DIW Weekly Report 22+23 2026

