recovery, Transformation and Resilience Plan.

These non-refundable grants aim to facilitate the launch of CTOs, which will aid in the promotion and development of energy communities by creating a supportive network for stakeholders interested in such projects. CTOs will serve as physical and/or virtual spaces that provide information, advice and support for these initiatives.

Figure 35. Beneficiaries of CTOs



Source: MITECO

The first funding call, with a budget of €20 million, accepted applications from 28 November until 23 January 2023. A total of 79 projects were selected, spanning most of Spain's Autonomous Communities, except for La Rioja, Ceuta and Melilla, where no applications were received. Public entities, such as city councils, provincial councils and autonomous communities, made up 77% of the recipients. The remaining 23% consisted of organisations like SMEs, associations and social economy enterprises. Most of the funded offices are located in municipalities facing demographic challenges.

Incentive Programme for Unique Energy Community Pilot Projects (EC IMPLEMENTA Programme)

The EC Implementa Programme is part of Component 7, "Deployment and Integration of Renewable Energies" of the Recovery, Transformation and Resilience Plan for implementing the Next Generation EU funds. This grant scheme is designed to incentivise unique pilot projects within energy communities, supporting the establishment of new renewable and citizen energy communities. It encourages open and voluntary participation and aims to deliver environmental, economic and social benefits to members and local communities. These communities can produce, consume, store and sell renewable energy, as well as access all energy markets.

Support is provided through non-repayable grants, given to beneficiaries after project implementation is verified and the investment is certified. To ease project financing, up to 80% of the granted aid can be advanced to the recipient. This support is intended for energy communities that are already legally established.

Table 15. Types of action for which aid is granted

Areas of action	Description
I. Renewable electricity	This includes energy sources such as biomass, biogas and other renewable gases, as well as wind, hydro and solar photovoltaic.
II. Thermal renewable energies	This category covers energy sources like aerothermal, biomass, biogas, biomethane and other renewable gases, along with geothermal, hydrothermal and solar thermal. It also involves systems to harness these energy sources.
III. Energy efficiency	Focuses on applications that enhance the energy efficiency of thermal building envelopes.
IV. Sustainable mobility	Covers initiatives like setting up infrastructure for electric vehicle charging and acquiring plug-in electric and fuel cell vehicles for shared transport options.
V. Demand-side management	Includes behind-the-meter storage and regulation systems featuring hydro storage or other innovative solutions. These may consist of next-generation batteries or repurposing vehicle batteries (second-life batteries). It also involves aggregating thermal energy demand and implementing systems to offer demand flexibility.

Source: IDAE

The first call was launched in 2021 with an initial budget of €40 million. It attracted a higher number of applications than expected, resulting in funding for 45 projects. In 2022, the IDAE increased the budget to support additional projects. This expansion enabled the financing of more initiatives, prioritising social inclusion and the engagement of local communities. The second call for CE-Implementa targeted larger projects,

each requiring an investment of over €1 million. It concluded in September 2022, with 29 projects awarded. These involved more than 470 activities and engaged 93,000 participants, of whom 85% were individual members and 15% were SMEs and local entities. Most of the successful proposals included self-consumption facilities.

The third and fourth calls took place between 19 December 2022 and 13 February 2023. Both focused on promoting projects in renewable energy production, energy efficiency and sustainable mobility, with the option to integrate demand-side management systems like energy storage. The third call targeted smaller projects requiring investments of less than €1 million, with a budget of €10 million. In contrast, the fourth call focused on medium and large projects, each with investments exceeding €1 million, and allocated €30 million for this purpose.

3.3.4. Next Generation Grants for self-consumption and behind-the-meter storage systems

In 2021, the Council of Ministers approved the first measure under the Recovery Plan for renewable energies, through Royal Decree 477/2021, providing €660 million in **grants for self-consumption installations, behind-the-meter storage** and renewable energy-based air conditioning. These grants were **available until 31 December 2023** and were distributed across six programmes, with **an initial allocation of €450 million for self-consumption and €110 million for behind-the-meter storage**.

The original budget of **€660 million could be increased to €1,32 billion** if requested by the various Autonomous Regions. By the end of June 2024, the **budget had expanded to €2,085,964,256.50**.

Grants are divided across the following programmes:

1. **Renewable self-consumption in the services sector, with or without storage.**
2. **Renewable self-consumption in other sectors, with or without storage.**
3. **Adding storage to existing renewable self-consumption installations in the services and other sectors.**
4. **Renewable self-consumption in the residential sector, public administrations (PAs) and the tertiary sector, with or without storage.**
5. **Adding storage to existing renewable self-consumption installations in the residential sector, public administrations and the tertiary sector.**
6. Thermal renewable installations in the residential sector.

On 17 May 2022, Royal Decree 377/2022 was published, expanding the range of beneficiaries in the aid programmes to include self-employed workers in incentive programmes 1, 2 and 3. Under this decree, companies are permitted to carry out installations for individuals or oth-

er businesses in any location within these programmes. Additionally, it increases the flexibility of storage capacity installation, raising the ratio of installed storage capacity to generation power from 2 kWh/kW to 5 kWh/kW.

3.4. Historical data

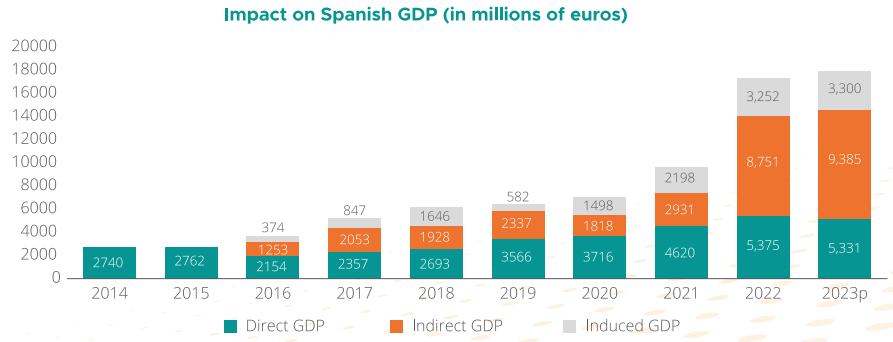
This section has been compiled using data collected and published in annual reports over the years. The historical data in this report may have margins of error due to industry growth, the number of companies surveyed, database usage and categorisation changes.

3.4.1. Economic impact of the photovoltaic industry

Over the past decade, the photovoltaic sector has progressed significantly. It has moved from isolated installations (typically for agricultural purposes) without grid access to becoming the leading technology in terms of installed capacity in Spain.

In 2014, the industry's economic impact on GDP was nearly €2.74 billion, a **figure that rose to €18.02 billion by 2023**. **This change reflects that the photovoltaic industry has doubled its size in the past two years.**

Figure 36. Historical data. Contribution of the Spanish photovoltaic sector to GDP between 2014 and 2022 (millions of euros)



Source: UCLM and UNEF

As shown in Figure 36, the most significant growth has occurred over the last two years, continuing an upward trend. In **absolute terms, the sector's contribution to the national GDP increased by 4% compared to 2022**, which was considered a peak year due to the substantial growth from the previous year.

THE ECONOMIC IMPACT OF THE INDUSTRY ON GDP HAS RISEN FROM €2.74 BILLION IN 2014 TO €18.02 BILLION IN 2023.

Nationally, since 2018, the sector has contributed over €79.49 billion to GDP, leading to **€9.49 billion in tax revenue for public finances,**

including national taxes, local taxes and national insurance contributions. This has had a substantial direct impact on tax revenues.

Figure 16: Fiscal balance (millions of euros)

	2018	2019	2020	2021	2022	2023p
TAX REVENUE						
National taxes	602.0	764	954	1320.6	1656.8	1490.0
Local taxes	22.9	112.77	110	153.6	242.4	257.9
National insurance contributions	186.0	233	237	347.5	389.5	395.2
Total tax revenue	**810.9**	**1,126**	**1,301**	**1,821.7**	**2,288.8**	**2,143.1**

Source: UCLM and UNEF

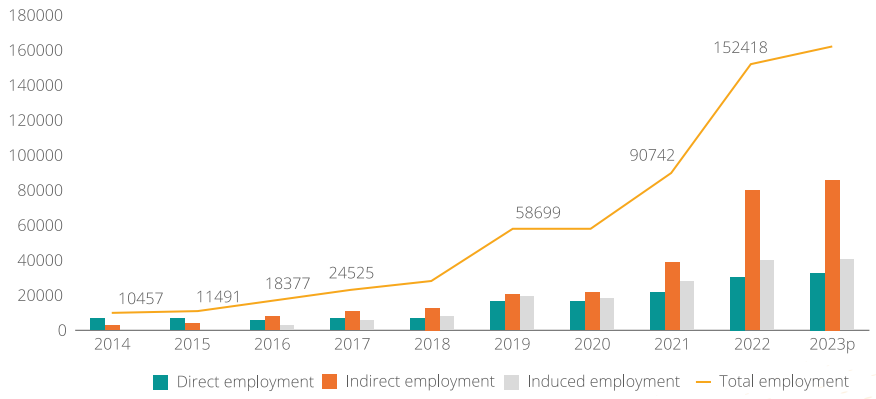
SINCE 2018, THE SECTOR HAS CONTRIBUTED OVER €79,49 BILLION TO GDP, WITH TAX REVENUES OF €9.49 BILLION TO THE PUBLIC COFFERS.

At local level, tax contributions have risen by 6% compared to 2022, bringing in €257.9 million for local administrations in 2023. This boost has enhanced the economic conditions of thousands of municipalities, fostering sustainable local development, tackling depopulation and generating wealth in rural Spain.

3.4.2. Impact of the photovoltaic industry on employment

In 2023, the entire value chain of the photovoltaic sector employed **a total of 162,396 people** through direct, indirect and induced jobs. Of these, 34,037 were directly employed by the industry, 86,968 were indirectly employed and 41,391 were employed in induced positions.

Figure 37. Historical series: Job creation trends by employment type from 2014 to 2023.



Source: UNEF

THE REMOVAL OF THE SUN TAX IN 2018 AND THE 2020 AUCTIONS WERE TURNING POINTS FOR EMPLOYMENT GROWTH, DOUBLING THE NUMBER OF WORKERS BETWEEN 2018 AND 2020.

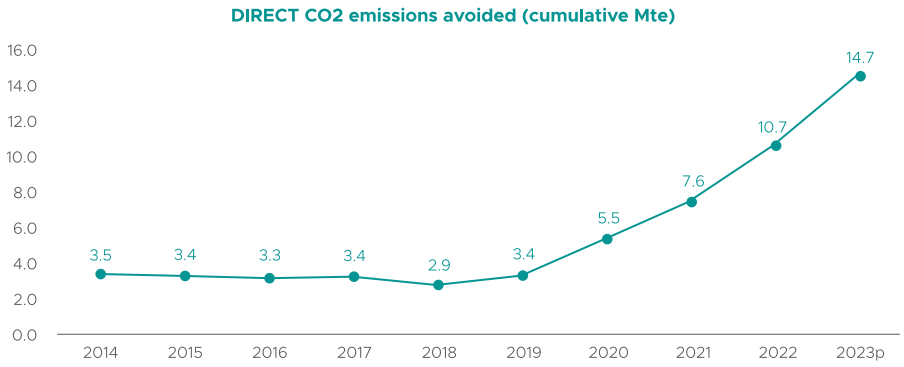
The employment trend shows two key turning points in job numbers. These coincide with the removal of the sun tax in 2018 and the initiation of auctions and administrative milestones in 2020. This highlights the significant impact of legal certainty and political planning from public institutions on job creation and industry growth.

Referring to these two turning points, the **total number of workers doubled between 2018 and 2020. By 2023, the sector reached its historical peak employment levels**.

From 2014 to 2023, the number of jobs created shows that **indirect employment** has consistently been the largest segment, boasting an average annual growth rate of 45%. In 2023, indirect employment peaked at 86,968 jobs, a 7% increase from the previous year.

THE PHOTOVOLTAIC SECTOR HAS CREATED 33,134 DIRECT JOBS SINCE 2018.

Figure 38. Direct employment in the photovoltaic sector from 2014 to 2023.



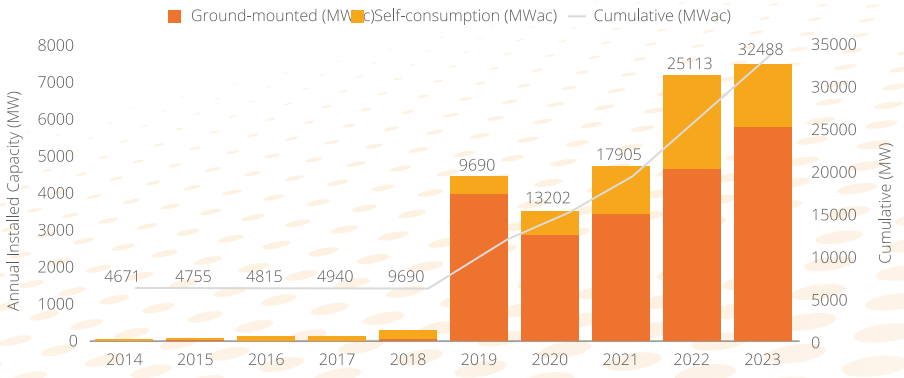
Source: UNEF

Regarding direct employment, 34,037 people were employed nationwide in 2023, marking a **9% rise compared to 2022**.

3.4.3. Development of photovoltaic solar power capacity in Spain: ground-mounted plants and self-consumption

Based on data from Red Eléctrica's website concerning the annual installed capacity of ground-mounted plants, along with UNEF's data on self-consumption, the total photovoltaic capacity **in 2023 reached 32,602 MW. This made it the leading source of generation in terms of installed capacity**.

Figure 39. Annual installed capacity between 2014 and 2023 (MW)

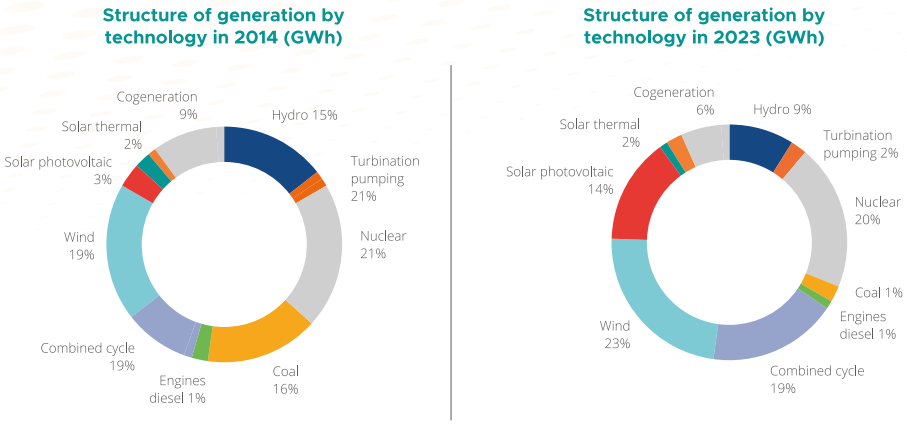


Source: UNEF and REE

BETWEEN 2018 AND 2019, THE INSTALLATION OF NEW CAPACITY INCREASED BY 84%, FROM 5,255 MW TO 9,690 MW IN A YEAR.

Figure 38 indicates that there was a stagnation in new capacity installations from 2014 to 2018. **However, between 2018 and 2019, the number of new generation installations surged by 84%**, rising from 5,255 MW to 9,690 MW in just one year. In 2023, the ground-mounted plant segment achieved a record high.

Figure 40. Generation structure by technology in 2014 and 2023 (GWh).



Source: REE

The structure of electricity generation has changed significantly since 2014. Figure 40 highlights the notable rise of solar photovoltaic technology within the current energy mix, reaching 14% of total generation in 2023. **While the proportion of solar energy has grown, the share of fossil fuels like coal has dropped** dramatically from 16% to 1%. In addition, nuclear generation has remained steady, whereas combined cycle plants have experienced a substantial increase in output, rising from 9% in 2014 to 17% in 2023.

Ground-mounted plants

By 2023, ground-mounted plants have emerged as the fastest-growing segment of the photovoltaic industry, becoming crucial to the Spanish energy mix. In 2014, solar photovoltaic energy constituted only 3% of the generation structure, but **by 2023, ground-mounted plants alone accounted for 14% of generation**.

While photovoltaic contribution to the generation structure includes both self-consumption with surpluses and ground-mounted plants, the latter have been instrumental in the energy market's entry, successfully decarbonising consumption sectors where self-consumption has not taken off.

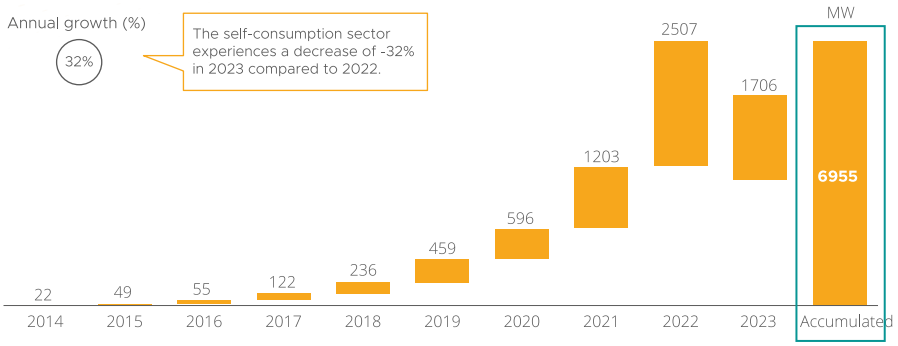
From 2014 to 2018, the installation of new ground-mounted plants was stagnant. However, **the sector experienced exponential growth from 2018 to 2023**. Since 2018, more than 27,662 MW have been installed solely as ground-mounted capacity, making up 85% of the total capacity installed to date.

Self-consumption

Following the peak in 2022, the installation of self-consumption systems has stabilised. The perception of low energy prices, coupled with

high interest rates and significant inflation, has heavily impacted household economies, leading to a notable reduction in self-consumption installations, particularly in the residential sector.

Figure 41. Increase in Spanish photovoltaic self-consumption installations (MW).



Source: UNEF

Historically, **both ground-mounted plants and self-consumption have seen gradual growth since 2018**. Although 2022 was a record year for self-consumption installations, driven by high energy prices linked to the war in Ukraine, 2023 saw a total decrease of 32% in these installations.

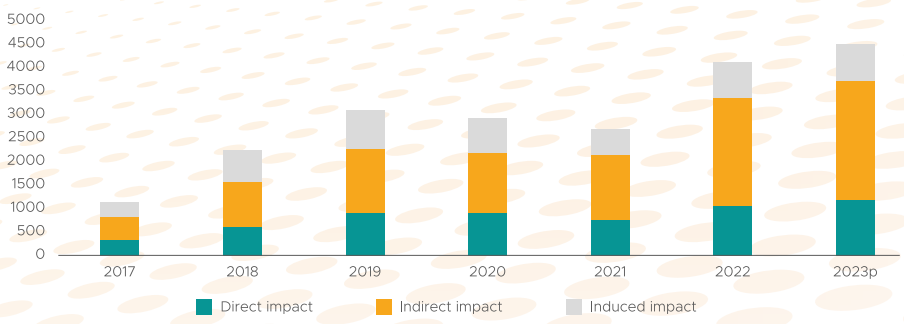
SELF-CONSUMPTION DROPPED BY 32% IN 2023 COMPARED TO 2022, DUE TO THE PERCEPTION OF LOW ENERGY PRICES AND INFLATION.

Despite lower figures compared to the previous year, **2023 still marks the second-highest number of installations on record**. Prospects for self-consumption remain positive, with anticipated gains from the electrification of industrial consumption and the development of energy communities, which are expected to expand significantly in the coming years.

3.4.4. Trade balance of the photovoltaic sector

Spain continues to maintain a positive export balance in the photovoltaic sector, as it has in recent years. In 2023, **exports set a new record, reaching €4.53 billion**. This marks the highest figure recorded, surpassing the previous record of €4.17 billion in 2022.

Figure 42. Economic impact (GDP) of exports in the Spanish photovoltaic sector in millions of euros.



Source: UNEF

Since 2017, exports have cumulatively added up to €16.42 billion to the trade balance. The most significant contribution has been from the indirect impact of exports, which totalled €7.75 billion over seven years.

SINCE 2017, EXPORTS HAVE TOTALLED €16.42 BILLION, SHOWING REMARKABLE RESILIENCE EVEN DURING THE COVID-19 CRISIS.

The historical data depicted in figure 42 shows a consistent increase in the external trade balance, with the exception of the 2020-2021 period when the Covid-19 crisis moderately affected exports. **The limited impact and swift recovery demonstrate considerable resilience in foreign markets.**

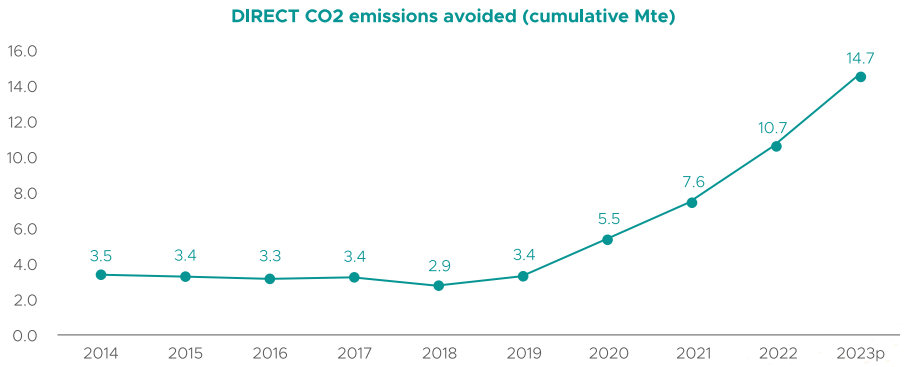
3.4.5. Environmental footprint

The path towards decarbonising the national electricity sector and reducing emissions relies on two key actions: first, promoting the integration of renewable energies into the energy mix; and second, encouraging the adoption of technological advancements to enhance energy efficiency. Solar photovoltaic energy stands out among these strategies for its capacity to meet both objectives.

THE CARBON FOOTPRINT OF PHOTOVOLTAIC PANELS IS OFFSET WITHIN 6 TO 9 MONTHS THANKS TO THE PRODUCTION OF CLEAN ENERGY.

By using renewable sources, photovoltaic plants do not directly emit greenhouse gases as they do not require fossil fuel combustion. However, assessing their environmental footprint involves considering the entire lifecycle impact of the panel. **The carbon footprint resulting from the manufacture of photovoltaic panels is offset within 6 to 9 months through the clean energy** produced by the panel itself. This comprehensive analysis, which compares and evaluates the sustainability of each generation technology, reveals that **given a panel's lifespan of 25 to 30 years, the carbon footprint of this technology is highly positive**.

Figure 43. DIRECT CO2 emissions avoided (cumulative Mte)



Source: UNEF and UCLM

Figure 43 illustrates the amount of megatonnes of CO2 equivalent avoided through production within the energy mix by replacing combined cycle generation. In **2023, the photovoltaic sector has prevented 4.699 MtCO2** equivalent thanks to the substitution of combined cycle power generation.

Cuida de tu empresa mientras cuidas del planeta

En Naturgy tenemos soluciones de autoconsumo que se ajustan a las necesidades de tu empresa y cuidan del planeta.

Venta directa | PPA onsite | Ayudas y subvenciones

¡y mucho más!

Naturgy Solar

- Estabilidad en el precio de tu energía a largo plazo.
- Servicio llave en mano para que no te preocupes por nada.
- Con el asesoramiento, garantía y seguridad del grupo Naturgy.

Infórmate:

900 799 960

naturgy.es

Escanea este QR

IN 2023, THE PHOTOVOLTAIC SECTOR PREVENTED THE EMISSION OF 4.699 MILLION TONNES OF CO2 EQUIVALENT, SIGNIFICANTLY CONTRIBUTING TO THE DECARBONISATION OF THE ENERGY MIX.

The focus of new emission reduction **challenges** lies in integrating photovoltaic energy during off-peak hours through **storage systems**. These systems not only prevent energy wastage but also enhance grid efficiency, enabling more effective demand management. Moreover, **decarbonising the economy, particularly the industrial sector**, is a significant challenge that can be **tackled through electrification**. Electrification will not only result in more competitive prices, increasing the industry's resilience and independence from external events, but it will also advance its sustainability efforts.

3.5. Outlook

In 2023, there was a notable increase in cumulative capacity, with ground-mounted plants surpassing **26,595 MW of cumulative photovoltaic capacity**. While the self-consumption sector has stabilised, it experienced a decline in annual installations compared to 2022.

A significant milestone in July 2024 led to the **authorisation of 28 GW of new renewable installations, 90% of which are photovoltaic projects**. This positions photovoltaic technology at the forefront of efforts to meet the energy targets outlined in the new draft of the integrated National Energy and Climate Plan (NECP) 2021-2030.

The approval of 24,870 MW of photovoltaic projects highlights investor confidence, project viability and the quality of the sector's proposals. This ensures sustained growth in installed capacity, which is essential for achieving the NECP objectives and securing the energy transition.

Looking ahead, **2024 is set to be a promising year for the installation of ground-mounted plants**. However, several factors may impact medium- and long-term outcomes. These include the development of storage solutions, interest rates for project financing, the electrification of the economy, the growth of the domestic component manufacturing industry and the advancement of energy communities.

The capacity growth required from the authorisation of 28 GW of ground-mounted plants underscores **the critical role of energy storage** in ensuring a decarbonised economy, stable renewable supply and flexible grids capable of managing renewable energy flows. According to the data in this report, by the end of 2023, Spain had already installed 1,878 MWh of behind-the-meter storage between 2022 and 2023. **This capacity must be rapidly expanded to meet future demands**, integrating advanced technologies such as lithium-ion batteries, thermal storage and renewable hydrogen.

The current challenges in implementing these solutions include reducing costs, boosting storage capacity and efficiently integrating them into both grid and standalone industrial and residential applications.

Spain must expedite the **electrification of its economy** to meet national and European decarbonisation targets within the set deadlines. Electrifying key sectors such as transport, residential heating and industrial processes is crucial for transitioning from an energy model reliant on foreign fossil fuels to one based on domestic renewable sources.

BY THE END OF 2023, SPAIN HAD INSTALLED 1,878 MWH OF BEHIND-THE-METER STORAGE BETWEEN 2022 AND 2023.

By **November 2023, cumulative renewable energy generation had already surpassed the total output of 2022**. However, advancing electrification demands significant investment in infrastructure and technology, alongside policies that promote the adoption of sustainable electrical solutions.

In 2023, the energy balance showed that fossil fuels still accounted for a large portion of energy consumption, particularly in sectors such as transport (80% oil) and industry (57% natural gas). Electrifying these sectors not only has the potential to reduce greenhouse gas emissions and improve energy efficiency, but it also **presents an opportunity to achieve energy sovereignty**.

Developing a **domestic manufacturing industry** for photovoltaic components is crucial for reducing dependency on imports, bolstering the local economy and creating jobs. The Net-Zero Industrial Act, an initiative from the Green Deal Industrial Plan, aims to enhance the EU's capacity to manufacture technologies that facilitate the transition.

Spain has a significant opportunity to attract strategic investments in domestic manufacturing, strengthen the renewable technology component value chain and ensure energy security by increasing competitiveness. **The challenge lies in making the most of the Temporary Crisis and Transition Framework adopted by the European Commission** in March 2023.

WE NEED TO CAPITALISE ON THE COMMISSION'S TEMPORARY CRISIS AND TRANSITION PERIOD TO ENHANCE DOMESTIC MANUFACTURING OF PHOTOVOLTAIC COMPONENTS.

Currently, Spain is bolstering its strategic autonomy through aid programmes and initiatives designed to **stimulate the national manufacturing industry**. Supportive policies will play a crucial role in encouraging investment in domestic technology and manufacturing.

The sector also has significant opportunities in the form of **collective self-consumption**, allowing communities and consumer groups to share photovoltaic installations, with particularly notable potential in the **rise of energy communities**. These models lower individual costs, improve access to solar energy and encourage community participation. They provide frameworks for citizens and small businesses to generate, use, store and sell renewable energy.

In the coming years, energy communities are expected to experience significant growth due to legislative progress, the adoption of European directives and the establishment of new **Community Transformation Offices** aimed at facilitating the development of Energy Communities nationwide.

Nonetheless, there are serious challenges that could disrupt the en-

ergy transition, such as retroactive taxes in Aragon, moratoriums and halted projects in La Rioja, storage barriers in Asturias, and restrictions on free enterprise in the Canary Islands and Catalonia. Despite these obstacles, the future looks promising, driven by the ambitious targets of the NECP, a growing pipeline of projects and the increasing importance of collective self-consumption and energy communities.

4

STORAGE AND HYDROGEN

4.1. International Framework

Storage is crucial for the expansion of renewable energy, providing stability and flexibility to its generation, and reducing dependence on the time of day and seasonal variations. At residential level, a storage system gives consumers more autonomy in how they use the energy they produce, allowing them to engage with the energy market.

Storage systems play a key role in both on-site and self-consumption setups. They enable the production of low-cost energy, which can be stored and used later when generation costs are higher. Additionally, they **help support power plants during peak demand periods or, when production exceeds demand, they prevent bottlenecks when feeding energy into the grid**. Furthermore, these systems can reduce grid congestion at times of high consumption, thereby minimising the need for grid expansion and reinforcement.

Lithium-ion batteries are among the most widely marketed technologies.

These **batteries** are known for their low weight, which translates to a very high energy density, typically ranging from 75 to 250 Wh/kg. They have a lifespan of roughly 4,000 to 10,000 cycles and a high depth of discharge, making them more efficient. Within the category of lithium-ion batteries, LFP (Lithium iron phosphate) batteries stand out with an energy density of 325 Wh/kg, while NMC (Nickel manganese cobalt/aluminium) and NCA (Nickel cobalt aluminium) batteries reach 255 Wh/kg and 250-300 Wh/kg, respectively. The former is often used for large-scale applications, whereas the latter is suited for residential use.

The chemistry of these batteries is linked to different characteristics and plays a crucial role in determining their suitability for various applications. Generally, LFP chemistries are preferred for electrical applications for several reasons. Firstly, they are more cost-effective as they do not require nickel or cobalt. Additionally, they are safer due to their less volatile reaction in the event of combustion. Furthermore, the primary disadvantage of LFP batteries—their lower energy density compared to NMC batteries—is not an issue for stationary electrical applications, as these batteries do not need to be moved during their lifespan.

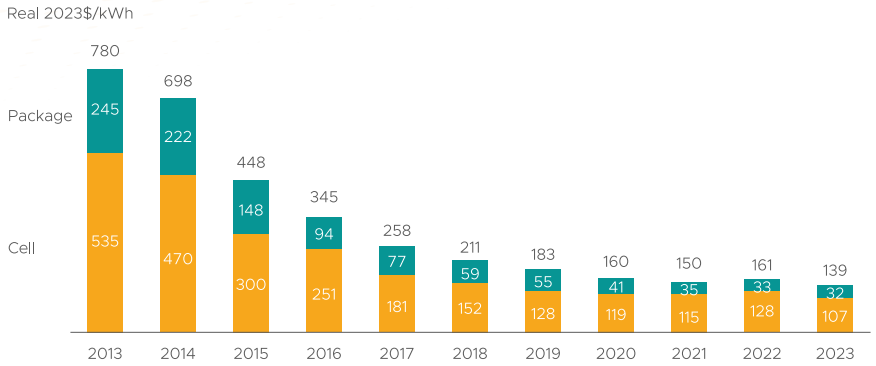
In this context, sodium-ion batteries also present an attractive option. Although they have lower energy density, this is not a disadvantage and they offer reduced costs since sodium is more abundant and accessible than lithium.

4.1.1. Energy storage in 2023: prices

IN 2023, LITHIUM-ION BATTERIES SAW A DROP IN PRICES.

Lithium-ion battery prices have steadily decreased over the years, with the exception of a rise in 2022. According to BloombergNEF, the price of a lithium-ion battery pack in 2023 is about $139/kWh. At present, the cost of lithium-ion and lead-acid batteries is comparable, ranging from €100 to €200/kWh.

Figure 44: Lithium-ion battery prices, 2013-2023



Source: BloombergNEF. Historical prices have been updated to reflect actual 2023 dollars. The weighted average value of the survey includes 303 data points for passenger cars, buses, commercial vehicles and stationary storage.

Source: BloombergNEF

4.1.2. Energy storage in 2023: installed capacity

By 2023, **China** has established 32 GW of storage systems, 97% lithium-ion batteries.[1] The current five-year plan (2021-25) aims to reduce the unit cost of storage by 30% by 2025 for new storage technologies. In **August 2023, China announced new restrictions on graphite exports in response to measures by the US and EU** aimed at reducing reliance on exports of essential battery materials from China.

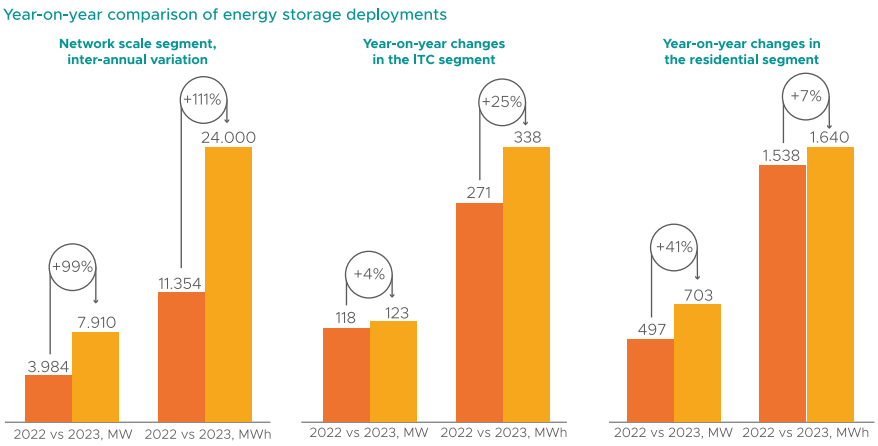
In **Latin America**, Chile[2] has been encouraging energy storage, announcing earlier this year a $2 million allocation for large-scale storage auctions. In March 2024, a lithium-ion battery farm with a capacity of 139 MW was commissioned to store energy generated by a photovoltaic farm. In October 2023, Brazil initiated a public consultation on storage regulation.

In 2023, the **US** installed 8.7 GW of storage capacity, marking a 90% increase from the 4.6 GW installed in 2022. This includes 7.91 GW of large-scale storage, 123 MW for industrial and commercial use and 703 MW for residential storage. The increase in installed capacity occurred predominantly in the latter half of the year, driven by the reduction in

1. https://english.www.gov.cn/news/202402/14/content_WS65ccbff1c6 0868f4e8e405c.html#:~:text=-The%20country's%20installed%20new%2Dtype,National%20Energy%20Administration%20(NEA).
2. https://tamarindo.global/articles/chile-a-showcase-for-storage-and-the-energy-transition/

lithium-ion battery prices and measures implemented by the IRA concerning storage. These measures include tax incentives for self-consumption storage projects (Standalone storage investment tax credit) and manufacturing (Advanced manufacturing tax credit 45X).

Figure 46: Annual growth of storage capacity in the US, 2022-2023.



Source: PVmagazine

4.2. European Framework

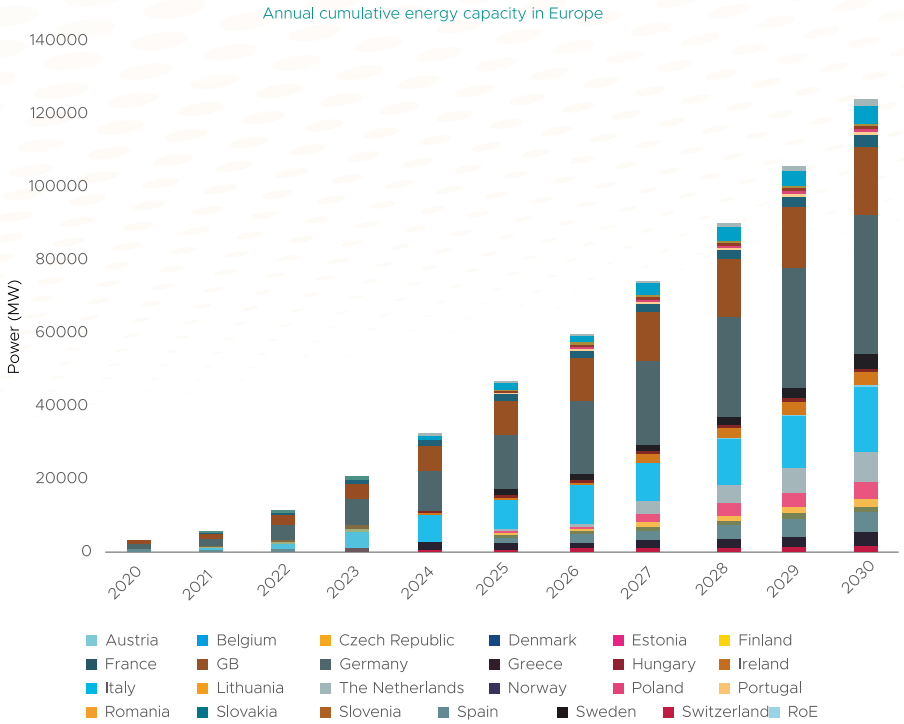
In 2023, **Europe** installed nearly 10 GW of energy storage capacity, more than twice the amount installed in 2022 (4.5 GW). Of this, 2.7 GW is from front-of-meter installations and 7.2 GW is from behind-the-meter installations.

The UK reached a cumulative capacity of 3.5 GW in 2023, marking a 40% increase compared to 2022.[3] Germany installed over 500,000 battery systems for residential use. Italy's[4] Energy Plan sets a target to achieve 6 GW of storage capacity by 2030 and to work towards this goal, 1.1 GW was installed in the residential sector in 2023.

3. https://modoenergy.com/research/modo-battery-energy-storage-year-review-2023-capacity-revenues-frequency-response

4. https://www.pacificgreen.com/articles/keys-italys-runaway-energy-storage-demand/

Figure 47: Annual cumulative storage capacity in Europe, 2020-2030.



Source: Energías Renovables

4.2.1. European regulation

In March 2023, the European Commission adopted a set of **Recommendations on energy storage**. These recommendations remind Member States of the dual role of storage—both production and consumption—within the regulatory framework and propose ending double taxation. They urge nations to incorporate measures for storage development in their national energy and climate plans and to define both regulatory and non-regulatory actions to address the barriers facing this technology.

THE EU HAS RECOMMENDED ENDING DOUBLE TAXATION ON STORAGE FACILITIES.

The electricity market design includes a definition of energy storage and its various technologies, **promoting their active participation in the market**.

The **European Critical Raw Materials Act**, announced in March 2023, sets minimum levels for using European-origin strategic raw materials in extraction, processing and recycling by 2030. The 2023 list of strategic raw materials intended exclusively for batteries includes lithium, manganese, graphite and nickel. By requiring a substantial portion of these raw materials to be sourced within Europe, this measure aims to strengthen the battery value chain across the continent.

In March 2023, the **Energy Storage Coalition** was announced. The organisation promotes the creation of a financial, legal and political frame-

work to enhance the attractiveness of investment in this technology, supporting its development and growth.

The new **Regulation (EU) 2023/1542**, issued by the European Parliament and the Council on 12 July 2023, **governs batteries and their waste**, encouraging a more sustainable and secure lifecycle. This marks a significant step forward in regulating the entire lifecycle of batteries, focusing on safety, sustainability and competitiveness. Within this framework, specific regulations have been established for industrial batteries with a capacity exceeding 2 kWh.[1] Starting in 2027, these industrial batteries, whether placed on the market or put into service from 2027 onwards, will be required to have a digital passport.

Additionally, from 2026, it will be compulsory for these batteries to have a carbon footprint declaration. This measure is intended to increase transparency and promote the reduction of greenhouse gas emissions linked to the production and use of batteries.

Regarding **recycling**, the regulation sets ambitious targets to be achieved from 2030 onwards. Industrial batteries will need to contain a minimum amount of recycled content, with particular emphasis on recovering critical raw materials like lithium, lead and nickel. This initiative aims to reduce reliance on extracting new resources and to foster a circular economy where materials are reused efficiently. With these measures, the European Union seeks to lead the shift towards more sustainable mobility and enhance its competitiveness in the global clean technology market.

Finally, in the European context of innovation and sustainability within the battery sector, the **BATT4EU** initiative stands out. This partnership between the European Commission and the European Battery Alliance Association **aims to competitively and sustainably enhance the European battery value chain**, covering everything from material production to recycling and reuse.

A key objective of BATT4EU is to encourage collaboration among researchers, businesses and other stakeholders, thereby creating a robust European ecosystem that can lead the shift towards a greener economy. This involves investing in projects that advance manufacturability, recyclability and integrate cutting-edge technologies like sensors and self-repair systems to prolong battery life.

By 2030, the initiative aims to boost energy density by over 60%, double battery lifespan and cut costs by 60% compared to 2019 levels.

1. https://circulareconomy.europa.eu/platform/sites/default/files/2024-03/1qp5rxiZ-CEPS-In-DepthAnalysis-2024-05_Implementing-the-EU-digital-battery-passport.pdf

4.3. National Framework

4.3.1. Behind-the-meter storage

Behind-the-meter storage refers to systems connected to self-consumption installations, which allow batteries to be charged directly using the energy generated by these systems.

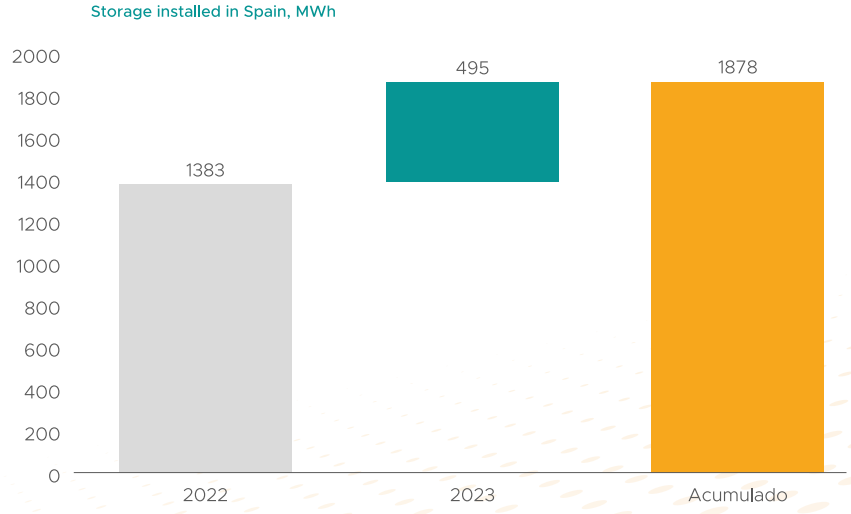
According to UNEF's annual internal studies, **495 MWh of new behind-the-meter storage was installed in 2023**. This marks a 64% reduction compared to 2022, when 1,383 MWh of storage capacity was added.

By the end of 2023, Spain had a total of 1,878 MWh of behind-the-meter storage installed between 2022 and 2023. Regarding sector distribution, the industrial sector accounted for the largest share of this new capacity **at 47%, followed by the residential sector at 32%, the commercial sector at 20% and the remaining 1% dedicated to isolated self-consumption**.

Figure 48. Storage installed in 2023

Source: UNEF (C&I: Commercial and industrial)

Figure 49. Behind-the-meter storage installed in 2023



Source: UNEF

4.3.2. Large-scale storage

Large-scale in-plant storage is classified into two categories. The first is **“stand-alone” storage**, which involves battery plants that do not receive power from generators. Instead, they store energy sourced from the transmission grid, bought at low prices and sold at higher prices during periods of peak demand. The second category includes **“hybrid systems”**, where batteries are connected to renewable energy generation facilities, such as photovoltaic farms.

4.3.3. Requests for Stand-alone and Hybrid Access to REE

According to data from Red Eléctrica de España (REE), there is a notable increase in grid access requests for both stand-alone and hybrid energy storage.

As of the publication date of this report, **requests for 8,318 MW have been made in distribution grids**. Of these, 4,298 MW have already been granted permits, meaning they have passed technical and regulatory assessments for development, though they are not yet generating. An additional 4,020 MW are in the process of obtaining authorisations.

In the transmission grid, requests have totalled 10,763 MW, with 7,465 MW already permitted and a further 3,298 MW undergoing the authorisation process.

It is important to distinguish between requested access capacity and installed capacity. Requested **access capacity** refers to the potential storage projects aim to connect to the grid, representing the maximum capacity they intend to use for energy storage. Meanwhile, **installed capacity** refers to the actual storage capacity that has been physically implemented and is operational on the grid.

The application and granting process for grid access permits is governed by Royal Decree 1183/2020 and CNMC Circular 1/2021. These regulations outline the conditions and methodologies for connecting energy generation and storage facilities. Permits are issued based on technical criteria including security, regularity, quality of supply and economic efficiency. To be considered viable and contribute to system stability, applications must meet these standards. In addition, REE conducts specific studies to evaluate access capacity, taking into account scenarios that represent the final objectives of the current planning framework.

4.3.4. Capacity mechanisms

The Spanish electricity system has a high reliance on renewables, which sometimes cannot meet all the energy demand during peak periods. Capacity mechanisms have been introduced to address this challenge, ensuring security of supply.

Spain has chosen to implement a **capacity market** as one of these mechanisms. REE will secure the necessary capacity to meet peak demand through auctions, **which are open to consumer, generation or storage facilities**. Successful bidders will receive a monthly settlement price for ensuring capacity supply during critical periods. There are two types of auctions: annual auctions, which provide services over a five-year period, and adjustment auctions, which complement annual auctions and offer services for twelve months.

In October 2023, MITECO introduced a draft resolution **establishing the "value of lost load" (VoLL) and the "reliability standard"**, both crucial for approving the capacity market in the peninsular electricity system. Value of lost load is defined as the maximum price per MWh that customers are willing to pay to avoid interruptions in electricity supply, set at **22,879 EUR/MWh**. The reliability standard, meanwhile, measures the number of hours annually when demand is unmet, set at 0.94 hours.

These parameters are vital for ensuring the security of electricity supply and facilitating the integration of renewable energy sources. The draft resolution also highlights the importance of these measures for deploying technologies that enhance flexibility and resilience in the electricity system, such as storage and demand response.

4.4. UNEF auction proposals

The increased deployment of renewables leads to a greater role for them in the electricity system. However, renewable energy sources are highly variable, resulting in greater price volatility. Prices tend to be lower when renewable generation is high and higher when it is low. Energy storage offers a solution to this price fluctuation by purchasing energy (charging) during low-price periods, which typically coincide with high renewable generation, and selling it (discharging) during high-price periods, when renewable generation is usually lower.

Nevertheless, several barriers discourage investment in energy storage. Firstly, the incentive from the difference between maximum and minimum electricity prices might not cover storage costs. In other words, the overall market price volatility may not be sufficient to offset the levelised cost of storage (LCOS) of a facility. This risk is inherent in how electricity markets currently operate, as prices are influenced by external factors such as methane gas prices or CO2 emission rights. This makes it challenging to predict the extent of price volatility that storage can benefit from, as it depends on factors beyond the electricity market's control. Therefore, a dedicated remuneration mechanism for storage is essential to make these facilities financially viable and provide more predictable returns.

Although deploying battery storage systems is relatively straightforward, **uncertainty about their profitability has resulted in slower rollouts compared to renewable generation technologies**. This can lead

to insufficient storage capacity to manage the price drops caused by high levels of renewable generation, meaning **potential revenues from storage systems are not immediate, which deters investment**. Both these issues highlight the clear need for a specific remuneration mechanism for storage.

Renewable energy auctions establish a remuneration framework through the REER mechanism, which involves setting a settlement price

(EUR/kWh) that installations commit to over a long-term period, such as 10-15 years. Installations can receive payments or face penalties based on the difference between this settlement price and the market energy sale price.

In contrast, storage does not generate electricity but engages in arbitrage, buying energy during low-price periods and selling it during high-price periods. Therefore, storage should be compensated based on the daily price differential (spread), which is the difference between the lowest and highest prices within the same day.

4.4.1. UNEF proposal for Storage auctions: Storage Economic Framework

For **commercial and industrial sectors**: **C&I (<10MW)Residential (>10MW)** This mechanism works in a financial Contract for Difference (CfD), which settles based on daily market price variations. In these auctions, storage facilities bid on a price difference, ΔP bid (EUR/kWh), which they believe will make their business feasible. MITECO determines the required storage volume, and within this auction, the lowest bids are selected and awarded their bid price, ΔP. Storage facilities then operate in the electricity markets to maximise profitability.

Each day, the successful bid, ΔP awarded, is compared to the day's highest and lowest price difference, ΔP daily, regardless of how the storage was operated. If the awarded price is lower than the daily market price difference, the storage facility receives additional compensation, R daily, equivalent to the difference between these values, ΔP daily - ΔP awarded. Conversely, if the awarded price is higher than the daily market price difference, the facility must return to the system an amount equal to the difference, ΔP daily - ΔP awarded.

UNEF HAS SUBMITTED TWO PROPOSALS FOR STORAGE AUCTIONS: STAND-ALONE AND HYBRID

This approach is well-suited for stand-alone storage facilities but less so for those integrated with power generation plants. Furthermore, combining with generation facilities operating under a different remuneration scheme can be complex. UNEF proposes two alternative methods to integrate storage into auctions.

4.4.2. UNEF proposals for Generation with Hybrid Storage auctions:

REER + REA auctions

UNEF initially suggested integrating the existing Renewable Energy Economic Regime (REER) auctions with the proposed Storage Economic Regime (REA) auctions. This would involve conducting two separate auctions: one focusing on generation technologies and the other on storage technologies. In the case of the generation auctions, facilities would be required to include a specified amount of storage capacity. This storage capacity would then be settled separately, either on the open market (as a merchant) or through the REA mechanism. Installations under both the REER and REA regimes would have their settlements managed separately, making use of the fact that they are distinct Physical Units for settlement purposes.

The implementation of this auction is complex, as the REA might not align with Royal Decree 960/2020, which regulates REER auctions. This misalignment could necessitate the creation of new regulations, potentially delaying the auction process to a much later date. Additionally, determining the appropriate amount of storage to integrate with each generation facility presents another challenge. However, the urgent need to incorporate substantial storage capacity means delays are not ideal. UNEF, therefore, suggests a much simpler alternative mechanism that could be implemented with minimal regulatory adjustments.

REER Auctions with Storage (REERcA)

UNEF proposes that facilities taking part in REER auctions be required to include a specified amount of storage. Generation from these facilities would be compensated like any other REER facility. However, the storage component would function independently in the various day-ahead and intraday markets, managed by both OMIE and REE.

This approach allows facilities with integrated storage to manage the risk that their storage units might not earn enough in the markets to cover costs and remain profitable. **Although this might result in slightly higher generation costs, the benefits include added storage capacity, reduced energy spillage, increased integration of renewables into the system and a diminished reliance on fossil fuel technologies during periods of lower renewable generation**.

In this proposal, a key challenge is determining the appropriate size of storage to accompany each generation facility. Several options are being considered:

- One possibility is to adopt similar proportions to those outlined in the NECP. According to the NECP, the total renewables capacity is set at 138 GW, comprising 76 GW of solar and 62 GW of wind, with only 22 GW allocated for storage. Following this ratio, every 1 MW of renewables should include 160 kW of storage. Ideally, this storage should be capable of providing power for four hours,

addressing the need to transfer large amounts of energy from periods of high renewable generation to times when generation is lower.

- Another approach could involve considering the current installed and yet-to-be-installed capacity. At present, there are already 6 GW of pumped storage in operation, along with over 27 GW of photovoltaic and more than 31 GW of wind capacity.

- A further option is to consider more technical criteria to establish a standard ratio between generation capacity and storage capacity for all auction participants.

    - For instance, based on the Access and Connection Detail Specifications, the Static Criterion estimates a 90% probability of being able to inject energy into the grid. Therefore, the required storage would need to handle the energy that cannot be injected during the remaining 10% of the time.
    - Alternatively, one could stipulate that storage should be capable of managing the 5% maximum spillage outlined in Article 13.5 of Regulation (EU) 2019/943 of the European Parliament and the Council dated 5 June 2019.

Other methods for determining the appropriate size of storage for each hybrid generation facility could also be considered valid.

4.5. Hydrogen

Hydrogen is not a primary energy source because it does not exist freely in nature and cannot be used directly. **It is an energy vector**, or carrier, which means that energy must be supplied to produce it from raw materials.

One of the key advantages of hydrogen is its high availability, as it can be generated from various sources. It **also boasts a high energy density per unit mass, making it a very efficient fuel. Additionally, hydrogen is a clean energy source, as it only emits water when combusted**. Hydrogen is a very light gas and one of its main drawbacks is the challenge of storing and transporting it. Large tanks are needed to store a significant amount and there is a high risk of leaks during transport.

The method by which hydrogen is produced determines its classification by colour. Black-brown hydrogen is derived from coal and grey hydrogen comes from natural gas; both processes release significant CO2 emissions into the atmosphere and do not utilise renewable energy sources. Blue hydrogen is also produced from hydrocarbons, but a substantial proportion of the emissions are captured. Hydrogen can be produced using thermal energy or electrical energy, as is generally the case with yellow, pink or green hydrogen. Yellow hydrogen is produced

from electricity sourced from the primary grid, while pink hydrogen is generated from electricity derived from nuclear power. Lastly, **green or renewable hydrogen is produced from renewable sources, making it the most sustainable and cleanest method of production**. Yellow, pink and green hydrogen utilise water as the primary resource through a process called electrolysis.

Figure 50: Colour classification of hydrogen

Source: MITECO.

A device that produces hydrogen from water and electricity is known as an **electrolyser**. There are various types, with the most common and efficient being alkaline electrolysers, known for their low cost; polymer electrolyte membrane (PEM) electrolysers, which operate at low temperatures and are compact; and solid oxide (SOFC) electrolysers, which function at high temperatures.

A **fuel cell** is a device that converts hydrogen into electrical energy. These can be classified according to their application: portable fuel cells for small devices like computers or mobile phones, stationary fuel cells for generating larger amounts of electricity and mobile fuel cells used in transport. Some devices also function as both an electrolyser and a fuel cell, known as reversible fuel cells.

4.5.1. Regulation

In 2023, the EU adopted two Delegated Acts outlining detailed rules for renewable hydrogen. **Delegated Regulation 2023/1184** specifies the conditions under which green hydrogen can be classified as renewable liquid or gaseous fuels of non-biological origin (RFNBOs). According to the legislation, electrolysers must be linked to new renewable installations, which will subsequently increase renewable capacity.

Delegated Regulation 2023/1185 provides a methodology for calculating greenhouse gas emissions from RFNBOs. It **sets a minimum threshold for greenhouse gas (GHG) emission reductions** applicable to recycled carbon fuels and details a methodology for evaluating GHG emission reductions from renewable liquid and gaseous fuels of non-biological origin, as well as from recycled carbon fuels.

Finally, **Order TED/641/2023** lays out the regulatory framework for announcements under the **Incentive Programme aimed at projects that produce electricity and heat from renewable energy sources**, substituting fossil fuels. This programme is part of the Recovery, Transformation and Resilience Plan, funded by the European Union through NextGenerationEU. The main aims of the programme are to encourage projects that generate electricity and heat using renewable sources by providing financial and regulatory incentives, thereby reducing reliance on fossil fuels.

3 OF THE 7 WINNING PROJECTS IN THE FIRST RENEWABLE HYDROGEN BANK AUCTION ARE FROM SPAIN.

Within the European framework, the Commission has allocated €720 million to seven renewable hydrogen projects, selected through the European Hydrogen Bank's tender process. Successful bidders will receive grants to bridge the price gap between production costs and market price, which is currently influenced by non-renewable technologies. The winning projects are required to produce 1.58 million tonnes of renewable hydrogen over ten years, with grants ranging from €8 million to €245 million. The bids submitted ranged from €0.37 to €0.48 per kg of renewable hydrogen produced.

Three of the seven companies awarded contracts are Spanish and members of UNEF:

- **Benbros Energy**, for its El Alamillo H2 project, which will produce 65kt of green hydrogen over 10 years at a production cost of €0.38/kg.
- **Angus**, for its HYSENCIA project, set to produce 17kt of green hydrogen over 10 years at a production cost of €0.48/kg.
- **Renato Ptx Holdco**, for its MP2X project, which will produce 511kt at a production cost of €0.48/kg.

The 2023 update of the NECP introduces 15 new measures aimed at boosting green hydrogen in Spain and anticipates that installed electrolyser capacity will reach 11 GW by 2030, up from the 4 GW projected in the 2020 hydrogen roadmap.

THE EUROPEAN COMMISSION PLANS TO LAUNCH THE SECOND EUROPEAN HYDROGEN BANK AUCTION AT THE END OF THE YEAR.

In August 2023, MITECO announced a **second call for proposals under the hydrogen value chain incentive programme**, offering €66.6 million, in addition to the €40 million available in the first round. Also that month, the European Commission released the terms and conditions for the European Hydrogen Bank, with the first auction providing €800 million for renewable hydrogen producers.

4.5.2. Call for Large-Scale Renewable Hydrogen Hubs

In July 2024, the Ministry for Ecological Transition released the regulatory guidelines for large-scale renewable hydrogen hubs. This initiative aims to **support projects with electrolysis capacities exceeding 100MW and a pre-existing commitment to purchase 60% of the hydrogen produced**.

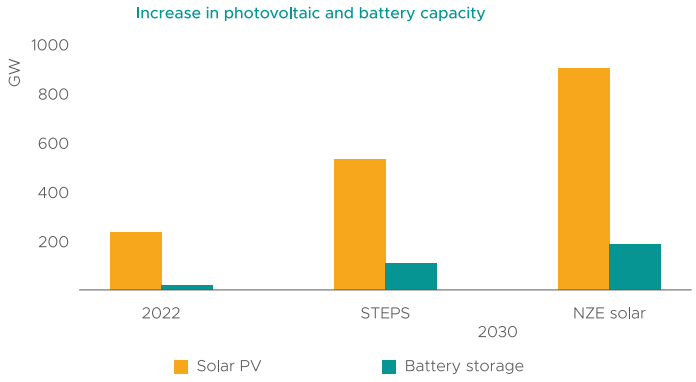
With **funding of €1.2 billion from NextGenEU**, this programme seeks to foster the large-scale production and consumption of renewable and electrolytic hydrogen, along with its derivative fuels, to fully integrate this energy vector into Spain's energy mix.

This call, following previous initiatives such as H2 Pioneers, H2 Value Chain and Important Projects of Common European Interest (IPCEI), will remain open until 31 December 2025.

4.6. Trends

In line with the goal of tripling renewable energy by 2030 announced earlier this year, the expansion of energy storage systems in the coming years is essential. According to BloombergNEF, **it is anticipated that 57 GW of new storage capacity will be added by 2024**. The IEA, in its World Energy Outlook 2023, projects that **between 100 and 200 GW of new storage capacity will be installed by 2030**, depending on the scenario.

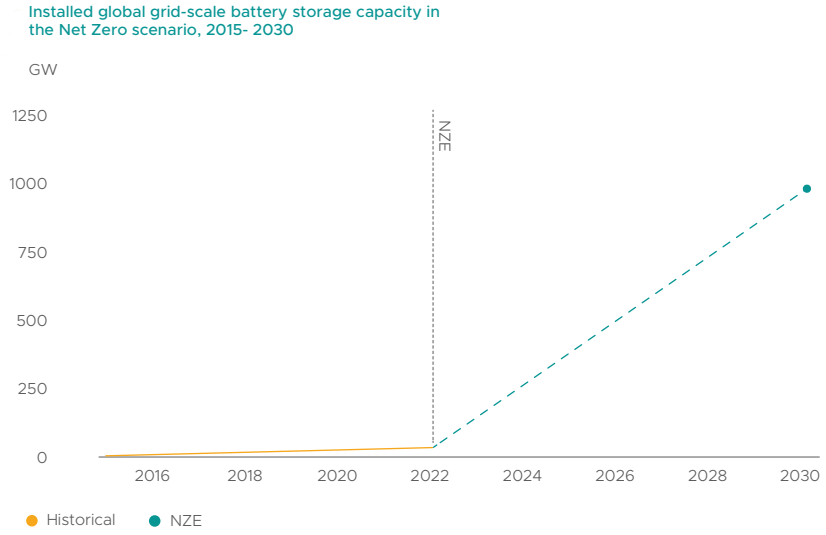
Figure 50: New installed storage capacity in 2022 and 2030.



Source: IEA

Regarding usage type, the IEA predicts that **cumulative battery capacity for large-scale plants will reach nearly 970 GW by 2030**.

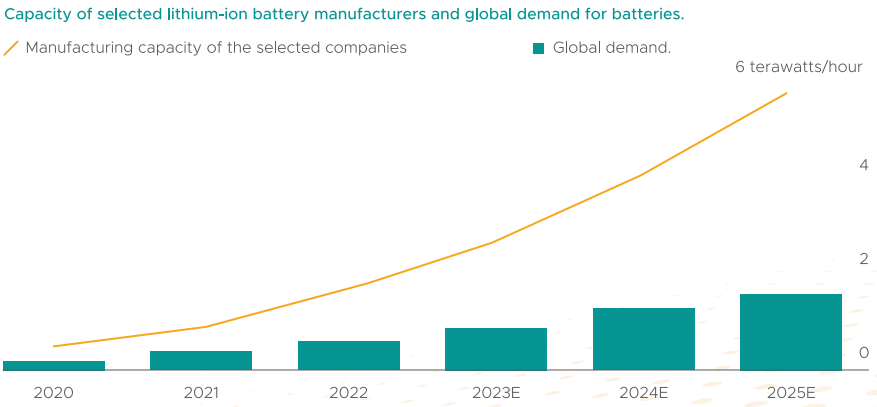
Figure 51: Cumulative large-scale storage capacity, 2022-2030.



Source: IEA

BloombergNEF forecasts that lithium-ion batteries will comfortably meet demand over the next few years. In addition, the cost of these batteries is expected to continue decreasing in 2024.

Figure 53: Lithium-ion battery capacity produced and global demanded capacity, 2020-2025.



Note: Nominal capacity as of 15 November 2023, including 20 battery manufacturers listed in the BloombergNEF report Company Profiles: Global Battery Manufacturers 2023

Source: BloombergNEF

In the realm of emerging technologies, **sodium-ion batteries show promise as contenders to lithium-ion batteries**. These sodium-ion batteries are more cost-effective due to the plentiful availability of the material and the lower costs associated with extraction and processing. Currently, their energy density ranges from 130 to 160 Wh/kg, with expectations to reach 200 Wh/kg in the future. In November 2023, European battery manufacturer Northvolt unveiled a sodium-ion battery

with 160 Wh/kg, and in January 2024, Chinese supplier BYD announced plans to build a factory with a production capacity of 30 GWh/year for these batteries. **Flow batteries** represent another cutting-edge technology, characterised by their energy storage in tanks that are external to the cell. Their primary advantage is a long lifespan of 10,000 cycles and a flexible energy capacity, thanks to their decoupled design. However, tank size results in low energy density, making them more suitable for large-scale storage applications.

The cost of energy storage is **being significantly reduced** by the development and increasing adoption of lithium-ion batteries. This technology has proven to be an efficient and increasingly affordable solution. However, high lithium futures have spurred the development and exploration of alternatives like sodium batteries, which are emerging as a viable market option.

Conversely, **progress in hydrogen as an energy carrier is slower than anticipated** due to various challenges. Technological and regulatory obstacles, along with a lack of financing, have hindered its large-scale deployment and development. Furthermore, sectors that can be easily decarbonised, such as transport and heating, have shown little interest in hydrogen, as electricity has taken a leading role in these areas. This shift towards electricity has redirected attention and resources to more immediate and established solutions, further slowing the momentum for hydrogen.

5

PHOTOVOLTAIC INDUSTRY

This chapter was created in collaboration with FOTOPLAT, the Spanish Photovoltaic Technology Platform.

5.1. Current state of photovoltaic technologies

This section will explore the current state of technological development and innovation trends in photovoltaic solar energy, focusing on its various components and applications.

BY THE END OF 2023, CRYSTALLINE SILICON TECHNOLOGIES ACCOUNTED FOR 97% OF THE GLOBAL PHOTOVOLTAIC MODULE MARKET.

Photovoltaic cells: semiconductor materials

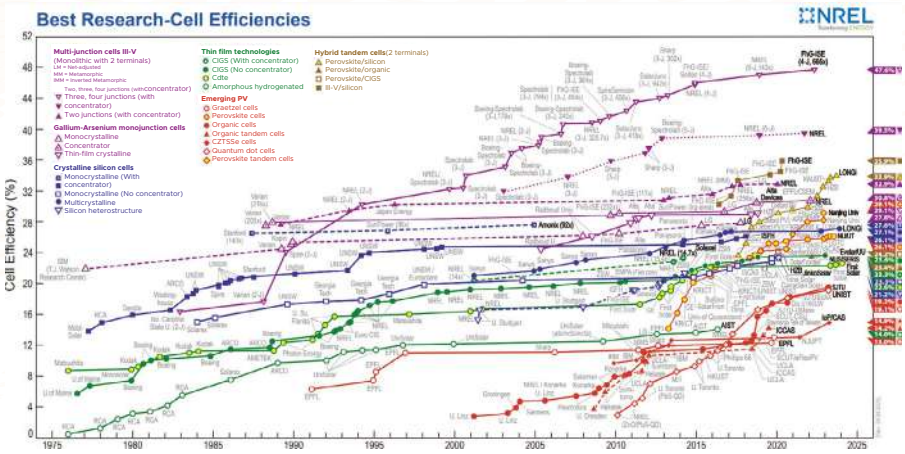
The majority of photovoltaic cells are based on crystalline silicon (c-Si). By the end of 2023, c-Si cells held a dominant position in the global market with a 97% share, while other technologies accounted for only 3%. **Monocrystalline silicon cells, in particular, have achieved a record high efficiency of 26.1%** (Figure 54).

In recent years, perovskite photovoltaic cells have gained attention due to their high efficiencies, which are comparable to those of silicon, but they benefit from much simpler manufacturing processes and significantly lower production costs. This enables the creation of far more versatile modules. Notably, the laboratory efficiency record for a perovskite PV cell stands at 26.1% (Figure 53). Moreover, perovskites can be combined with crystalline silicon modules to form tandem cells, which achieve even higher efficiencies, surpassing the theoretical Shockley-Queisser limit of 30%. Data from the NREL indicates that the record efficiency for silicon-perovskite tandem cells is 33.9% (Figure 53). These tandem cells not only provide higher efficiencies but also offer greater durability compared to traditional silicon cells. As a result, the development of perovskite PV cells has become a priority for the scientific community, which views them as the key material for the next generation of photovoltaic modules.

PEROVSKITE IS EMERGING AS A KEY MATERIAL FOR THE NEXT GENERATION OF PHOTOVOLTAIC MODULES, WHICH WILL BE MORE FLEXIBLE, LIGHTER AND HAVE LOWER PRODUCTION COSTS

Organic cells are another notable alternative to silicon-based materials. They enable the production of much lighter, more flexible and semi-transparent modules, with lower production costs and simpler manufacturing methods—features they share with thin-film cells. Despite significant improvements in recent years, achieving an efficiency of 19.2%, they still lag behind the standard efficiency levels of crystalline silicon cells (Figure 53).

Figure 54. Laboratory efficiency trends of various photovoltaic cells.



Source: NREL

Photovoltaic modules: manufacturing techniques

In recent years, significant progress has been made in the manufacture of photovoltaic modules by connecting photovoltaic cells, employing new production techniques to enhance energy efficiency and reduce costs. For crystalline silicon modules, the manufacturing process comprises several stages:

1. Initially, the silicon undergoes reduction, purification and crystallisation.
2. This is followed by the production of ingots,
3. which are then used to create wafers.
4. Afterwards, the photovoltaic cells are produced.
5. Finally, the process concludes with photovoltaic module assembly, where the cells are interconnected with the other necessary components.

As previously mentioned, crystalline silicon modules continue to dominate the market. In 2023[1], the photovoltaic module industry experienced further expansion with Asia, particularly China, maintaining its status as the leading producer. Europe and the United States held modest market shares of 0.6% and 1.6%, respectively. After enduring several years of pressure from rising material and transportation costs, module prices dropped to US€0.12/Wp by the end of 2023 in a saturated market. This decline helped ensure that photovoltaic energy remained competitive, even as electricity prices fell after reaching record highs in 2022.[2]

1. Snapshot of Global PV Markets 2024 (IEA), (2023 Results)
2. Trends in photovoltaics applications 2023 (IEA), (2022 Results)

HUAWEI

Building a Fully Connected, Intelligent World

Fusionsolar

Smart String ESS, More Energy, More Safety, Reducing LCOS by 20%

More Revenue: Pack-level Optimization & Rack-level Optimization with more usable energy, ensuring higher revenue in peak shaving & frequency regulation scenarios

Optimal Investments: Supporting pallet transport with prefabricated installation, supporting battery augmentation enabling flexible investment

Smart O&M: Automatic SOC calibration, no expert on-site visit

Safety & Reliablity: '4+2' Mutiple-level protection, proactive safety

solar.huawei.com/es

PERC technology (passivated emitter rear contact cell) is notable for its capacity to enhance the efficiency of monocrystalline silicon modules by improving solar irradiation absorption. This innovation involves adding an extra layer to the back of the solar panel to reflect light that was not initially absorbed back towards the semiconductor material, thereby maximising energy capture.

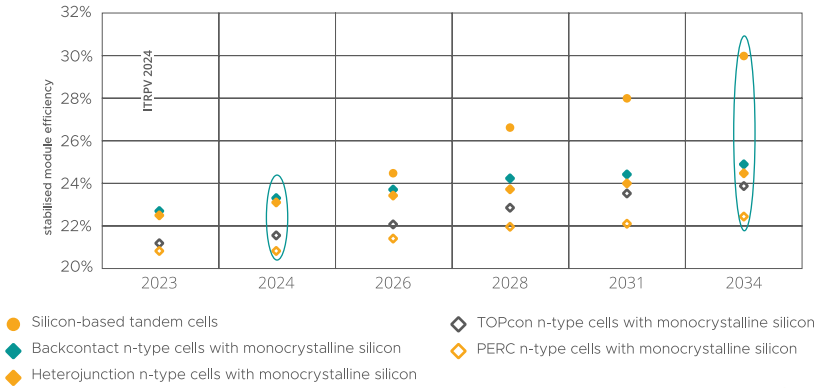
In 2021, module manufacturers advanced the production capacity of PERC modules, investing in new cell formats and production lines to boost the efficiency of this technology and develop new wafer formats. Monocrystalline silicon PERC modules are anticipated to achieve an average efficiency of 21% in 2023, with expectations to exceed 22.4% over the next decade.[1]

Modules with Tunnel Oxide Passivated Contact (TOPCON) cells are the next generation after PERC technology. One key advantage is that they can be manufactured using existing production lines, which helps to lower production costs for current facilities. These modules have the potential to achieve efficiencies close to 24% by 2032 (Figure 55).

Modules that utilise back contact solar cells can achieve even higher efficiencies. This design shifts all front contacts to the back of the device, reducing the shadow cast by front-facing contacts. There are various configurations for these modules, such as all back contact solar cells and interdigitated back contact (IBC) cells.[2]

Additionally, tandem modules, which incorporate tandem or heterojunction cells, can attain much higher efficiencies by combining two materials with different crystallisations or structures. This technology significantly surpasses the efficiency of traditional photovoltaic modules, reaching very high levels and exceeding the Shockley-Queisser limit.

Figure 55. Module efficiency trends in mass production with different technologies



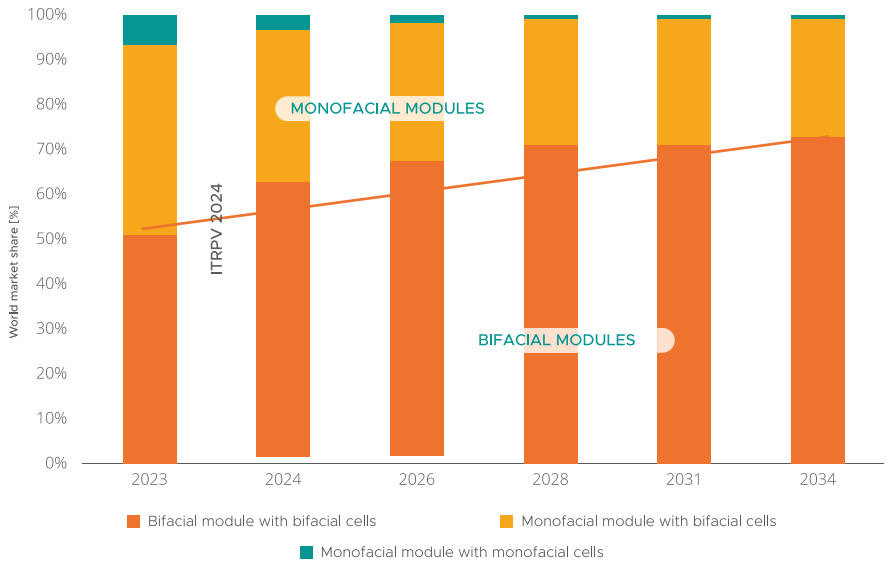
Source: ITPRV, 2024

Bifacial modules have recently gained prominence due to their capability to absorb radiation from both sides. This feature enables them to capture both direct and reflected radiation from the surface on which they are installed. Projects using bifacial technology can enhance efficiency and energy output while optimising space usage.

1. International Technology Roadmap for Photovoltaics (ITRPV), 2024 (2023 Results)
2. https://www.pveducation.org/pvcdrom/manufacturing-si-cells/rear-contact-solar-cells

According to the International Technology Roadmap for Photovoltaics (ITRPV) report, bifacial modules are expected to account for about 50% of the photovoltaic market by 2024. This market share is anticipated to rise to 70% in the following years (Figure 55).

Figure 56. Market share of mono and bifacial modules



Source: ITPRV, 2024

Solar trackers

Solar trackers enhance the efficiency of photovoltaic plants by adjusting panel orientation to follow the sun's movement, thereby optimising the angle at which sunlight strikes them. This technology can boost efficiency by 10-20% in single-axis systems, with potentially even larger gains when used alongside bifacial modules. It is crucial that trackers are reliable in various operating conditions to ensure the ongoing performance of the PV installation. One key advantage of solar trackers is their ability to increase energy generation during peak solar radiation hours, both at the start and end of the day.

INNOVATIVE MODULE DESIGNS THAT INCORPORATE TECHNOLOGIES SUCH AS PERC, TOPCON, HJT OR TANDEM ARE AIMED AT ENHANCING PERFORMANCE WHILE REDUCING MANUFACTURING COSTS.

There are two main types of solar trackers: single-axis trackers, which adjust the panel's position from east to west, and dual-axis trackers, which vary the panel's orientation according to the season. Although dual-axis trackers come with higher costs, they provide a greater increase in efficiency.

This sector has seen notable growth in recent years, reflecting the overall development of the photovoltaic industry. In 2022, single-axis trackers dominated the solar tracker market, accounting for 90% of sales. However, dual-axis trackers are expected to increase their market share in the coming years. The United States led the solar tracker market last year, with around 40% of the market share, although Europe is anticipated to see significant growth between 2022 and 2030.[3]

3. https://www.precedenceresearch.com/solar-tracker-market

Current trends in the solar tracker industry focus on maintaining performance and reliability while using fewer materials, which helps to lower costs and improve life cycle analysis (LCA). In addition, there is progress in integrating smart technologies and adapting to new types of photovoltaic cells.

Inverters

The efficiency of state-of-the-art branded inverters is 98% or higher.[1]

The main types of inverters, classified by their power, include central inverters, string inverters and micro-inverters. String inverters hold a 64% market share, central inverters 34% and micro-inverters 1%. The DC/DC converter segment accounts for 5% of the inverter market.[2]

Inverters: Grid Integration

A key challenge for inverter technology is integrating with the grid. Due to the characteristics of photovoltaic generation, several advancements are needed for it to consistently form the majority of the electricity mix. These advancements primarily focus on inverters.

The main advancements include:

Preparation for voltage dips: A voltage dip involves a reduction of more than 10% in voltage, followed by rapid restoration. Nearly all new inverters are equipped to handle this. Gridforming inverters: These inverters can generate grid infrastructure, not just electricity. On a more technical level, an inverter is considered gridforming if it can: Create system voltage; contribute to short-circuit capacity and system inertia; allow disconnection of demand at low frequency; act as a sink for harmonics, interharmonics and system imbalances; prevent adverse reactions in the control system.[3]

Blackout-start inverters: These inverters can 'switch on' the grid after a blackout and are generally seen as an advanced step beyond gridforming.

Photovoltaic applications: Agrivoltaics

Agrivoltaics integrates electricity production with agricultural activities on the same land, fostering a synergy between photovoltaic energy and food cultivation. Particularly advantageous in arid or semi-arid regions, this approach optimises water use and shields crops from excessive solar radiation. In viticulture, for example, the shade provided by solar panels can enhance grape quality, slow down premature ageing and lower infrastructure expenses.

The generation of electricity through agrivoltaics offers numerous benefits: it can boost the economic value of land by over 30%, provide

1. Photovoltaic report, Fraunhofer 2023
2. Photovoltaic report, Fraunhofer 2023
3. Gridforming Capabilities: Towards System Level Integration, ENTSO-E 2021

farmers with greater long-term profit opportunities, improve environmental conditions and increase total soil productivity by 60-70%.[4] This demonstrates that agrivoltaics could play a vital role in the energy transition, strengthening the interconnection between water, food security and energy.

France has led the way in Europe by promoting agrivoltaics through public tenders since 2017. Several other countries have either initiated similar projects or integrated agrivoltaics into their plans, including the United States, South Korea, India, Israel, Germany and Italy[5]. Additionally, there are projects underway in China, Japan and Malaysia. Globally, the installed capacity of agrivoltaics now exceeds 14 GWp[6]. Despite its significant potential, this technology is not yet widely considered a viable option in subtropical and semi-arid regions.

In Europe, the 2022 Solar Energy Strategy encourages multifunctional land use to tackle land scarcity. It emphasises agrivoltaics as a means of combining energy production with agricultural protection and productivity, while ensuring agriculture remains the primary use of the land.

Conceptualisation of Bioagrivoltaics. Source: UNEF

Spain is already home to several innovative agrivoltaic projects. These photovoltaic systems are deployed across a diverse range of crops, including cereals, red peppers,

vineyards, broccoli, artichokes, thyme and pitaya. The configurations vary, featuring installations overhead, on the ground between crop rows and in greenhouses. At European level, agrivoltaic technology encounters several challenges. These include concerns about the potential loss of subsidies from the Common Agricultural Policy (CAP), the necessity for incentives and support for implementation and R&D, the development of specific regulations, the promotion of best practices to enhance social acceptance and the need to establish income-sharing agreements among developers, operators and farmers. These issues are compounded by the unique regulatory and social frameworks of each country.

In addition, Spain has introduced the concept of Biogrovoltaics, which aims to effectively integrate agricultural and livestock activities—considered primary activities—with the secondary activity of electricity generation through photovoltaic technology. This approach emphasises ecological production principles and shared management of light to positively impact farming and livestock operations.

4. Gonocruz RA, Nakamura R, Yoshino K, Homma M, Doi T, Yoshida Y, et al. Analysis of the rice yield under an agrivoltaicsystem: A case study in Japan. Environments - MDPI. 2021 Jul 1;8(7).

5. Trommsdorff M, Dhal IS, Özdemir ÖE, Ketzer D, Weinberger N, Rösch C. Agrivoltaics: solar power generation and food production. In: Solar Energy Advancements in Agriculture and Food Production Systems. Elsevier; 2022. p.159-210.

6. Trommsdorff M, Gruber S, Keinath T, Hopf M, Hermann C, Schongerger F, et al. Agrivoltaics: Opportunities for Agriculture and the Energy Transition. A guideline for Germany [Internet]. Freinburg, Germany; 2022. Available from:www.ise.fraunhofer.de

Photovoltaic applications: Floating solar

Floating solar systems are installed on bodies of water using floating structures. By being positioned over water surfaces, these systems help minimise evaporation and curb algae growth, which is particularly beneficial for reservoirs and freshwater bodies. Moreover, the cooling effect of the water improves panel efficiency by reducing temperatures.

Key applications for these floating solar plants include:

- Reservoirs and hydroelectric power stations, where water bodies serve not just as storage but also for electricity generation.
- Irrigation ponds, which, alongside reservoirs, represent a significant market for these installations.
- Water treatment and desalination facilities.
- Aquaculture
- Quarries and mines
- Hybridisation with offshore wind energy

The primary markets for this technology are located in Asia, specifically in Singapore, South Korea and Taiwan. According to the Solar Energy Research Institute of Singapore (SERIS), the cumulative capacity surpassed 3 GWp by September 2021, up from 2 GWp at the end of 2020.

Spain has several floating photovoltaic plants, primarily used for self-consumption and water pumping, making them particularly relevant to the agricultural sector.

From a technological development perspective, these systems face challenges related to their structural design and interaction with water bodies. Consequently, research is focused on developing materials, technologies and designs that address these issues. Key areas of investigation include flotation systems, mooring systems, integrated control and power conversion systems tailored to the characteristics of floating PV, and systems resistant to corrosion and salt deposition.

Photovoltaic applications: BIPV

Building Integrated Photovoltaics (BIPV) plays a crucial role in developing Nearly Zero Energy Buildings (NZEBs). This approach involves replacing traditional building materials, such as roof tiles, windows and facades, with components that incorporate photovoltaic cells, turning these elements into electricity generators and promoting self-consumption. A major technological challenge is to integrate these systems aesthetically while meeting building regulations. Efforts are also focused on enhancing energy efficiency and reducing production costs.

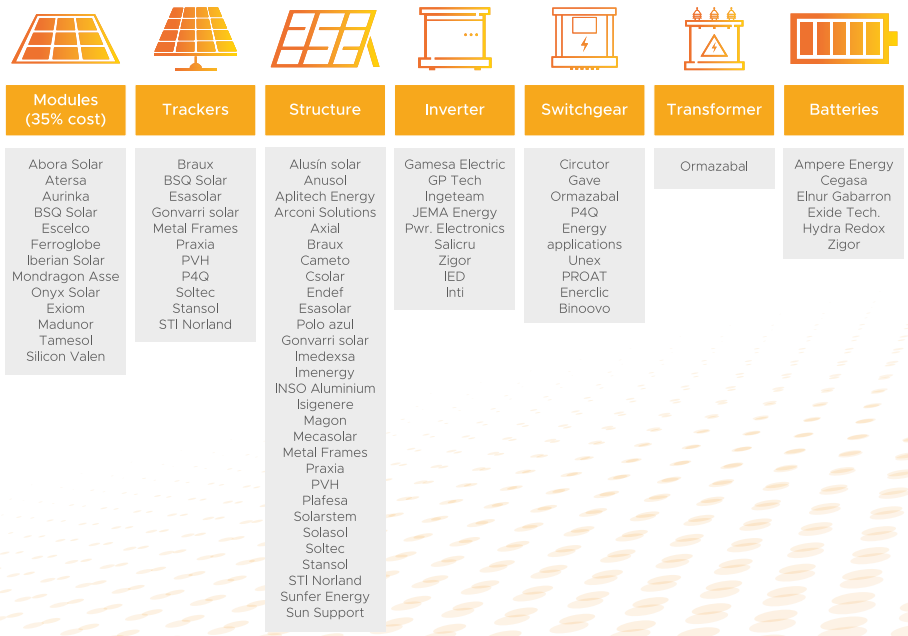
5.2. National photovoltaic industry: Solar energy Made in Spain

Recent geopolitical shifts in Europe have underscored the necessity to relocate supply chains back to the continent.

As we transition from an economy reliant on fossil fuels tied to specific geographic regions to one centred on high-tech renewable energies, our focus in energy policy has moved from geo-strategy to **techno-strategy**. Consequently, it is essential to consider strategic reserves for the production of renewable technologies.

Accelerating the ecological and energy transition is crucial not only for revitalising the economy and spurring reindustrialisation but also for establishing a domestic value chain that ensures our energy independence. The Recovery, Transformation and Resilience Plan (PRTR) in Spain aims to not only solidify economic growth but also to modernise the country's productive model through energy transition and digitalisation. Spain already holds a strong position in photovoltaic manufacturing, particularly in high-value sectors such as power electronics, solar trackers, structures and design. Spanish companies are global leaders in these fields and the nation can supply up to 65% of the component costs for a photovoltaic plant using domestically-produced technology.

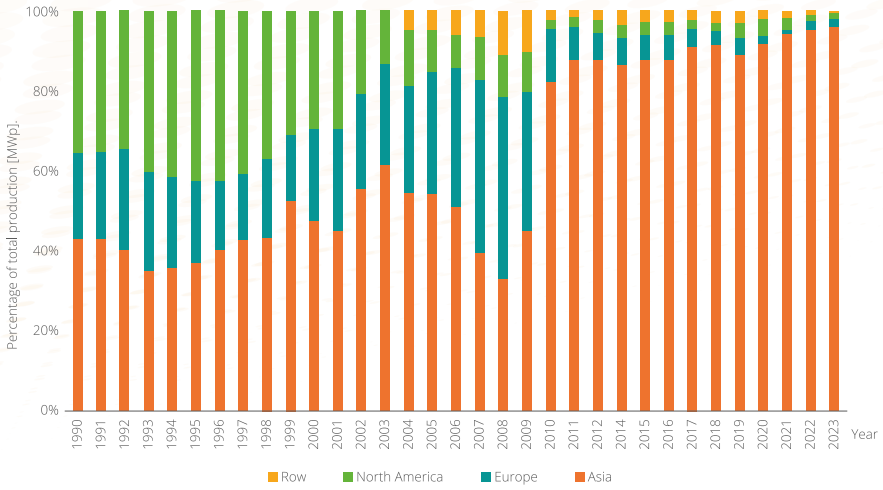
Figure 57: Spanish manufacturing companies in the photovoltaic value chain



Source: UNEF

Unfortunately, although some companies in Spain manufacture certain components domestically, the remaining 35% of costs, which pertain to photovoltaic panels, are largely sourced from Asia.

Figure 58: Asia's share of PV module component manufacturing over several years.



Source: Photovoltaic report, Fraunhofer 2024.

Regarding components, Spain hosts one of the world's top ten inverter manufacturers[1] and three of the ten leading solar tracker manufacturers.[2] **Remarkably, these companies achieved their market positions without a significant domestic demand** for their products, relying instead on international competition and focusing solely on exports. Moreover, all structural components are produced in Spain, with a portion being exported.

While China remains dominant in the industry, Europe still holds a share of global production, although it does not account for a significant part of installed photovoltaic capacity.

Recently, the European Solar Manufacturing Council (ESMC) estimated that at least 75% of Europe's photovoltaic demand should be met by European production[3]. To achieve this, Europe would need to establish 60 GW of manufacturing capacity by 2026. According to Solar Power Europe's EU Market Outlook For Solar Power 2023 - 2027 report, by 2023, Europe had operational capacity for:

- 26.1 GW for solar polysilicon production.
- 1.3 GW for wafer production.
- 2 GW for cell production.
- 14.6 GW for module production.

Data reveal that silicon production is the most advanced stage in Europe's manufacturing chain. However, there is a pressing need to expand capacities in other areas, especially wafer production, which has not experienced growth since 2020.

1. https://www.woodmac.com/press-releases/top-10-solar-pv-inverter-vendors-account-for-86-of-global-market-share/

2. https://www.blackridgeresearch.com/blog/top-solar-pv-photovoltaic-panel-single-dual-axis-tracker-system-manufacturers-makers-companies-firms-suppliers#top-10-global-solar-pv-tracker-companies

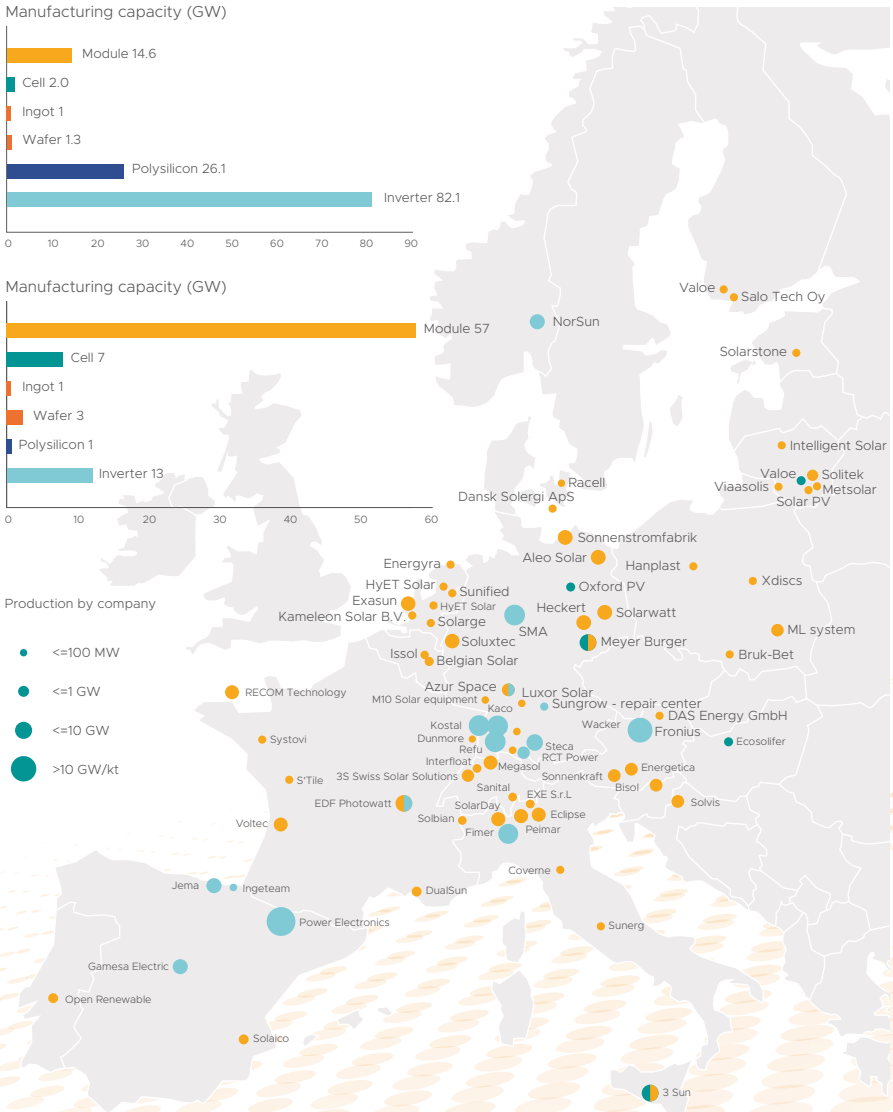
3. https://www.pv-magazine.es/2022/03/14/fabricacion-solar-en-la-ue-ha-llegado-el-momento/

State of the European module industry by component:

Solar Silicon Production: Wacker Chemie stands as the sole polysilicon manufacturer within the EU, boasting a capacity of 60,000 metric tonnes in Germany, which translates to over 26 GW of cell/module products. REC Solar Norway ceased operations in November 2023, resulting in a loss of 8,500 tonnes of production capacity and more than 100 jobs.

Silicon Ingot and Wafer Manufacturing: European production of silicon ingots and wafers has suffered due to challenging market conditions and insufficient political support. The bankruptcy of Norwegian Crystals in August 2023 marked a significant setback for the European photovoltaic supply chain. Meanwhile, NorSun halted production temporarily in September 2023 and German start-up NexWafe plans to commence production in 2025 with an annual capacity of 250 MW.

Figure 59: Industrial PV capacities in Europe



Source: EU Market Outlook for Solar Power 2023-2027 from Solar Power Europe

MÁS DE 30 AÑOS *contigo*

ORES & BRYAN
SABSEC GROUP

SUSTANAIBLE GUARANTEES TO CREATE A BETTER FUTURE

At Ores & Bryan we ares specialists in the management of technical insurance for companies in the photovoltaic sector. thanks to our extensive exoerience we can say that we have grat technicians in charge of finding the best solution for our clients.

RENEWABLE ENERGY INSURANCE
GRID CONNECTION INSURANCE
GRID - OWNER INSURANCE
PRIVATE - TO - PRIVATE INSURANCE - CONTRACT PERFORMANCE
DECOMMISSIONING INSURANCE
SURETY INSURANCE - PPA CONTRACTS

SYRETY INSURANCE
INSURANCE FOR AUCTIONS
INSURANCE FOR CAPACITY TENDERS
MEFF SURETY INSURANCE
SURETY INSURANCE FOR ICIO *(Tax on Construction and Facilities)*
LICENCE CONDITIONAL SURETY INSURANCE
JUDICIAL SURETY INSURANCE

GENERAL INSURANCE
ALL RISK ASSEMBLY
CIVIL LIABILITY INSURANCE
(Operation of the Plant, Promoter, Property agains third parties, to the Activity)
PLANT DAMAGE INSURANCE
PERFORMANCE INSURANCE
D&O INSURANCE
CIBER RISK INSURANCE

CONTACT:

www.oresybryan.com
www.avalesyfianzas.com
911 298 361
info@oresybryan.com
in Ores & Bryan
in Avales y Fianzas

Download here your
Renewable Energy Book

Solar Cell Production: EU manufacturing capacity for solar cells rose to 2 GW in 2023. Meyer Burger leads as the largest manufacturer with 1.4 GW capacity in Germany and intends to expand to 3.5 GW by 2025. Enel's 3Sun facility in Sicily is set to boost its capacity to 3 GW by 2024. Both companies are also expanding their operations in the United States.

Solar Module Manufacturing: Many EU module manufacturers import cells from Asia due to the lower investment costs. As of 2023, 57 module manufacturers are operating in the EU, with a combined capacity of 14.6 GW, reflecting a 59% increase compared to 2022.

Future Announcements and Projects in Development: Carbon plans to establish a vertically integrated factory with a 5 GW capacity in France, expected to employ over 3,000 people by 2027. Meanwhile, MCPV is developing a 3 GW heterojunction cell and module plant in the Netherlands, slated for completion by 2026.

Materials Processing and Production Equipment: While much of the equipment processing and production for cells and modules is concentrated in Asia, some European companies, such as von Ardenne in Germany and Borealis in module encapsulation, continue to lead in the field. In the Balance-of-System sector, the EU boasts significant players like K2 in Germany and Soltec and TrinaTracker in Spain.

Europe’s strength in solar technology is underpinned by a vast and well-connected research and development (R&D) ecosystem. European solar manufacturers collaborate with specialised photovoltaic research institutes across several countries, including AIT in Austria, IMEC in Belgium, Fraunhofer ISE & CST, FZ Jülich and ZSW in Germany, CEA-INES and IPVF in France, TNO in the Netherlands and CSEM in Switzerland, among others.

In Spain, several initiatives have been undertaken in the PV module manufacturing value chain. However, many of these initiatives are no longer operational and their machinery may be outdated.

The country is home to a range of industries, including chemicals, metallurgy and glass manufacturing, which possess the expertise necessary to enhance most processes within the manufacturing supply chain.

Some initiatives present opportunities for further development. For instance, Ferroglobe and Aurinka are collaborating on a project to establish a factory for Enhanced Metallurgical Grade Silicon, alongside an additional project focused on recycling solar panels. Aurinka also operates a 75 MW panel manufacturing plant in Madrid. Spain boasts several prominent module manufacturing facilities, including Escelco in León, BSQ's sites in Manzanares and Toledo, and Onyx Solar, which specialises in building-integrated modules. The most significant development is Exiom's module factory in Oviedo, with a projected capacity of 500 MW.

The country also leads in developers, engineering and EPC (Engineering, Procurement and Construction) companies, with Prodiel as one of the global leaders. Spanish service and consultancy firms leverage their locally acquired expertise to invigorate industry exports worldwide.

Overall, Spain is well-positioned to become a photovoltaic industrial hub. However, safeguarding existing industry, maintaining a stable market and improving financing conditions for domestic manufacturers are essential.

To achieve full potential, a coordinated European strategy is vital to making the PV value chain a key continental asset, akin to the approach taken with hydrogen. The European industry should be strengthened by recalling how feed-in tariffs once spurred the growth of renewables. **The Recovery Plan presents a prime opportunity to establish a photovoltaic hub in Spain, which could have a substantial economic and social impact** by creating jobs and supporting revitalisation efforts. While recent aid to the value chain is a positive development, it is crucial to ensure its effectiveness and appropriate distribution. In response to the energy crisis triggered by the situation in Ukraine, the European Commission has prioritised solar energy. It aims to deploy over 320 GW of photovoltaic capacity by 2025 and has set a target of 600 GW by 2030, with initiatives like the PV-IPCEI, led by Spain, playing a key role.

5.3. FOTOPLAT

Throughout 2023, FOTOPLAT, the Spanish Photovoltaic Technology Platform, has continued to adapt to the rapid growth of the sector. The platform has not only expanded its online presence via webinars but also strengthened its team and restructured its operations at the beginning of 2024. To enhance the **dissemination and analysis of technological innovations in Spain's photovoltaic sector**, FOTOPLAT has placed greater emphasis on webinars. **Public-private collaboration** remains a key focus, as it supports the development of the national PV industry by showcasing industrial advancements and demonstration projects that enable technology transfer and access to new knowledge. This strategy aims to help FOTOPLAT members solidify their presence in various markets, thereby enhancing their competitiveness and efficiency.

IN 2023, FOTOPLAT WELCOMED 13 NEW MEMBERS, INCREASING THE TOTAL NUMBER OF AFFILIATED ENTITIES TO 239 BY THE YEAR'S END.

In 2023, FOTOPLAT undertook a review and refinement of platform operations. The key outcomes of this process were:

- The introduction of thematic quarters replaced traditional working groups.
  - Each quarter features a series of webinars focusing on a specific technology,
  - culminating in a panel discussion where partners can pose questions.
  - Insights from these webinars are compiled into a thematic technology document.
- Meeting durations were reduced, particularly for the Executive Committee (EC).

- The FOTOPLAT General Assembly is now receiving greater publicity through communication campaigns, resulting in more than a 100% increase in participation.

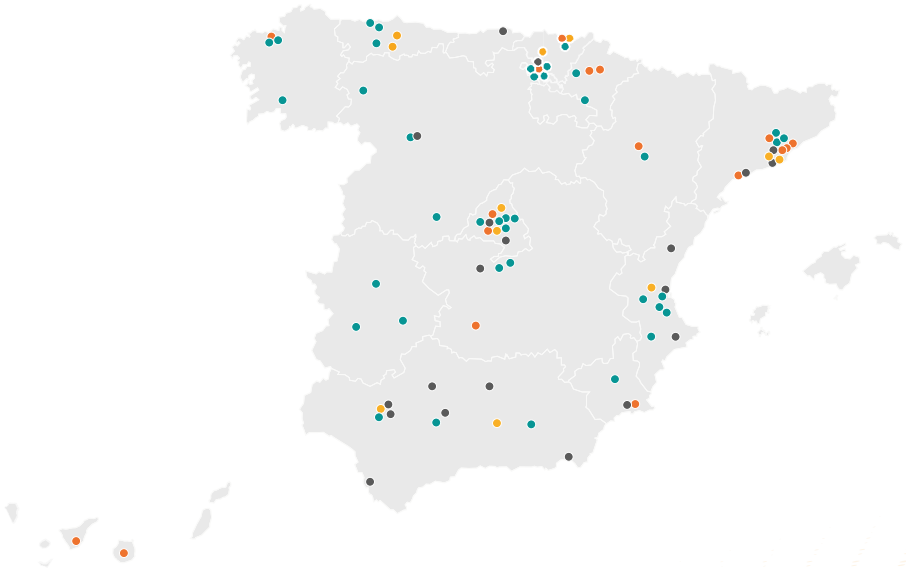
The themes addressed or planned for the thematic quarters include:

1. Agro-photovoltaics
2. Panel recycling
3. Gridforming inverters
4. Software for photovoltaics

Additionally, a **capacity map**, developed in collaboration with UNEF, is available as a resource. To offer more detailed information on technological aspects, the FOTOPLAT website features a form that gathers the research capabilities of platform partners, enabling searches based on various criteria.

IF YOU WOULD LIKE YOUR COMPANY TO BE INCLUDED IN THE CAPABILITIES MAP, PLEASE CONTACT US.

Figure 60. Capacity map of the Spanish photovoltaic industrial sector.



MANUFACTURERS:

- Alusín Solar (Structures)
- Ampere Energy (Batteries)
- Atersa (Panels)
- Braux (Structures, Trackers)
- BSQ Solar (Modules)
- Cegasa (Batteries)
- CSolar (Structures)
- Esasolar (Structures, Trackers)
- Escelco (Panels)
- Exide Technologies (Batteries)
- Ferrosolar (Silicon Purification)
- Gave (Protections)
- Gonvarri Solar (Structures)
- GP Tech (Investors)
- Hydra Redox (Batteries)
- Imedexsa (Structures)
- Ingeteam (Investors)
- INSO (Structures)
- Isigenere (Floating PV)
- JEMA Energy (Investors)
- Magon (Structures)
- Mondragon (Module assembly)
- Onyx Solar (Panels)
- Ormazabal (Electrical equipment)
- Power electronics (Inverters)
- Praxia (Structures, Trackers)
- PVH (Trackers and Structures)
- Sener (Followers)
- Solarstem (Structures)
- Soltec (Trackers, Structures)
- Stansol (Structures, Trackers and Floating PV)
- STI Norland (Trackers, Structures)
- Sunfer Energy (Structures)
- Sun Support (Structures)
- Trina Solar (Trackers and Structures)
- Zigor (Inverters, Batteries)
- Izpitek Solar (Electrical equipment)
- HD Solar Spain (Electrical equipment)
- IDAIN Professionals (Electrical equipment)

TECHNOLOGY COMPANIES:

- Acciona
- Binoovo Solar
- Enertis
- Exiom group

- Green Power Monitor
- Isotrol
- Leadernet
- Phoenix Contact
- Tamesol
- Tecnalia
- Teknia group
- Weidmuller
- Engineering Simulation Consulting
- Whitewall energy
- Spanish Energy Storage Association
- Suntropy
- IECO
- **RESEARCH CENTRES:**
- CENER
- CETENMA
- CIC Energigune
- CIEMAT
- CIRCE
- Eurecat C. Tecnológico Cataluña
- Funditec
- ICMAB-CISC
- IK4 Tekniker
- ICIQ Inst. Catalan Inv. Química
- IMDEA Energía
- ITER Instituto Tecnológico y de Energías Renovables
- Instituto Tecnológico de Galicia
- IREC Inst. Inv. Energía de Cataluña Instituto Tecnológico de Canarias
- **UNIVERSITIES AND INSTITUTES:**
- EPSU Mondragón
- Instituto de Energía Solar UPM
- Instituto de Materiales Avanzados UJI
- ICFO Instituto de Ciencias Fotónicas
- ISFOC
- Nanophotonics Tech Center, UPV
- Univ. Pablo de Olavide
- Univ. Carlos III de Madrid
- Univ. de Almería
- Univ. de Cantabria
- Univ. de Castilla-La Mancha
- Univ. de Córdoba
- Univ. de Jaén
- Univ. Politécnica de Cartagena
- Univ. Politécnica de Cataluña
- Univ. de Sevilla
- Univ. de Cádiz
- Univ. de Valladolid
- Univ. de Miguel Hernández
- Univ. de Rovira i Virgili

Source: UNEF and FOTOPLAT

FOTOPLAT provides **its partners with technical reports that detail the state of photovoltaic technology at national, European and international levels**. These reports include the Market Study and Internationalisation Plan, the State of the Industry and Photovoltaic Technology, the Photovoltaic Strategy and Socio-Environmental Aspects. A reorganisation of these reports is being considered, although approval from the IEA is still pending.

In 2023, FOTOPLAT remained committed to promoting and facilitating knowledge exchange among industry stakeholders. It participated in various events, such as the **10th Solar Forum and GENERA 2023**, where it organised dedicated sessions to discuss the latest trends and technological advances in the photovoltaic sector.

FOTOPLAT PROVIDES VARIOUS TOOLS TO ITS MEMBERS TO SHOWCASE SPAIN'S EXPERIENCE, POTENTIAL AND TECHNOLOGICAL EXPERTISE.

FOTOPLAT also continued collaborating with other Technology Platforms that share similar objectives in the energy transition. It actively participated in the Coordination Committee of Spanish Technology Platforms in the Energy Sphere (CCPTE) and the GICI Group of FUTURED. During the CCPTE's annual assembly, a round table discussion took place with a senior FOTOPLAT representative present. At European level, FOTOPLAT is notable for its involvement in the European Photovoltaic Platform (ETIP PV), the Joint Programme of the EERA-PV and the signing of a collaboration agreement with EU-PVSEC in 2023. Internationally, FOTOPLAT contributes to activities within the International Energy Agency, specifically the PVPS programme. Its tasks include strategic analysis and the promotion of BIPV, alongside participation in the SHC programme.

5.4. Outlook

Growth and Potential of Photovoltaics

Photovoltaics has emerged as a significant global industry poised to revolutionise electricity markets. By 2030, renewables, spearheaded by solar PV, are expected to account for 80% of the newly added global electricity generation capacity. Manufacturing capacity for solar panels is rapidly expanding and could exceed 1,200 GW annually by the end of the decade. However, current deployment utilises only a portion of this potential, highlighting substantial opportunities for further growth.

Investment in Photovoltaics

Since 2020, investment in clean energy has risen by 40%, with more than €1 billion being invested daily in photovoltaic technology worldwide. This surge in investment reflects the maturity and economic competitiveness of photovoltaic technology, as well as its strategic significance for energy security and job creation in the green energy sector, both globally and in Spain.

Impact on Emission Reduction and Energy Transition

Photovoltaics plays a vital role in reducing emissions and transitioning towards a clean energy system. Greater integration of PV is anticipated to help decrease reliance on fossil fuels, particularly natural gas. As a pivotal green technology, photovoltaics is essential for achieving climate targets and opening pathways to a sustainable future.

Challenges and Integration Needs

The large-scale deployment of photovoltaics presents challenges for integration into electricity systems. Enhancing storage capacity is necessary to fully capitalise on the impact of solar energy. With manufacturing capacity heavily concentrated in countries like China, it is crucial for Spain to develop a **“techno-strategic”** policy to ensure a robust **“Spanish technological reserve”**.

Global Influence and Changing Trends

Photovoltaics is reshaping global investment and energy use dynamics. The decline in fossil fuel growth, alongside the increased adoption of clean energy, signifies a shift towards a more sustainable energy system. Policies supporting green energy are proving effective, accelerating the pace of this transition.

The Future

Projections suggest that accelerating the transition to clean energy, such

as photovoltaics, could keep global warming below 1.5°C. To achieve a swift and orderly energy transition, proven policies and technologies must align with energy security and sustainability goals, and strong international cooperation is essential.

In essence, photovoltaics is a crucial and viable solution to the energy and climate challenges we face. Its growth and integration into the energy system offer promise for a cleaner and more sustainable future, though this will require coordinated efforts and substantial investment in infrastructure and support policies.

Nationally, strategic priorities include fulfilling the National Energy and Climate Plan, fostering a photovoltaic industry in Spain and developing regulations to achieve both of these goals.

LEDVANCE.ES

LEDVANCE

RE **NEW** ABLES

LEDVANCE RENEWABLES

ALL-IN-ONE FOR PHOTOVOLTAIC SOLUTIONS

LEDVANCE, as a manufacturer with more than 110 years in the electrical sector, offers a wide range of products and services for renewable systems. The company has a complete range of photovoltaic modules, hybrid and string inverters and batteries for residential, commercial and industrial use. It offers assistance to the entire value chain, from technical and commercial support, to supply and after-sales services.

6

UNIÓN ESPAÑOLA FOTOVOLTAICA (UNEF)

6.1. What is UNEF?

Founded in 2012, the Spanish Photovoltaic Union (UNEF) has become the leading photovoltaic association in Spain and one of most prominent in the renewable energy sector.

+178
Associated companies

By 2023, the association has grown to include over 780 member companies.

UNEF is organised into **six sections**: Storage, Energy Communities, Distributors, Manufacturers, Installers and Engineering, Producers and a Mixed section. This structure forms a democratic forum that advocates for regulatory stability, sustainable development and the internationalisation of the photovoltaic sector.

The association also holds the presidency and co-secretariat of FOTOPLAT, the Spanish Photovoltaic Technology Platform. Initiated in March 2011 by the Ministry of Economy, FOTOPLAT brings together universities, research centres and leading companies in photovoltaic R&D&i in Spain.

Moreover, UNEF is a member of SolarPower Europe, the European photovoltaic sector association, and a founding member of the Global Solar Council, the international association.

UNEF as a meeting forum

UNEF's open institutional structure is designed to incorporate all stakeholders and interests within the photovoltaic sector, regardless of their activity, size or area of operation.

In 2024, the UNEF assembly approved changes to the statutes, allowing new players to join, increasing the number of board members and establishing the Board of Directors Management Committee.

The **General Assembly** serves as the association's governing body, where all member companies convene annually. During these meetings, they approve the annual budget, the action plan and, if necessary, elect representatives for the Board of Directors.

The **Board of Directors**, elected every two years during the General Assembly, represents the interests of UNEF's various sections. It also includes the individuals responsible for General Management, the General Secretariat and the representative of the Territorial Delegations.

UNEF has representatives in fourteen autonomous communities who act on the association's behalf at regional level. These representatives are responsible for maintaining a strong relationship with their respective regional governments and for regularly bringing together companies that are based or operate in their area.

To enhance its operations, the association has established new directorates focusing on social acceptance and energy communities.

In Catalonia, UNEF operates through UNEFCAT, a brand that strengthens its regional presence. The Territorial Council of Catalonia was established in 2021. This council serves as an advisory body for UNEFCAT and comprises companies located within the region.

UNEFCAT in Barcelona

Sections by sector activity

UNEF is organised into six distinct sections based on the activities of its member companies:

Storage Section: this is for companies involved in the manufacturing, distribution or sale of storage systems for photovoltaic projects.

- **Energy Communities Section**: companies working with renewable energy generation, energy efficiency services, supply, consumption, aggregation and storage within an energy community fall under this category.
- **Distributors Section**: this section includes companies that distribute components for photovoltaic systems.
- **Manufacturers Section**: designed for companies that produce solar-grade silicon, wafers, cells, modules, inverters, module support structures and other specific components for photovoltaic systems.
- **Installers and Engineering Section**: this is for member companies involved in system assembly, project engineering, system maintenance and the administrative processing of photovoltaic projects.
- **Producers Section**: companies primarily focused on electricity production belong to this category.
- **Mixed Section**: this section encompasses various activities, such as project financing, the production of auxiliary components for

photovoltaic systems, consultancy or professional services, market representation, research centres, public entities, testing and certification laboratories, training centres and energy communities.

The UNEF team comprises professionals from various fields who collaborate to manage all the association's activities effectively. The technical office, led by a general directorate, is organised into 11 directorates. They are responsible for crafting and implementing the strategic focus of the sectoral association. They include the technical, self-consumption, energy communities, storage & green hydrogen, associates, events, institutional & international, communication and public advocacy, regulation & financing, social acceptance, and studies and environment directorates. Currently, the UNEF team consists of 19 members.

6.2. Objectives of UNEF

UNEF's primary aim is to serve as the institutional representative for the Spanish photovoltaic sector, supporting its growth and advocating for its interests at national, regional and international levels.

This involves promoting a transition to a sustainable and efficient energy model centred on self-consumption and solar energy generation, with the goal of combating climate change and preserving biodiversity. Ensuring regulatory stability and legal certainty within the electricity sector are key aspects of the association's work.

In 2023, UNEF continued its strategy of engaging with government officials responsible for energy and industry, the European Commission, Autonomous Communities, local councils, political parties and energy sector institutions, such as the Institute for Energy Diversification and Saving (IDAE), the Electricity Market Operator (OMIE) and the National Securities Market Commission (CNMC), among others, as well as civil society representatives.

Services for members

UNEF maintains an effective information system with its member companies, delivering alerts on the latest energy sector developments. This includes a daily press bulletin summarising major news, a weekly bulletin highlighting news relevant to the association, a monthly bulletin featuring key industry figures and quarterly reports on the electricity market.

UNEF HAS A NETWORK OF REGIONAL DELEGATES THAT PROVIDES US WITH A CLEAR INSIGHT INTO EACH AUTONOMOUS COMMUNITY

In 2023, over 350 communiqués were distributed to an internal database of more than 3,000 individuals and an external database of approximately 3,500. The newsletters had an average open rate of 50%.

In addition, UNEF provides highly sought-after technical and legal ad-

visory and consultancy services. These cover issues related to subsidies and grants, legislation, regulation, access and connection,

taxation and environmental aspects within the photovoltaic solar energy sector. In 2023, the association successfully resolved over 550 queries within the year.

Institutional action

The Spanish Photovoltaic Union (UNEF) maintains **ongoing engagement** with key national and European decision-makers in energy regulation, ensuring their decisions are informed by reliable data from the sector. The association leverages an extensive network of institutional, political and social **contacts** to strengthen its objectives and activities in support of the photovoltaic sector.

In 2023, UNEF engaged consistently with all significant players in the sector. Given that it was an election year with new municipal, regional and national governments coming into power, UNEF communicated its demands and future challenges to all political parties. Numerous institutional meetings were held, focusing on municipalities and Autonomous Communities that were lagging in project development, which posed challenges to the advancement of photovoltaic technology. Notably, UNEF provided mediation services in some municipalities at the request of local authorities and companies, achieving excellent results.

In addition, we have engaged with all the Autonomous Communities by holding face-to-face meetings with representatives from most regions, particularly focusing on Aragon, La Rioja, Asturias, Valencia, Catalonia and the Community of Madrid.

We have also organised meetings for Directors General from across the Autonomous Communities, establishing a valuable forum for information exchange at national level. Close coordination with UNEF delegates within these regions has been crucial in keeping us informed about the progress and challenges regarding ground-mounted solar plants and self-consumption initiatives in each area.

We have also begun to establish connections with key sectors to drive the increase in electricity demand, such as data centre associations, and have entered into agreements with universities and other organisations to promote training for young people entering the photovoltaic sector.

To summarise, our collaborations have extended to the following stakeholders:

- Local, regional, autonomous and national governments through meetings and advisory activities
- Representatives from the renewable sector and civil society, including political parties, environmental organisations, and agricultural and livestock entities
- Organisations involved in technological development and R&D&I, such as CDTI and CIEMAT

- Universities, research centres and leading companies in R&D&I in photovoltaic solar energy, through our role in maintaining the FOTOPLAT Secretariat
- ICEX, where UNEF acts as a Collaborating Agent and participates in its Solar Sector Plan

Signing of the agreement with the Xunta de Galicia

Source: Xunta de Galicia

Participation in the regulatory debate

In 2023, regulatory activity was moderate, marked by numerous public consultations aimed at **reviewing frameworks significantly affecting solar energy**, both for ground-mounted plants and self-consumption.

IN 2023, REGULATORY SUBMISSIONS AND PROPOSALS WERE SENT TO 26 DIFFERENT REGULATORY PROCESSES.

UNEF actively engages in these consultation processes, presenting its positions formulated in Working Groups and approved by the Board of Directors.

Moreover, the association adopts a **proactive approach by submitting proposals to regulators** and producing reports on specific issues to influence the regulatory debate.

In the regulatory arena, UNEF has undertaken the following actions and proposals:

Comments and Regulatory Proposals

1. Comments on the Order of Remuneration Parameters
2. Comments on supply, contracting conditions and aggregators
3. Comments on the Law for the Protection of Land Use in Irrigated Lands
4. Comments on the Draft Royal Decree on Energy Communities

5. Comments on the Proposed Resolution for Storage Aid
6. Comments on the Public Consultation on SPGM Access Concessions
7. Comments on the Public Consultation for the Access Tender at the Lancha Just Transition Node
8. Comments on the Public Consultation on the Design of the European Electricity Market
9. Comments on the Local Public Consultation about Challenges in Deploying Renewable Energy Installations
10. Comments on the CNMC's Demand Circular
11. Comments on Detailed Specifications
12. Comments on the NECP Update Consultation
13. Comments on the Order for Granting Access to SPGM in just transition nodes
14. Comments on the CNMC's Proposal for demand participation and storage (P.O 3.2)
15. Comments on the Public Consultation for PLATER
16. Comments on the CNMC Draft Circular about information on forward products
17. Comments on the Energy, Climate and Air Strategy of the Community of Madrid
18. Proposal for the Resolution Calculation setting values for lost load value and reliability standards
19. Amendments to non-legislative proposal RDL 2_2022 of Castile and León
20. Comments on the draft decree concerning the Imperial Eagle in Castile-La Mancha
21. Comments on the proposed CNMC resolution on exceptions to connection code requirements
22. Comments on the Proposed Order on Remuneration Parameters for 2024
23. Amendments to Royal Decree Law 8/2023
24. General State Budget Act
25. Proposal to remove exemptions for supporting voltage dips in new self-consumption installations
26. Proposal to include solar futures in the PVPC tariff

Capitalising on the election year, UNEF released a ten-point policy guide for political parties at regional and local levels. In addition, UNEF prepared over 40 regulatory analysis notes throughout 2023 to keep members informed about various legislative actions at national, regional and sometimes municipal levels.

Support for internationalisation

In 2023, Spanish photovoltaic companies continued to make significant strides in their internationalisation efforts. To assist its members in ex-

panding their activities globally, the Spanish Photovoltaic Union (UNEF) intensified its efforts to create new opportunities and tap into emerging markets. This involved identifying and analysing potential projects in various countries, thereby laying a strong foundation for future global ventures.

UNEF HOLDS THE PRESIDENCY OF THE NATIONAL ASSOCIATIONS COMMITTEE OF THE SOLARPOWER EUROPE STRATEGY COMMITTEE AND ACTIVELY PARTICIPATES IN THE GLOBAL SOLAR COUNCIL.

As a sectoral partner of **ICEX** in the solar energy field, UNEF played a prominent role at the international photovoltaic fair, Intersolar, held in Munich, Germany. At this prestigious event, UNEF set up an information stand that served as a platform to showcase the innovations and technological advancements of Spanish photovoltaic companies. This provided visitors and potential international partners with the opportunity to see firsthand the capabilities and expertise of the Spanish sector, thereby fostering new collaboration and business opportunities. Moreover, UNEF organised various activities and meetings with key stakeholders, further enhancing Spain's presence and visibility in the global solar energy landscape.

UNEF has been accepted as a member of the IRENA Coalition for Action Steering Group, joining various working groups promoted by IRENA, including: the Business and Investors Group, Community Energy Group, Decarbonising End-Use Sectors Group, Renewables in Agriculture Group, Sustainable Energy Jobs Group and Towards 100% Renewable Energy Group.

The organisation participated in the high-level event **SPIREC** Spain 2023 - Renewables for People, which was organised by the Ministry for Ecological Transition and the Demographic Challenge (**MITERD**), the Institute for Energy Diversification and Saving **(IDAE)** and the Renewable Energy Policy Network for the 21st Century (**REN21**). This international conference took place from 20-23 February 2023 at IFEMA and gathered ministers, mayors, senior decision-makers, experts and opinion leaders from across the globe. The focus was on discussing and sharing insights, experiences and solutions to accelerate worldwide adoption of renewable energies and progress towards climate neutrality. UNEF used this global platform **to promote the Spanish photovoltaic sector**. During the conference, UNEF organised a session titled **"Good practices in ecological and socio-economic integration of energy initiatives"**, showcasing examples of integrated projects that maximise social and environmental benefits linked to renewable energy deployment.

In 2023, UNEF has enhanced its collaboration with organisations such as the **International Energy Agency**. Within the framework of the PV Technology Programme Task 1 (PVPS Task 1), UNEF has been actively involved in preparing the Trends Report 2024.

The association has also been active in the **SolarPower Europe Strategy Committee** and the Market Design Working Group, focusing on market reform.

UNEF is co-chair of the Global Solar Council, an organisation established at COP21 in Paris in 2015 to unite the solar energy sector internationally, share best practices and stimulate market development worldwide.

Participation in COP28

As a member of the **Global Solar Council**, UNEF participated in the 'Energy Action Event' held during COP28 in Dubai.

The association contributed to several round-table discussions, emphasising the crucial role of the photovoltaic industry and its potential as a biodiversity reservoir. UNEF also underscored the importance of engaging with local territories using the highest standards of excellence.

During these sessions, UNEF highlighted the need to triple renewable energy capacity by 2030 and stressed the importance of phasing out fossil fuel subsidies. The organisation emphasised that **industrial decarbonisation is vital for meeting the climate targets** outlined in the Paris Agreement and called for public-private cooperation and international partnerships to achieve these objectives.

6.3. Summary of UNEF activities

Solar Forum

In 2023, the Solar Forum celebrated its tenth edition with the theme "A decade of solar dialogues: forging the transformation towards sustainability", achieving a record attendance of over 1,200 participants. Notable figures at the event included Teresa Ribera, Third Vice-President of the Government and Minister for Ecological Transition and the Demographic Challenge of Spain; Antonio Lopez-Nicolas, Deputy Head of Unit C1 (Renewable Energy Policy and Energy System Integration) at the European Commission; Beatriz Corredor, President of Redeia; Rocío Prieto, Director of Energy at the National Securities Market Commission; and Gaetan Masson, Co-Chair and CEO of the Becquerel Institute, among others.

Over two days, leading companies from the Spanish photovoltaic sector engaged in discussions with public institutions and civil society representatives. The aim was to develop a roadmap to accelerate the energy transition and stimulate the country's economic recovery.

2nd and 3rd Self-consumption and Energy Communities Summits

The 3rd Self-consumption Summit took place in 2023, attracting over 340 participants. The event was opened by Teresa Ribera, the Minister for Ecological Transition and the Demographic Challenge, who focused on the progress and status of Next Generation aid for self-consumption, access and connection for distributed generation, and underscored the significance of local entities. She also highlighted the development and evolution of collective self-consumption and energy communities. Key topics discussed included new business models, behind-the-meter storage systems and the safety and quality of self-consumption installations.

Inauguration of the 3rd Self-consumption and Energy Communities Summit

Source: UNEF

The 3rd Self-consumption and Energy Communities Summit, inaugurated by Teresa Ribera, the Minister for Ecological Transition and the Demographic Challenge, took place on 8 June 2023.

The conference featured contributions from more than 40 national experts in distributed generation and energy communities. Discussions centred on the challenges in developing energy communities and the obstacles faced by self-consumption projects, such as connecting to distribution networks and navigating administrative procedures.

Solar Energy and Sustainability Conference

Sustainability and environmental protection are among the top priorities for our association. At UNEF, we are committed to **promoting measures that enhance biodiversity** in photovoltaic plants by using a seal of excellence in sustainability for ground-mounted installations.

On 30 January 2024, we hosted the **second National Conference on Sustainability and Photovoltaic Plants** at the Congress of Deputies. This event attracted high-level political and institutional figures, including Hugo Morán, Secretary of State for the Environment at the Ministry for Ecological Transition and the Demographic Challenge; Marta Gómez Palenque, General Director of Environmental Quality and Assessment at the same ministry; and Francina Armengol, President of the Spanish Congress of Deputies. Parliamentary spokespersons, General Secretaries and Directors from various Autonomous Communities were also in attendance.

During the conference, the independent environmental consultancy EMAT presented the findings of the third Sustainability and Solar Energy Report. Additionally, twenty-two UNEF 2023 Seals of Excellence in Sustainability were awarded to ground-mounted solar energy projects, recognised for their exceptional standards of social and environmental integration.

2nd UNEF Conference on Sustainability and Photovoltaic Plants

Source: UNEF

Following the national conference, a regional event was held in Valencia on 24 June 2024, attracting over 200 participants. This turnout underscored the significant social and political interest in sustainability and specific measures to enhance biodiversity. The event featured numerous representatives from the Valencian Community, including Carlos Mazón, President of the Generalitat Valenciana; Felipe Javier Carrasco, Regional Secretary for Industry; Salomé Pradas, Regional Minister for the Environment; Nuria Montes, Regional Minister for Innovation; and Manuel Argüelles, Director General for Energy and Mines, among others.

The conference highlighted the harmony between clean energy production and biodiversity preservation in photovoltaic plants, while also emphasising the opportunities these plants present for fostering biodiversity development.

2nd International Summit on Storage and Hydrogen for Photovoltaic Energy

Organised by UNEF on 22 and 23 May 2023, the **2nd International Summit on Storage and Hydrogen for Photovoltaic Energy**, themed 'The future of photovoltaic energy', brought together more than 40 national and international experts, along with institutional representatives and over 455 attendees from the national photovoltaic sector.

The event focused on crucial topics concerning the future of photovoltaic energy and green hydrogen, stressing the opportunities that exist between clean energy production and biodiversity preservation in photovoltaic plants. It also addressed major **opportunities and business models for energy storage, as well as the technological challenges and regulatory barriers hindering its development**. Discussions included the necessary measures to deploy electrolysers for producing and consuming renewable hydrogen, along with presentations of successful examples of decarbonising industry and society through thermal storage and green hydrogen.

Technical and dissemination conferences

In 2023, UNEF was instrumental in advancing the photovoltaic sector, organising four webinars and six technical conferences. These events, conducted in both in-person and digital formats, have become key industry benchmarks. The high-quality content presented at these conferences has significantly spurred debate and reflection within the photovoltaic sector.

Conferences in Autonomous Communities:

- Photovoltaic Challenges - Catalonia
- Construction and Installation - Castile and León
- Construction and Installation - Andalusia
- Construction and Installation - Castile-La Mancha
- Bioagrivoltaics - Castile-La Mancha

Training courses:

- Introductory Course to the Electricity Market (online)

Webinars:

- How to Improve the Quality and Optimise the Management of Self-consumption Installations to Ensure Their Performance - Praxedo
- How to Effectively Monitor Performance, Facilitate Maintenance and Optimise the Operation of a Portfolio of PV Assets - Ampere
- Benefits of an EMS Platform for Renewable Energy Developers - Energy Pool
- Go Digital or Die During PV Plant Construction - Wiloc

Participation in Genera 2023:

Once again, UNEF collaborated with Genera, the International Energy and Environment Fair, to provide a platform for discussions on the energy transition. This event featured participation from leading companies and institutions in the sector. During the fair, UNEF organised three technical conferences that focused on significant issues related to photovoltaic solar energy and its role in shifting towards a more sustainable energy model:

- Conference on Financing
- Conference on Self-consumption
- Technology Conference in collaboration with Fotoplat

Conferences and webinars organised by or featuring FOTOPLAT:

FOTOPLAT PRESENTED ITS TECHNOLOGICAL STRATEGY, FOCUSED ON RE-INDUSTRIALISATION AND THE REVIVAL OF EUROPEAN INDUSTRY.

FOTOPLAT has significantly expanded its involvement in events, reports and conferences. In 2023, the notable event at Genera attracted over 150 attendees from the R&D&I sector in photovoltaics, alongside speakers from the Ministry of Science and Innovation, Huawei, Iberdrola and Baywa RE. FOTOPLAT also participated in the bioagrivoltaic conference in Toledo, among other events.

In addition, FOTOPLAT has increased the number of its technical webinars, covering topics such as:

- Photovoltaic Simulations: Software and Imagination
- Examining the Effects of Wind in the Photovoltaic Sector
- Impact of Soiling on Power Losses
- Energy Communities Based on Photovoltaic Self-consumption
- Lithium-Ion Batteries with LFP Technology for Photovoltaic Storage
- Perovskites: Materials that Transform Light Capture
- BIPV as a Key Material for Sustainable Building
- Perovskite on Silicon: A Sustainable Technological Disruption
- New ‘No Glass’ Photovoltaic Module

Working Groups

As part of the decision-making process and the support we offer to our member companies, UNEF regularly holds Working Groups that establish the foundation for future actions of the organisation. UNEF organises regular meetings for the following Working Groups:

Access and Connection WG: this group focuses on key issues regarding the integration of PV plants into the electricity grid.

Agrivoltaic WG: this group addresses topics related to dual land usage, explores potential applications of photovoltaic technology in agriculture, and discusses R&D&I strategies aimed at enhancing agricultural resilience through PV systems.

Storage WG: this group monitors advancements in storage technology and regulatory developments at both national and European levels.

Self-consumption WG: this group reviews current regulations, proposes improvements to Royal Decree 900/2015 and develops new connection schemes for shared self-consumption systems.

Communication WG: this group identifies strategic priorities for UNEF's communication efforts.

Circular Economy WG: established in response to a request from MITECO, this group is committed to tackling issues related to the recycling of solar panels and components, as well as R&D in manufacturing that aligns with circular economy principles.

REE Mirror WG: this group discusses topics related to REE Working Groups, including grid planning and grid codes.

Financing WG: this group delves into matters concerning project financing.

Hydrogen WG: this group explores potential synergies and applications of photovoltaic technology in hydrogen production.

Integration of PV in Buildings WG: this group is dedicated to promoting the technology and tracking national regulations around nearly zero energy buildings.

Internationalisation WG: this group monitors the international photovoltaic market and has planned three commercial visits to key markets, namely India, Arab countries and North Africa, and sub-Saharan countries.

Environment WG: this group focuses on understanding standard practices at plants and the measures being implemented to reduce environmental impact. The aim is to compile a manual of recommendations to minimise the environmental footprint of our facilities, streamline administrative processes and reduce compensatory measures. This is the newest addition to the Working Groups.

Operation and Maintenance WG: this group analyses procedures for modifications to existing facilities.

Energy Policy WG: this group discusses Spanish and European regulations, including the 2017 auctions, and has produced a report on PPA contracts. **Prevention, Occupational Risks (ORP) WG**: this group addresses health and safety issues within the photovoltaic sector.

Communication and public engagement

In 2023, the association reaffirmed **the importance of photovoltaic technology in the energy transition**, emphasising its commitment to

SOCIAL MEDIA CONTINUES TO GROW AS A COMMUNICATION CHANNEL, WITH UNEF'S FOLLOWERS EXCEEDING 73,000 ACROSS TWITTER, INSTAGRAM, FACEBOOK AND LINKEDIN.

sustainability and **biodiversity protection** in the deployment of installations. This communication initiative was bolstered by **collaboration with various civil society organisations**, including trade unions, consumer associations and political parties, which helped to disseminate the message in an objective, unbiased and data-driven manner.

The association stressed the importance of promoting the positive aspects of this renewable energy source as the focal point of its communication strategy. Emphasis was placed on the crucial role of this technology in **combating climate change**, as well as its **potential to bolster a national industry** that generates employment and wealth, serving as an economic driver.

IN 2022, THE ASSOCIATION ACHIEVED OVER 5,200 IMPACTS THROUGH NEWS AND OPINION ARTICLES PUBLISHED IN BOTH ONLINE AND OFFLINE MEDIA.

Social media has become an essential communication channel for UNEF, boasting over **65,000 followers** across platforms: 25,000 on Twitter, 6,000 on Facebook, 41,000 on LinkedIn and 1,500 on Instagram, with notable growth on LinkedIn and Instagram.

6.4. Commitment to sustainability

Seal of Excellence in Sustainability

UNEF is dedicated to advancing a sustainable energy transition, **aiming for new renewable facilities to provide direct benefits to the local area** and create shared value with local communities.

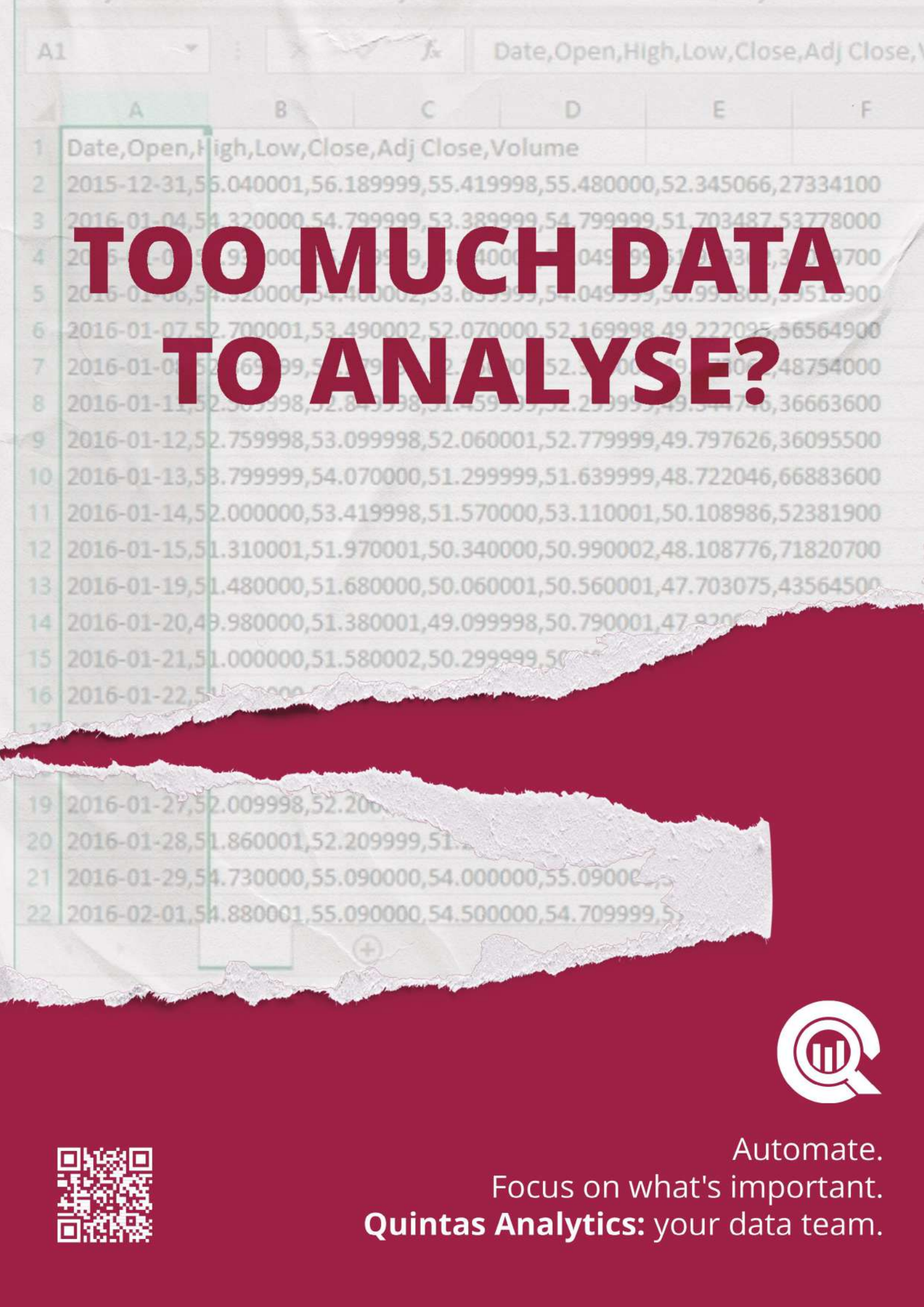
In 2019, we published our **Sustainability Recommendations**, a document outlining measures to enhance the environmental and social integration of photovoltaic installations. This document was presented to Teresa Ribera, the Vice-President and Minister for Ecological Transition, and distributed to sustainability officials across the Autonomous Communities.

THE SEAL OF EXCELLENCE IN SUSTAINABILITY CERTIFIES PLANTS MEETING THE HIGHEST SOCIO-ECONOMIC, ENVIRONMENTAL, GOVERNANCE AND CIRCULAR ECONOMY STANDARDS.

Building on this initiative, UNEF has developed **its own certification system for the sustainability** of photovoltaic installations. The objective of the Seal of Excellence is to certify that the photovoltaic plant project has been designed with high sustainability standards, focusing on **four key areas**:

- Socio-economic impact
- Environmental integration and biodiversity protection
- Governance
- Circular Economy

The auditing process for the UNEF Seal of Excellence in Sustainability is conducted by independent certifying bodies. Currently, we have two authorised entities: CERE and SGS.


TOO MUCH DATA TO ANALYSE?
Automate.
Focus on what's important.
Quintas Analytics: your data team.

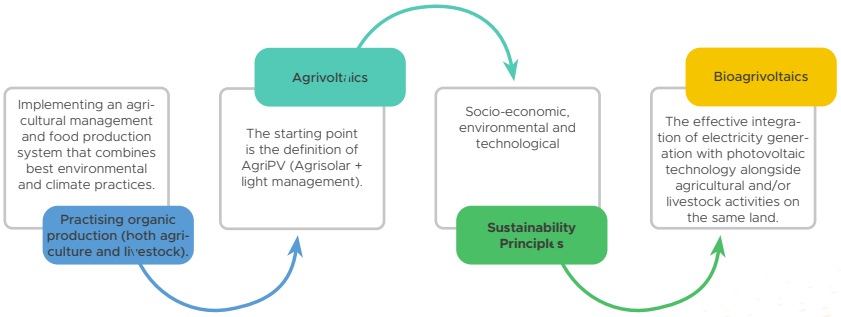
At present, 45 plants have been certified with the Seal of Excellence in Sustainability, of which 12 are operational.

UNEF proposal: Bioagrivoltaics

The EU Solar Energy Strategy highlights the need for a large-scale expansion of photovoltaic technology, incorporating innovative approaches such as multiple land use through agrivoltaics, which combines solar energy generation with agricultural activities.

Taking this concept further, UNEF introduces bioagrivoltaics, defined as the **effective integration** of photovoltaic **electricity generation** with **agricultural** and/or livestock activities on the same land. This approach operates under **ecological production** principles, including shared light management (R&D), to positively influence agricultural and livestock practices while supporting biodiversity.

In defining bioagrivoltaics, UNEF drew upon the concepts of ecological and agrivoltaic production, incorporating sustainability principles (socio-economic, environmental and technological) that have informed the development of the UNEF Seal of Excellence in Sustainability.



Definition Bioagrivoltaics. Proposal: UNEF

Bioagrivoltaics aims to achieve the following goals:

- In environmental and climate terms, it seeks to **maintain high levels of biodiversity, conserve natural resources and enforce strict standards for animal welfare and production.**

- **It aims to enhance agricultural productivity and support the economic well-being of farmers and livestock breeders**.
- It **seeks to create opportunities in rural areas** by implementing measures to revitalise land use, prevent depopulation, generate quality employment and reduce energy and social vulnerabilities among the population.

6.5. UNEF Studies

In 2023, the studies department has significantly ramped up its activities to enhance knowledge within the sector. The core topics covered include reports on the electricity market, the state of self-consumption and behind-the-meter battery installations, analysis of projects undergoing administrative procedures, environmental monitoring of ground-mounted plants and support for international organisations such as the International Energy Agency, IRENA,

REN21 and SolarPower Europe, among others.

Throughout 2023, UNEF has conducted over **25 studies and reports**:

1. Annual Report 2023
2. Report on self-consumption installed capacity in 2023
3. Electricity market monitoring report (March)
4. Report on installed storage in 2023
5. Electricity market monitoring report (May)
6. Report on the cost-effectiveness of behind-the-meter storage 2023
7. Self-consumption profitability report 2023
8. Coordination Biodiversity Study on PV plants
9. Report on water consumption in PV installations
10. Report for the Embassy of Moldova on the electricity market
11. Electricity market monitoring report (July)
12. IEA Task 1 National Status Report
13. IEA Task 1 Trends Report
14. Proposals for a Photovoltaic Industrial Strategy
15. Periodic analyses of the status of photovoltaic project processing
16. Price cannibalisation study
17. Analysis of daily market prices in 2023

18. Electricity market monitoring report (September)
19. SolarPower Europe: European Market Outlook 2023 (Spain)
20. SolarPower Europe: Global Market Outlook 2023
21. Weekly photovoltaic capacity factor
22. Analysis of the hourly profile of hydropower generation (with turbination and pumping)
23. Analysis of the hourly storage profile
24. Study of dynamic coefficients: Increasing the profitability of collective self-consumption
25. Proposal to Improve Access and Connection Conditions for Self-consumption
26. UNEF's regulatory proposals for the renewable sector
27. Electricity market monitoring report (November)
28. Final settlement 2022 for the electricity sector
29. 29. Analysis of the CNMC resolution, which sets the access tolls for electricity transmission and distribution networks effective from 1 January 2024, along with the system charges for 2024.

UNEF is deeply committed to the sustainability of the solar photovoltaic sector. To support this commitment, regular studies have been conducted to demonstrate how biodiversity enhancement measures at solar plants can create thriving habitats for flora and fauna, often turning these areas into de facto nature reserves. Three reports have been published, highlighting the strong environmental stewardship at these installations.

Biodiversity studies on birds and other wildlife at three solar photovoltaic sites (2021, 2022 and 2023)

In October 2021, UNEF released a report titled **"Biodiversity Study of Birds and Other Faunal Species at Three Solar Photovoltaic Installations"**, aiming to expand scientific knowledge on the environmental impacts of these facilities. Commissioned by the consultancy EMAT, the study assessed biodiversity at three solar installations, using birdlife as the primary bioindicator. The findings revealed that **photovoltaic installations are conducive to a diverse range of birds, invertebrates and other vertebrates, providing a safe breeding space** and aiding in the protection and conservation of species, including some that are protected.

In 2022, to build on previous findings and maintain momentum, UNEF commissioned EMAT to extend their studies. This time, additional plants across the region were included to reinforce the conclusions drawn in 2021. The plants studied were **La Magascona/Trujillo III** in Trujillo, Cáceres, and **Mula** in Mula, Murcia, both owned by Vela Energy; **El Quintillo** in Puertollano, Ciudad Real, belonging to the Renovalia Energy Group; and **Flotas de los Alamos** in Totana, Murcia, owned by ENEL Green Power España S.L.

The findings from 2022 and 2023 have strengthened the earlier hypotheses, showing that **photovoltaic plants serve as sanctuaries for wildlife**. The calm environment, lack of human intervention and the avoidance of insecticides, fertilizers and phytosanitary products, along with biodiversity-enhancing measures such as nesting boxes, drinking troughs, ponds and ecological corridors, **have a positive effect on biodiversity**, supporting the growth of flora and fauna in these areas.

If the site is well-selected, avoiding damage to high-value areas and the most sensitive species, and proper maintenance is undertaken, photovoltaic plants **can achieve a greater level of faunal biodiversity in the medium term than what existed previously**.

6.6. UNEF partners

INSTALLERS AND ENGINEERING COMPANIES

1KOMMA5
695 864 206
https://www.1komma5grad.com

8.2 MADRID
-
www.8p2.de; www.8p2.fr

ABASTE
914179963
http://www.abaste.com/

ABEI ENERGY
957 91 07 08
https://www.abeienergy.com/

ABO ENERGY ESPAÑA
963 531 180
https://www.aboenergy.com/es/

ACELERA ENERGÍA
(+34) 683 170 577
https://www.aceleraenergia.com/

ACOPLAN
+34 687 502 159?
https://acoplan.es

CLEANSUN
(+34) 630 021 095
CLEANSUN.ES

ADAMANT SOLAR
644 73 72 85
https://adamantrenewables.com/?lang=es

AETRON SOLAR
679780616
www.aetron.es

AFRY
672497053
afry.com

AGROENER
(+34) 955 410 729
WWW.AGROENER.COM

AICOSEN
938 891 995
https://www.aico.cat/aicosen-ser-veis-energetics

ALBA RENOVA
948 701 070
https://albarenova.com/

ALBEDO SOLAR
669 480 328
www.albedosolar.com

PICO INGENIEROS
609 107 741
https://picoingenieros.com/

HONRUBIA SOLAR
(+34) 617 127 092
https://www.honrubiasolar.es/

ALENER
954 996 100
https://alener.es/

ALFA GLOBAL
963 52 60 80
www.alfaglobal.es

ALFA INSTALLACIONS
93 470 65 40
https://www.alfainstal-lacions.com/es/

URBISOLAR
(+34) 694 499 662
https://urbisolar.com/

ALFASOL ENERGÍA
(+34) 621 248 283
https://alfasolenergia.es/

ENERGÍA ALJAVAL
(+34) 957 429 538
www.energia-aljaval.com

ALTERNA ENERGÍA
902 559 228
www.alternaenergia.com

ARESOL
941 255 868
www.aresol.com

ALTIMIRAS ENGINYERS CONSULTORS
938 891 949
http://altimiras.net/

AMDA ENERGIA
976 531 020
www.amda.es

AOD RENOVABLES
938047883
www.aodiberica.com

AWERGY
(+34) 865 572 826
https://awergy.com/

ARCONI SOLUTIONS
(+34) 613 325 286
https://arconi.solutions/en/

AREA VERDE SOLAR
622 458 669
www.areaverdesolar.com

ARTEIN
(+34) 629 642 241
www.mbartein.com

ARTENG
608 807 669
www.arteng.es

ARTICO
(+34) 636 250 181
www.grupoartico.com

OVE ARUP Y PARTNERS SA

(+34) 915 239 276

arup.com

ASTURMADI

985 52 57 55

http://www.asturmadireneergy.com/

ATLAS RENEWABLE ENERGY

(+34)636 470 663

www.atlasrenewableenergy.com/

SUELOS RENOVABLES

639 157 715

www.suelosrenovables.com

AUTOSOLAR

961 430 113

https://autosolar.es/

AVENIR ENERGIA

603 419 266

https://avenirenergia.com/

AXPO

915 947 170

https://www.axpo.com/es/es/nuestros-clientes.html

AZENTÚA

-

https://azentua.es/

BAI SOLAR

628767058

-

BAOBAB SOLAR WORKS S.L.

(+34) 625 581 290

www.baobabsolar.com

BARTER

902 004 102

www.barterenergy.es

ALGEBAT

956 927 177

http://www.algebat.com/

BDL ENERGY

954 218 103

www.bdlenergy.es

SOTYSOLAR

(+34) 685 608 158

https://sotysolar.es/

BELECTRIC ESPAÑA

649 681 832

https://belectric.com/en/

SILMA INGENIERÍA

987 403 675

https://www.silmaingenieria.com/

BAI SOLAR

628 767 058

BIKOTE SOLAR

944 383 608

https://bikotesolar.com/

BIOK ENERGY

(+34) 629 071 657

www.biokenergy.com

BLUEPROM

93 702 3249

www.blueprom.com

CANSOL

(+34) 685 077 987

www.cansol.es

CERDÁ RENOVABLES

34965546577

www.cerdasatori.com

CERFO

691 563 679

https://cerfo.net/

CERO2

622 570 656

www.cero2.es

CIRCE - CENTRO TECNOLÓGICO

976 976 859

https://www.fcirce.es

CKS LEVANTINA SOLUTIONS S.L.

670 349 010

www.ckslevantina.com

CVE RENOVABLE ESPAÑA SL

910 051293 (PENÍNSULA) / 822 621094 (CANARIAS)

www.clever-solutions.es

KOOI SECURITY ESPAÑA SL

973 208 060

www.saufer.com

METEO FOR ENERGY

955 188 169

http://www.coagener.com/es/

ORSTED

914 569 500

www.grupocobra.com

WHEREVER SIM GMBH

(+34) 695 600 026

www.cres.es

ZE ENERGY

622 246 883

WWW.CREENSOLAR.COM

CONERSA

911 852 352

www.grupoproingec.com

COPSA

947 241 733

https://www.copsaec.com/

INGENIA 21

677 50 34 61

https://www.ingenia21.com/

SOLARDAP

687 398 899

Www.solardap.com

DARGON
917 942 850
https://www.dargonenergy.com/index.php/es/

DEMESOL
(+34) 633 179 396
www.demesol.com

DENEL
(+34) 626 486 082
LOALNET.COM

INTELEC
953 884 997
www.intelec-ingenieria.com

ON+ SOLUCIONES ENERGÉTICAS
(+34) 616 491 596
www.onplussol.es

DIVERXIA INFRASTRUCTURE
902 565 274
www.diverxia.net

E4E SOLUCIONES
918 119 224
https://www.e4e-soluciones.com/

EFELEC ENERGY
948 049 366
https://www.efelecenergy.com

EIFFAGE ENERGÍA SISTEMAS
967 101 707
http://eiffageenergiasistemas.com/

ELCOM INSTALACIONES
698 928 820
www.elcominstalaciones.es

UENERGIA
(+34) 623 394 925
www.uenergia.es

EIG INTEGRAL SERCICES
938 468 392
www.eigeintegral.com

EMEREN
686 106 222
https://www.emeren.com/

ENDEF SOLAR SOLUTIONS
(+34) 629 409 194
www.endef.com

ENERDÓS RENOVABLES
(+34) 622 775 383
http://www.enerdos.es

ENERGES GESTION MEDIOAMBIENTAL S.L
955 723 797
www.energes.net

ENERGÍA ALJAVAL
34 95 742 95 38
www.energia-aljaval.com

ENERGREEN IBÉRICA
-
www.energreen.it

ENERGY RENOVABLES INGENIEROS
(+34) 628 14 85 99
www.energyrenovables.es

ENERGY SOLAR TECH
910 070 265
www.energysolartech.com

ENERLAND
(+34) 610 800 969
https://www.enerlandgroup.com/es/

ENERPAL
979745042
www.enerpal.es

ENERPARC
(+34) 687 322 144
https://www.enerparc.de/es

SUNERGIA SISTEMAS
916 845 749
www.sunergiasistemas.es

ENERSIDE
93 674 15 36
https://enerside.com/

ENPIA
609 875 307
#

EQUIP SOLAR
(+34) 682 041 991
www.equipsolar.es

ESCALA SOLAR
651 059 307
www.escalasolar.es

ETER SOLAR
941 185 710
https://etersolar.com/

EUDER ENERGY
911 135 249
http://www.euderenergy.com/

EUROCONTROL
630 097 851
https://eurocontrol.apave.com/

FAST SOLAR
(+34) 603 596 136
www.fastsolar.es

FICHTNER
-
https://www.fichtner.de/

ZINKEE
-
https://www.zinkee.com/solar

FOTOVOL
972 645 684
www.fotovolgroup.com

FOTOVOLTAICA 10
619 283 131
*

FREE POWER
935 724 162
www.freepower.es

FRIDA SOLAR
91 840 90 35; 673 025 376
www.fridasolar.es

INSOLAC RENOVABLES
954 529 942
www.insolacrenovables.com

GAMPEN INGENIERÍA, S.L.
670 704 855
http://www.gampen.es/

GEESOL
955 737 322
www.geesol.com

G-ENER
-
WWW.G-ENER.COM

GENKII
681 947 932
WWW.GENKII.ES

GE&PE INGENIERIA
954 636 737
www.geype.com

GOLDBECK SOLAR
(+49) 6201 7103 576
www.goldbecksolar.com

GREEN GENIUS
680 520 914
www.greengenius.com

GREEN4YOU
-
www.green4you.es

GREENFY
934 675 641
www.greenfyrenovables.com

GREENKW
946 510 262
www.greenkw.es

GREENSOLVER
(+34) 674 62 25 11
greensolver.net

GREENVOLT NEXT
650 225 742
https://next.greenvolt.com/es/

EM SOLAR Y RENOVABLES SL
(+34) 655 474 262
https://emsolar.es/

GS INIMA
910 505 250
www.inima.com

ENERHI
954 047 230
www.enerhi.com

HELIOSOLAR
(+34) 948 853 099
www.heliosolar.com

HEMAG SA
913 814 570
*

HOMESERVE
911 774 593
www.homeserve.es

HONRUBIA SOLAR
(+34) 617 127 092
https://www.honrubiasolar.es/

IBERSUN
946038084
www.ibersun.es

ICOENERGÍA
(+34) 912 569 955
www.icoenergia.com

ID ENERGY GROUP
(+34) 926 21 63 43
https://www.idenergy.group/

IDALIA ENERGY
722 112 388
www.idaliaenergy.com

IGU ENERGY
https://www.iguenergy.com/

IJES SOLAR
966 295 877
www.ijessolar.com

IKAV ENERGY
(+34) 661 433 958
https://www.ikav.com/

IL CONSULTING ENGINEERS
(+34) 645 614 225

IMENERGY POWER PLANTS
910 299 277
www.imenergy.es

INCALEXA
(+34) 622 789 488
https://www.incalexa.com/

GRUPO INCOMA
(+34) 654 625 706
http://grupoincoma.es/

FOTOENERGY
915 661 644
www.fotoenergy.es

INFINITYSUN
937 869 917
www.infinitysun.es

INGEMATIS (INGENIERÍA Y PREVENCIÓN INTEGRAL)
984 283 111 - 985 692 227
www.ingematis.com

IASOL
976 070 317
www.iasol.es

INGESENER
(+34) 608 22 63 18
https://www.ingesener.es/

EKISOLAR
945 001 023
www.ekisolar.com

INITEN
922 332 211
www.initen.com

INOCUA
(+34) 627 903 058
-

SOLAR UP!
935 80 28 98
https://solarup.es/

NIEVES ENERGÍA
(+34) 900 500 111
https://www.fotovoltaica.nievese-nergia.com/

ISP POWEN
900 535 795
www.powen.es

INSTALSUD
-
https://sud.cat

INSTELLA
(+34) 677 876 185
www.instella.es

INTELIUM
868 085 888
www.intelium.es

INTI ENERGIA
971 299 674
www.intienergia.com

INESOL
913 681 504
www.inesol.es

IPLAN
613 79 82 53
https://iplangestion.com/

IRRADIA ENERGIA
(+34) 610 786 601
https://www.irradiaenergia.com/

ELECTRICIDAD ISAAC
983 880 458
www.electricidadisaac.com

ISEMAREN
(+34) 680 521 407
https://isemaren.com/

ISOTROL
955 036 800
https://www.isotrol.com/

IZHARIA
91 603 02 17
https://www.izharia.com

JINKO POWER SPAIN
-
*

JORFE
973 249 706
www.jorfe.es

KEEEP
948 355 171
www.keeep.es

KENERGY
(+31) 20 491 71 50
www.kenergy.nl

POWEN
(+34) 666 759 591
www.powen.es

KIWA PI BERLIN IBÉRICA S.L.U
(+34) 681 007 567
www.pi-berlin.com

KONERY
(+34) 686 163 004
www.konery.com

KYREON SL
667 915 671
www.kyreon.es

LILAN ENERGY
911 351 718
www.lilanenergy.com

LUZ NATURAL
635 463 737
www.luznaturalautoconsumo.es

MAGTEL
(+34)957 429 060
magtel.es

ROMEU
655 444 581
*

MASNORTE RENOVABLES
(+34) 667 766 703
renovables.masnorte.es

MVSCADA
685 540 752
https://mvscada.com

MB SOLAR
948 072 091
www.mbsolar.net

METEOCONTROL IBERICA
(+34) 911 980 753
https://www.meteocontrol.com/es/

METKA EGN
-
www.metka-egn.com

MINISTRY OF SOLAR
-
www.ministryofsolar.com

MINUSWAT
(+34) 696 390 654
www.minuswat.es

FMP-ENERGIAS
654 809 891
WWW.FMP-ENERGIAS.ES

MONEGAS SOLAR
659 488 424
www.monegas.com www.monegassolar.com

MONELEG, SL
(+34) 686 949 363
www,moneleg.es

MORERA VALLEJO RENOVABLES
954 318 000
https://www.grupomorerayvallejo.es/

NARA SOLAR
(+34) 653 236 118
https://www.narasolar.com/

NATURCLIMA
(+34) 625 694 131
https://www.naturclima.energy/

NAVARRO DESARROLLLO
663 293 286
*

NEOMERCO
(+34) 606 765 008
*

NEOSITEC
661 493 316
www.neositec.es

NESS
(+34) 679 99 75 13
www.ness.es

OPENGY
(+34) 664 321 929
www.opengy.com

NEWAL ENERGY
606 728 986
*

NEXER
(+34) 627 250 509
www.nexer.es

NEXUN SOLAR SPAIN
617 138 325
www.nexun.eu

NORSOL ENERGÍA SOLAR
947 233 082
www.norsol.es

NOVA RENOVABLES
626 859 993
https://nova-renovables.com/es/

NOVALUZ ENERGÍA
644 815 865
https://novaluz.es/

OBREMO
-
www.obremo.es

OCA GLOBAL
(+34) 659 08 44 10
https://ocaglobal.com/es

OCTOPUS ENERGY SERVICES
900 759 190
https://octopusenergy.es/

OKAMI POWER
(+34) 656 31 69 66
https://okamipower.com/

ONE SOLAR
(+34) 605 557 005
https://onesolar.energy

ONEXUS ENERGY
638 447 506
WWW.ONEXUS.ES

ONRENOVA ENERGIA
0034 722 413 280
www.onrenovaenergia.com

ONTEC ENERGY
(+34) 937 341 585
https://ontecenergy.com/

ORSTED
-
https://orsted.es/

ORYX POWER
-
https://oryxpower.com/

OZASAN RENOVABLES
688 751 700
WWW.OZASANRENOVABLES.ES

PGI ENGINEERING & CONSULTING
(+34) 690 828 477
https://www.pgiengineering.com/

PICO INGENIEROS
609 107 741
https://picoingenieros.com/

ENI PLENITUDE IBERIA
653 126 961
https://eniplenitude.es/

POLAR DEVELOPMENTS SL
(+34) 629 424 561
www.polardv.es

PRENERGY
934 870 613
https://www.prenergy.es

PROFINE ENERGÍA
-
*

PROGRESSUM
(+34) 682 443 099
www.progressum.es

PRONOR
985 201 642
https://www.pronor.es/

PROYECTAPV
(+34) 629 254 284
www.proyectapv.com

QUANTICA RENOVABLES
(+34) 609 016 509
https://www.quanticarenovables.com/

QUINTO ARMÓNICO
983 347 641
www.quintoarmonico.es

RA SOLAR SYSTEMS & SOLUTIONS SPAIN
913 835 827
http://ra-solar.es

RAD ENERGY
(+34) 621 391 417
https://radenergy.es

RATEDPOWER
-
https://ratedpower.com/

REDEXIS
(+34) 607 145 136
www.redexis.es

RENOVABLES REMO
(+34) 655 289 443
www.renovablesremo.es

RENERA ENERGY SPAIN
-
https://renera.energy/es/

RENERGETICA
*
www.renergetica.com/home-es

RDS
968 353 400 / 691 524 921
https://www.grupords.es/

RENOVALIA ENERGY GROUP
915 904 070; 915 904 090
http://www.renovalia.com

RENOVARTIA
(+34) 619 751 589
www.renovartia.net

RENOWA
(+34) 677 540 297
http://renowa.es/

RETELEC
918 307 831
https://retelec.com/

RIOGLASS SOLAR
984 499 000
www.rioglass.com

RIOS RENOVABLES
948 840 056
www.riosrenovables.com

RISEN ENERGY
(+34) 666 340 762
www.risenenergy.com

ROMUR RENOVABLES
-
www.romurenovables.com

SABIA ENERGIA, S.L.
(+34) 692 574 644
SABIA.ES

SAMARA ENERGIA
644 112 402
www.samara.energy

SANTIAGO ABAITUA
(+34) 651 845 403
*

SAVITAR
-
www.savitar.es

SCHLAICH DAUSS
930 107 593
https://schlaich-dauss.com/

SECOEX RENOVABLE
900 732 731
www.gruposecoex.com

SEYSES
680 858 718
https://seyses.com/es/

SENS
(+34) 919 18 02 20
https://www.sens-energy.es

INEL
962 917 014
www.inel.es

SFERA PROYECTO AMBIENTAL
952 207 189
https://www.sferaproyectoambien-tal.com/

SFERAONE
927 224 693
https://www.sferaone.es/

SICAME
*
https://www.sicame.com/es/nues-tras-soluciones/energias-renovables/energia-solar

SIG
(+34) 613 007 129
https://sigcoop.com/

SIMA
656 9790 03

IMPULSO SOLAR
935 482 426
www.impulsosolar.eu

SOLAR DEL VALLE
957 771 720
www.solardelvalle.es

LUMIO*
https://lumio.solar

SOLAR EXPRESS ENERGIA
960 045 794

SOLAR JIENNENSE
628 114 855
www.solarjiennense.com

SOLARCASA
635 557 504
www.solarcasa.cat

SOLARDRONE
623 101 644
https://solardrone.es/

SOLARIG GLOBAL SERVICES
910 571 818
www.solarig.com

SOLARMENTE
-
SOLARMENTE.ES

SOLARNUB
(+34) 851 950 040
www.solarnub.com

SOLARPACK
*
www.solarpack.es

SOLARTRADEX
931 696 597
https://solartradex.com/

SOLARTREE
(+34) 629 212 284
https://solartree.es/

SÓLIDA
(+34) 682 37 55 74
solida.com.es

SOLIDEO RENOVABLES
900 171 019
www.solideo.es

SOLISNOR
(+34) 683 132 109
https://www.solisnor.es/

SOLIT ENERGIA SL
935 950 960
https://solitenergia.com/

SOLSULET
722 532 393
www.solsulet.com

SUD RENOVABLES
938 866 948
www.sud.es

SUN365
(+34) 669 630 822
www.sun365.es

KEPTON (SUNKE GROUP)
932 224 989
kepton.solar

SVEA SOLAR
(+34) 666 111 944
www.sveasolar.es

SWITCH DRONE
644 485 332
www.switchdrone.com

TAUBER SOLAR IBERIA
(+34) 607 911 799
www.tauber-solar.de

TERRANOVA
-
http://terra-nova.es/

TTA
(+34) 934 463 234
www.tta.com

PERFECTA ENERGÍA
610 567 600
https://www.perfectaenergia.com/

TRINA SOLAR SPAIN
(+34) 617 800 728

TUCSON ENERGY
625 383 231
Tucson-energy.com

TVANT
609 584 300
www.tvant.es

UMBRELLA SOLAR INVESTMENT
-
www.umbrellasolarinvestment.com

UNIVERGY SOLAR
91 421 20 80
www.univergysolar.com

V3J
963 519 341
www.v3jingenieria.com

VALFORTEC
964 062 901
www.valfortec.com

VIPRESOL
(+34) 654 313 851
WWW.VIPRESOL.COM

VIRIDI
915 27 71 76
www.viridire.com

VIVE ENERGIA
900 250 350
www.viveenergia.com

VOLTALIA
91 425 84 59
www.voltalia.com

VOLTECNIA
(+34) 639 127 956
www.voltecnia-led.es

WATT SOLAR
670 583 787
www.wattsolar.es

WILOC
(+34) 617 433 632
WWW.WILOC.COM

WORLEY
(+34) 917 991 092
https://www.worley.com/ https://www.advisian.com/en/

WSP
942 290 260
https://www.wsp.com/es-ES

XESMEGA
988 616 781
xesmega.es

URBISOLAR
(+34) 694 499 662
https://urbisolar.com/

SILMA
https://www.silmaingenieria.com/

HANWHA ENERGY CORPORATION EUROPA SLU
-
-

NAIAD 2012 S.L.
-
-

ONE HUB ENERGIA, S.L. (ONE SOLAR)
-
-

SOLARO ENERGIA Y PROYECTOS DE INGENIERIA SL

MIXTA

3E_IBERICA
93 117 11 10
https://3e.eu/

ENERGETIC INSURANCE
691 155 079
www.energeticinsurnace.com

ABANCA SERVICIOS FINANCIEROS
616 300 436
WWW.ABANCASERFIN.COM

ABOVE
(+44) (0) 120 691 3898
https://www.abovesurveying.com/

ADDLESHAW GODDARD (SPAIN)
914 260 050
https://myag365.sharepoint.com/sites/Spain

AEMA
(+34) 655 867 753
www.aema.info / www.aemahispanica.com

AGERE INFRA
91 451 4693
https://www.agereinfra.com/

ALANTRA SOLAR
915 773 429
www.alantra.com/alantra-solar

ALEASOFT
900 102 161
www.aleasoft.com

ALLEN & OVERY
917 82 98 00
www.allenovery.com

ALTER ENERSUN
924 232 250
alterenersun.com

ALTER5
(+34) 659 035 520
www.alter-5.com

ALTERMIA
(+34) 671 665 923
www.altermia.es

ALUMBRA ENERGIA
-
alumbraenergia.es

ALUMBRA
914 585 815
https://www.grupoalumbra.es/es/

AMARENCO
35 193 5991 465
www.amarenco.com

AMPERECLOUD
(+34) 964 800 151
https://www.amperecloud.com

ANTUKO
*
https://antuko.com/

AP EXECUTIVE SEARCH
600 777 355
https://ap-executivesearch.com/

AQUISGRAN FINANCE
911 049 521
https://www.aquisgran.es/

ARRAM CONSULTORES
924 207 083
https://www.arram.net/

ACER
922 244 631
http://www.acer.org.es/

ACENEL
-
https://www.acenel.es/

SORECAN
928 235 397
www.sorecan.com

AUREA CAPITAL
915 215 548

AVANZA ENERGY

955 720 818

http://www.avanzaideas.com/

AVANZALIA

912 682 299

https://avanzalia.net/

AXON TIME

+34 966 59 21 50

https://axontime.com/

BA RAS

91 310 70 80

http://www.ba-ras.com/es/inicio/

BBVA

-

www.bbva.com

BAYWA R.E.

697 121 724

https://www.baywa-re.es/es/

BDO

914 36 41 90

https://www.bdo.es/

BECQUEREL INSTITUTE ESPAÑA

664 039 393

https://www.becquerelinstitute.eu/es

BLUETREE GROUP

91 657 22 87

https://bluetree.group/

BMS GROUP

954 286 216

https://iberia.bmsgroup.com/

BOVÉ MONTERO Y ASOCIADOS

915 615 414

www.bovemontero.com

BRIGHT SUNDAY

(+34) 610 719 463

https://www.brightsunday.com/

BULLFINCH

(+34) 600 555 828

https://www.bullfinch.com/

BUREAU VERITAS

(+34) 636 347 345

https://www.bureauveritas.es/

CNATS

-

https://www.upo.es/cnats/

CERE

(+34) 691 767 942

https://www.cerecertification.com/

CIRCULAR REPLAY

-

https://circularreplay.com/

GALP NEW ENERGIES, S.A.

952 020 580

https://enerclic.es/

SABIA ENERGIA, S.L.

656 829 560

http://kolya-pne.com/

DEL POZO & DE LA CUADRA ABOGADOS

608 282 068

www.dpdc.es

DELTA POWER

(+34) 617 534 462

www.deltapwr.com

DH2 ENERGY

(+34) 653 959 652

www.dh2energy.com

DNV GL SERVICES SPAIN,S.L.

976 398 424

https://www.dnv.es/power-renewables/index.html

DOS GRADOS CAPITAL

917 691 125

https://www.linkedin.com/company/35693947/admin/

ECO ENERGY WORLD

(+34) 687 845 177

eew.solar

ECONERGY

+44 7548 342535

https://www.econergytech.com/

ECOOO ENERGÍA CIUDADANA

912 940 094

www.ecooo.es

ECOPPIA SCIENTIFIC LTD

+34 91 076 71 38

ecoppia.com

ECROWD!

935511448

https://www.ecrowdinvest.com/

EDISON NEXT

(+34) 646 390 955

https://edisonnext.es/

EFORA TECHNOLOGIES

(+34) 649 984 908

www.efora-technologies.com

EKHI

689 337 021

https://ekhi.energy/

ELEIA ENERGÍA

918 205 215

https://www.eleiaenergia.com/

ELONA CAPITAL

(+34) 689 253 104

www.elonacapital.com

ENERCLUSTER

-

https://www.enercluster.com/

ENERFIP

+34 919 49 98 97

https://enerfip.fr

ENERGIAS RENOVABLES CINCA

*

L'ENERGÈTICA

938 574 000

http://www.lenergetica.cat/

ENERTIS APPLUS+

91 651 70 21

www.enertisapplus.com

PLENITUDE

675858143

https://eniplenitude.es/

PLENITUDE

(+34) 695 679 525

https://eniplenitude.es/renovables/

EHS TECHNIQUES

918 526 696

www.ehstechniques.com

ERANOVUM ENERGY

https://eranovum.energy/

ESCAN CONSULTORES ENERGÉTICOS

913 232 643

https://escansa.es/

ESPARITY SOLAR

663 2203 25

www.esparitysolar.com

SÍNTESI

687 055 067

https://sintesi.cat/es/energias-renovables/

ETURNITY AG

(+41) 81 511 54 86

https://eturnity.com/en-glob/solaren-glob/

EUROPEAN ENERGY

(+34) 651 810 244

www.europeanenergy.com

VULPES CONSULTORIA AMBIENTAL

655 664 408

https://vulpesambiental.com/

EVEROZE

https://www.everoze.com/

EZZINGSOLAR

(+34) 661 746 581

ezzing.com

FACTOR ENERGIA

91 193 50 85 / 93 362 15 60

www.factorenergia.com

FENÍE ENERGÍA

900 215 470

https://www.fenieenergia.es/nosotros/

FINERGREEN

+34 617 65 97 23

https://finergreen.com/

FLOBERS

(+34) 91 737 98 12

www.flobers.com

CENER

948 252 800

www.cener.com

TECNALIA

34 663 994 639

www.tecnalia.com

FUNDEEN

911 238 277

www.fundeen.com

GARCIA ALAMAN

913 597 589

www.galamanseguros.es

GESTION BAVIGENA

625 538 785

https://www.linkedin.com/in/gestion-bavigena-s-l-53ab79151/

GLIDE ENERGY

675 122 172

www.glide-energy.com

GREEN MIND VENTURES

(+34) 618 679 907

https://greenmindventures.com/

GREENCELLS GROUP

(+34) 670 474 106

https://greencells.com/

GREENING CONCESIONES SLU

603 559 927

GREENPOWERMONITOR, A DNV COMPANY

+34 935 510 703

www.greenpowermonitor.com

GRANSOLAR

917 364 248

https://gransolar.com/

IMAGINA ENERGIA

www.imaginaenergia.com

HELEXIA

658 68 50 97

helexia.es

HSF - HERBERT SMITH FREEHILLS

914 234 000

https://www.herbertsmithfreehills.com

HIVE ENERGY

965 059 765

https://www.hiveenergy.co.uk/

HOLALUZ

www.holaluz.com

HOLTROP

935 193 393

https://holtrop.legal/

HOWDEN IBERIA

917 811 515

Howdeniberia.com

IDEAS MEDIOAMBIENTALES

967 610 710

IEDRE ENERGETICA CORPORACION SL

954 285 238

IMPELIA ENERGY

608 052 319

*

INGELECTUS S.L.

+34 954 46 04 46

https://ingelectus.com/

INGEUS

619 293 620

www.ingeus.es

IES-UPM

910672523

www.ies.upm.es

ISFOC SAU

34 926 441 673

www.isfoc.net

IGP

622 244 200

www.islandgp.com

JLL

+34 639175496

https://www.jll.es/es/mercados/energias-renovables

K4K TRAINING & ADVISORY

+34 606 235 149

www.k4kadvisory.com

KIRA VENTURES

914 135 146

https://kira.ventures/es

KOOI SECURITY ESPAÑA SL

(+34) 935 247 400

www.247kooi.es

LAMAIGNERE CARGO, S.L.

(+34) 610 422 100

www.lamaignere.com

LAXTRON

686 790 980

*

KÄMPE

-

http://kampejobs.com/

LEVELTEN ENERGY

(+34) 638 218 064

https://www.leveltenenergy.com/

SOLARLAB

619 261 939

www.solarlab.es

MARSH

+34 948 366 602 | +34 676 721 849

https://www.marsh.com/us/home.html

MATRIX RENEWABLES SPAIN

91 343 22 64

https://matrixrenewables.com/

MENAPY

-

www.menapy.com

MERCADOS ARIES INTERNATIONAL

915 795 242

www.mercadosaries.com

METEO FOR ENERGY

945 771 085

MICROSEGUR

(+34) 619 148 994

https://microsegur.com/

MONTERO -ARAMBURU

910 327 693

WWW.MONTERO-ARAMBURU.COM

CIRCLE ENERGY

911 091 102

www.circle.energy

NEXUS ENERGÍA

900 818 533

https://www.nexusenergia.com/

NORDIC GUARANTEE

-

www.nordicguarantee.com

ONTIER ESPAÑA

+34 91 431 30 00

www.ontier.net

ORES & BRYAN CORREDURÍA DE SEGUROS

610 176 565

www.oresybryan.com

OSBORNE CLARKE

(+34) 649 442 811

https://www.osborneclarke.com/

OX2

+34 637 27 40 41

www.ox2.com

PARQUES SOLARES DE NAVARRA

948 247 418

www.parquessolaresdenavarra.com

PEXAPARK

41 788 519 665

https://pexapark.com/

PINSENT MASONS

91 048 4000

https://www.pinsentmasons.com/

GOPARITY

640 770 046

www.goparity.com

PREDIKTOR

+47 954 08 000

https://www.prediktor.no/pview/

QUALITAS ENERGY
914 238 270
http://www.qualitasenergy.com/

QBI SOLUTIONS
914 91 50 84
https://hubs.ly/Q02y6p9r0.com

GOLDENGREEN - QCAPITAL. ENERGY
34 687 725 011
www.QCapital.Energy

QUALIFYING PHOTOVOLTAICS
644 72 51 74
www.qpv.es

RECAP ENERGY
(+34) 620 881 834
https://www.recap.se/

RECYCLAIR
945 301 919

RENEWCO
-
https://renewcopower.com

RINA
(+34) 633 499238
https://www.rina.org/en

RISKPOINT
riskpoint.eu

RJ EURODEVELOPMENT
https://www.rn-j.com/en/

ROBINSUN
34 911 392 177
www.robinsun.com

RÚSTICUS
(+34) 690 026 070
https://rusticus.es/

SANZA ENERGY
*
www.sanzaenergy.com

WATTWIN
932 208 154
www.wattwin.com

SGS
+34 91 313 80 00
https://www.sgs.es/

RECYCLIA
914 170 890
www.recyclia.es

SIMMONS & SIMMONS LLPC
-
https://www.simmons-simmons.com/en/offices/madrid

SINIA RENOVABLES
-
https://www.siniarenovables.com/

SOLAR MONKEY
+34 644 570 340
www.solarmonkey.es

SOLARBAY
(+34) 616 968 427
-

2SOLAR BY SOLLIT
31 624 412 627
2solar.nl/es

SOOF
(+34) 638 80 98 27
www.soof.es

SPIRE SOLAR IBERIA SL
(+34) 625 280 950
https://testing.spiresolar.com/es/

SUNCO CAPITAL
(+34) 911 714 151
www.sun.co

SUNHERO
932 200 309
sunhero.com

SUNWISE
19 044 384 278
sunwise.io

TAIGA MISTRAL
913 576 310
www.taigamistral.com

TEXLA
954 502 220
-

GREEN TIE CAPITAL
+34 954 296 900
https://greentiecapital.com/

THUNDER HUNTER
634 875 217
www.thenergia.com

TRACE SOFTWARE INTERNATIONAL
-
https://www.trace-software.com/

TRAILSTONE RENEWABLES
(+34) 626 310 923
https://www.trailstonegroup.com/

TRANSEARCH
(+34) 630 460 768
www.transearch.com

UKA IBERIA
+ 34 678 247 230
uka-group.com

UL SOLUTIONS
933 681 310
https://www.ul.com/industries/energy-and-utilities/renewables

UNEF
-
-

UPNET TELECOMMUNICATIONS
(+34) 633 818 188
https://www.upnet.es/

AXPO SOLAR IBERIA

(+34) 683 13 73 08

urbasolar.com

VACOE SOCIEDAD COOPERATIVA

923 150 767

https://vacoe.es/

VECTOR RENEWABLES

34 917 025 369

https://www.vectorenewables.com/

VERDIA LEGAL

932 400 200

www.verdialegal.com

VINCES CONSULTING

+34 917 02 47 37

www.vincesconsulting.com

ENOVA ENERGIA

(+34) 654 280 378

enovaenergia.com

VOLATEQ

-

www.volateq.de

WFW

915 15 63 00

https://www.wfw.com/

WATTSTOR

+44 (0)7507719638

https://wattstor.com/

Wattwin

932 208 154

www.wattwin.com

WHEREVER SIM GMBH

+34 951 127 251

https://es.whereversim.de/

WHITE SUMMIT CAPITAL

-

https://whitesummitcap.com/

WIND TO MARKET

914 326 421

www.w2m.es

WORLDWIDE RECRUITMENT ENERGY

(+34) 647 462 396

https://energy.worldwiderecruitment.org/

YOUDERA

910 608 165

www.youdera.com

STORAGE

AMPERE ENERGY

965 02 36 56

https://www.ampere-energy.com

BAMBOO ENERGY

https://bambooenergy.tech/es/

BEEPLANET FACTORY S.L.

-

https://beeplanetfactory.com/

BK ENERGIES

-

https://bkenergies.com/

CHELION

-

www.chelion.eu

DYNESS

-

www.dyness.com

E22

917 364 248

energystoragesolutions.com/es/

ENEQUI

+34 650 53 09 20

https://www.enequi.com/es/

EXIDE

+ 34 670 73 93 17

https://www.exidegroup.com/

HYDRAREDOX

97 622 88 96

https://es.hydraredox.com/

RIC ENERGY

910 886 320

http://ric.energy/

RIELLO SOLARTECH

902 026 654

https://riello-solartech.com

SAJ

34 699 651 418

https://www.saj-electric.com/

SONNEN SPAIN

900 649 423

www.sonnen.es

STORAGE ENERGY

8,61351E+12

WWW.ABSENENERGY.COM

UBORA SOLAR

671449787

WWW.UBORASOLAR.COM

MANUFACTURERS

ACRE SURVEYING SOLUTIONS

902 490 839

WWW.GRUPOACRE.ES

ALLIMEX GREEN POWER

685 353 285

www.allimexgreenpower.com/es

ALUSÍN SOLAR

98 411 27 59

www.alusinsolar.com

APLITECH ENERGY

937 15 82 58

https://www.aplitech-energy.com/

ARRAY STI NORLAND

34 94 826 01 29

https://stinorland.com/

ARRAY TECHNOLOGIES

*

http://arraytechinc.com

ATERSA

*

https://www.atersa.com

AXIS COMMUNICATIONS
918 03 46 43
https://www.axis.com/es-es

BEYONDSUN
(+34) 619 970 465
https://www.beyondsunpv.com/

BMI
-
https://www.bmigroup.com/es/

BRAUX
(+34) 618 842 239
www.braux.es

BUILD TO ZERO
-
https://buildtozero.es/

CHINT ENERGY, S.L.
93 467 37 78
https://chintenergy.com/

CONVERT ITALIA SPA
+39 34 536 01 284
https://www.valmontsolar.com/

DITECH
-
it.ditech.es

DMEGC SOLAR
34 616 389 013
https://www.dmegcsolar.com/

EKS ENERGY
37 695 418 1521
https://eksenergy.com/

ESASOLAR
(+34) 916 264 552
https://esasolar.com/es/

ESCELCO
+34 987 526 880
www.escelco.eu

ESDEC BV
35 196 410 4113
esdec.com

EXTRUAL
96 721 66 62
www.extrual.com

FIRST SOLAR GMBH
49 172 6191 664
www.firstsolar.com

FISCHER IBERICA
(+34) 606 090 594
www.fischer.es

FRONIUS ESPAÑA
916 496 040
www.fronius.es

GAMESA ELECTRIC
+34 944 317 600
https://www.gamesaelectric.com/

GAVE
938422212
www.gave.com

GONVARRI SOLAR STEEL
+34 985 12 82 00
www.gsolarsteel.com

GOODWE
-
https://es.goodwe.com/

GROWATT
+34 699 734 029
https://es.growatt.com/

HUAWEI
+34 615 570 260
https://digitalpower.huawei.com/es/

HUAYAO PV
-
www.hy-pv.com

HYXI POWER
+34 690 60 67 45
www.hyxipower.com

IBC SOLAR
(+34) 662 339 280
https://www.ibc-solar.es/

INDEX
94 127 21 31
https://www.indexfix.com/

INGETEAM
94 828 80 00
https://www.ingeteam.com/es-es/sectores/energia-fotovoltaica/s15_24_p/productos.aspx

ISIGENERE - ISIFLOATING
(+34) 619 261 650
www.isigenere.com

JINKO SOLAR GMBH
-
https://jinkosolar.eu/

JOLT ACTIVATED
34 93 088 03 61
https://jolt-solutions.com/

K2 SYSTEMS S.L.U.
(+39) 349 336 2962
https://k2-systems.com/es/

LEDVANCE LIGHTING SA
629 170 687
https://www.ledvance.es/

LIVOLTEK
667 895 114
http://www.livoltek.com

LONGI
(+34) 678 925 168
https://www.longi.com/es/

LUXEN SOLAR
(+34) 868 075 061
https://www.luxensolar.com/

MAXEON SOLAR TECH
*
https://sunpower.maxeon.com/es/

MF RENOVABLES
924 290 111
www.mfrenovables.com

MIDSUMMER
(+46) 768 912 767
www.midsummer.se

MONDRAGON ASSEMBLY
34 672 690 900
www.mondragon-assembly.com

NEXTRACKER
+34 91 992 09 67
www.nextracker.com

ORMAZABAL

(+34) 916 95 92 00

https://www.ormazabal.com/es

POHLCON SOLAR

Fabricantes

49 160 557 98 09

www.pohlconsolar.com

PRAXIA ENERGY

985 211 117

https://www.praxiaenergy.com/

PROAT SL

935 790 610

www.proat.es

PROSOLAR BIRDS

680 931 542

https://prosolarbirds.com/

QN SOLAR

675 544 245

http://fyzq.case74.coyuns.cn/

ROBSYS ROBOTIC SYSTEMS

+90 552 781 76 81

https://rob-sys.es/

SAJ

34 622 852 499

https://www.saj-electric.com/

SALICRU

636 116 399

www.salicru.com

SCHLETTER ESPAÑA

96 676 75 34

www.schletter-group.com

SHOALS TECHNOLOGIES GROUP

*

www.shoals.com

SIGENERGY TECHNOLOGY

-

https://www.sigenergy.com/es

SILICONVALEN

653 246 230

www.siliconvalen.eu

SLENERGY

+34 659 273 794

www.slenergy.com

SMA

(+34) 609 132 227

www.sma-iberica.com

SOLARWATT ESPAÑA

659 510 910

www.solarwatt.com

SOLAX POWER

(+34) 667046788

https://es.solaxpower.com

SOLPLANET

(+34) 676 633 900

www.solplanet.net

SOLREINA

(+34) 633 401 027

http://solreina.com/

SOLTEC

(+34) 681 137 289

www.soltec.com

STANSOL ENERGY

(+34) 626 457 726

http://www.stansolgroup.com

STÄUBLI

937 206 550

https://www.staubli.com/en/

STEALTH ENERGY

34 651 503 958

www.stealthenergy.cn

SUN SUPPORT

958 541 360

https://www.sunsupport.es/

SUNGROW

(+34) 948 11 75 98

https://spa.sungrowpower.com

SUNOVA BECOMES THORNOVA SOLAR

613 062 268

https://www.sunova-solar.com/es/

SWATTEN

+34 653441658,

https://www.swatten.com/

TAMESOL

+34 603 167 813

www.tamesol.com

TRACTEL

610237240

www.tractel.com

UNEX

93 333 87 00

www.unex.net

VECTOR ENERGY

(+34) 935 748 206

www.vectorenergy.com

XIZAN ENERGY

-

https://www.xizanenergy.com/

YINGLI GREEN ENERGY SPAIN

918 436 726

http://www.yinglisolar.com

ZCS AZZURRO

-

https://www.zcsazzurro.com/es/

ZIGOR

-

http://www.zigor.com

PRODUCERS

AEA RENOVABLES

976 302 889

https://www.aearenovables.com/

AGR-AM

(+34) 638 063 793

NA

AGROLLUM

(+34) 619 700 179

www.agrollum.com

AIP MANAGEMENT

(+34) 661 435 198

https://aipmanagement.dk/

AJUSA
967 216 212
https://ajusa.es/

AKUO ENERGY
(+33) 1 47 66 09 90
https://www.akuoenergy.com/fr/

ALDESA
913 819 220
https://www.aldesa.es/

ALEPH CAPITAL
(+34) 663 124 224
https://alephcapital.es/

ALERION
*
www.alerion.it

ALTEN ENERGÍAS RENOVABLES
91 563 09 90
www.alten-energy.com

ANUDAL SLU
609961220
-

APTIMUS
Productores
-
https://aptimuscapital.com/

AQUILA CLEAN ENERGY
915 119 050
https://www.aquila-clean-energy.es/

ASCIA RENOVABLES
(+34) 915 56 28 66
https://grupoascia.com/renovables/index.html

AUDAX
93 240 53 06
https://www.audaxrenovables.com

AVINTIA
91 512 27 11
https://www.grupoavintia.com/divisiones-grupo/energia/

AZORA
-
-

BENBROS ENERGY
-
https://benbros.es/

BNZ ENERGY
(+34) 690 093 424
http://www.bnz.energy/

BRUC
*
www.brucmanagementprojects.com

CAMPO ZERO
-
-

CAPITAL ENERGY
+34 679 769 227
http://www.capitalenergy.es/

CEPSA
*
https://www.cepsa.com/es

CERO
-
www.cerogeneration.com

CIP
-
https://cipartners.dk/

COX ENERGY
(+34) 608 528 568
www.coxenergy.com

CTG EU
+34 919546300
https://www.ctg.com.cn/en/

CUBICO
664264333
https://www.cubicoinvest.com/es/

CVE RENOVABLE ESPAÑA SL
-
-

DISA
922 238 700
https://www.disagrupo.es/

DOMINION ENERGY PROJECT S.L.
917 434 950
www.dominion-global.com/es

EDINOR
*
www.edinor.eus

EDORA
*
WWW.GRUPOEDORA.COM

EDP Renovables España
900830004
https://www.edpr.com/es

ENCE
(+34) 659 136 291
https://ence.es/magnon-green-energy/

ENDESA GENERACIÓN
912139391
https://www.endesa.com/es

ENGIE España
91 310 62 70
https://www.engie.es/

ESTABANELL
(+34) 676 898 122
https://www.estabanell.cat/

EUROWIND ENERGY SL
34699451780
https://eurowindenergy.com/es

EVERWOOD CAPITAL
(+34) 911 332 757
https://everwoodcapital.com/

FERROVIAL
+34 91 586 25 00
https://www.ferrovial.com/es-es/

FF VENTURES
*
www.ffsventures.com

FINERGE SA
(+351) 226 080 180
www.finerge.pt

FRV
91 319 12 90
https://frv.com/

GALP NEW ENERGIES, S.A.
91 714 67 00
https://www.galp.com/corp/es/

GESTINALIA ENERGIA
644483078
http://www.gestinalia.info/

GOLDBECK SOLAR ESPANA, S.L.
-
-

GREEN ENERGY SPAIN
629100347
greenenergyofspain.com

GREEN PULSE
645 506 649
https://www.greenpulse.eu

GREENALIA
604074163
greenalia.es

GREENCOAT RENEWABLES
0044 7730 760 037
https://www.greencoat-capital.com/

GRENERGY
+(34) 91 708 19 70
www.grenergy.eu

HANWHA CONVERGENCE
647 91 75 91
www.hanwhaconvergence.com

HECE
(+34) 636 966 181
https://www.hanwha.com/en/products_and_services/affiliates/hanwha_energy.html

HELIO
34608294008
www.helioep.com

HERGO RENEWABLES
647 94 18 49
-

HYP Renewables Spain, S.L.
+351 215 875 400
https://hyperionrenewables.com/

IBERDROLA RENOVABLES
*
www.iberdrola.com

IBERIA SOLAR
*
www.iberia-solar.com

IBOX ENERGY
(+34) 608 528 568
www.iboxenergy.com

IBV SOLAR SPAIN
(+34) 669 294 359
https://www.ibvogt.com/

IGNIS ENERGÍA
910059775
https://www.ignisenergia.es/

INSTITUTO DE INGENIERÍA DEL CONOCIMIENTO (IIC)
914972323
www.iic.uam.es

IOSA GREEN ENERGY
669034140
-

IRIH
*
-

KM0 ENERGY
93 193 90 99
km0.energy

LIGHTSOURCE BP
+34 685851548
https://www.lightsourcebp.com/es/

NALA RENEWABLES
-
https://www.nalarenewables.com

NATURGY RENOVABLES
900 100 251
https://www.naturgy.com/inicio

NETON POWER
(+34) 608 876 868
www.netonpower.com

NEXWELL POWER
-
https://nexwellpower.com/

NORTHLAND POWER
914 56 78 59
https://www.northlandpower.com/

OBTON
(+45) 255 54 048
www.obton.com

OHLA ENERGY
-
https://ohla-group.com/

Opdenergy
(+34) 674 215 571
www.opdenergy.com

PAGOLA
(+34) 670 995 315
pagola@pagolaenergia.es

Parque Tecnológico ESGC
92 823 53 97
https://esgrancanaria.es/

PLENIUM PARTNERS
674125157
http://www.pleniumpartners.com

PORTIVA
420602202774
https://www.portiva.cz/en/

Powerstroom Tres SL
+34 625818070
-

PRODUCCIONES FOTOVOLTAICAS ZAMORANAS
*

PROKON
(+34) 676 061 293
www.prokon.net

PROYECTOS QNQ
34936623011
-

PRYNERGIA
915 140 300
www.prynergia.com

Q ENERGY
(+34) 616 389 013
https://qenergy.eu/europe/es/

QAIR
000 000 000
WWW.QAIR.ENERGY

QUINTAS ENERGY
954324365
https://www.quintasenergy.com/

R.POWER
(+34) 636 82 43 11
https://rpower.solar/es/

RECURRENT ENERGY
-
www.recurrentenergy.com

REDEN
917373617
https://reden.solar/es/

RENANTIS
(+34) 638 27 02 88
https://www.renantis.com

RENEWABLE POWER CAPITAL
(+34) 696 733 925
https://renewablepowercapital.com/

REPSOL
-

RP GLOBAL
(+34) 654 482 371
www.carril-solar.es

RWE RENOVABLES IBERIA
(+34) 674 127 857
https://www.rwe.com/en/the-group/countries-and-locations/rwe-renewables-in-spain

SACYR CONCESIONES RENOVABLES
628989318
https://www.sacyr.com/

SAETA YIELD
638428770
https://www.saetayield.com/

SHELL
-
https://www.shell.es/shell-energy-soluciones-energeticas.html

SMARTENERGY
+34 963 155 077
https://www.smartenergy.net/

SOLAR VENTURES SRL
39027621241
www.solarventures.it

SOLEK
+420 722 931 678
https://www.solek.com/es

SOM ENERGIA
(+34) 872 20 25 50
https://www.somenergia.coop/ca

SONNEDIX ESPAÑA
913186711
www.sonnedix.com

SOTO SOLAR
679838378
www.sotosolar.com

SSE RENEWABLES
-
www.sserenewables.com

STATKRAFT
+34 630500340
https://www.statkraft.es/

SUN INVESTMENT GROUP
696 681 432
https://suninvestmentgroup.com/

SUNOWATT
(+34) 607 073 495
*

TECHNIQUE SOLAIRE
*
http://www.techniquesolaire.com

TECNORENOVA SOLAR
982523513
www.tecnorenova.com

TERSA
-
www.tersa.cat

TOTAL ENERGIES
-
https://totalenergies.com/spain

VACOE SOCIEDAD COOPERATIVA
976233132
WWW.NAFTE.ES

VELTO RENEWABLES
91 368 57 31
https://veltorenewables.com/

VERBUND GREEN POWER IBERIA
667925693
www.verbund.com

VERSA
915713301
https://cyopsa.es/

VSB NUEVAS ENERGÍAS
960269784
www.vsb-energias.es

X-ELIO
911 770 010
https://x-elio.com/

ZE ENERGY
33699662326
https://ze-energy.com/en/

DISTRIBUTORS

AMARA NZERO
917 231 600
https://amaranzero.es/

AMIXALAN ENERGY
688 776 244
amixalanenergy.com

CEF ESPAÑA
663 648 569
www.cefltd.com

DPV ENERGY

963 318 066

https://dpvenergy.com

EASTECH SOLAR

91 632 41 11

www.eastech.es

ECOVATIOS

900 820 832

https://ecovatios.com/

ELECTRO STOCKS

936 036 688

http://www.grupoelectrostocks.com

Energy3000 Solar GmbH

+43 664 78 030 727

https://energy3000.com/

Green Efficient

922 688 320

www.greenefficientsolutions.com

Green Fusion Solar

917 377 378

www.greenpower-technologie.com

Grudilec

(+34) 630 435 994

www.grudilec.com

GRUPO JAB

(+34) 682 692 506

www.grupojab.es

GRUPO NORIA

935 922 838

https://gruponoria.com/

Krannich Solar

686403348

krannich-solar.com/es-es

LUMISOLAR

93 605 77 61

www.lumisolar.es

MYLIGHT150

(+34) 661 071 593

https://mylight150.com/es/

NATEC

+34 960 130 613

https://natec.com/es/

Paragon Solar

693 492 557

www.paragonsolar.es

PHOTON

958 447 167

http://photonrenovables.com

SALT & SUN ENERGY

93 130 27 47

www.ss-energy.es

SALTOKI

948 18 90 18

www.saltoki.com

SS360

678 484 513

www.solarsolutions360.com

Suministros Orduña

92 510 51 55

www.suministrosorduna.com

Taurus Renovables

(+34) 634 874 199

www.taurusrenovables.com

Wattkraft

+34 914 18 69 98

www.wattkraft.es

ENERGY COMMUNITY

OECOOP

623460705

www.oecoop.coop

SENDA

634891102

https://www.senda.green/

ZUIA INGENIERÍA

945 069 104

https://www.zuiaingenieria.com/

COMENVAL S.C.C.L-COMUNITAT ENERGÈTICA VALENTINS

-

-

COMUNITAT ENERGIA DEL PRAT, SL

-

Join the largest photovoltaic network with over 800 sector companies!

Spanish Photovoltaic Union (UNEF)

Velázquez 24, 28001, Madrid

+34 917 817 512 - info@unef.es

www.unef.es

Paseo de la Castellana 278
28046 Madrid (Spain)

(34) 913 49 71 00
www.icex.es

www.investinspain.org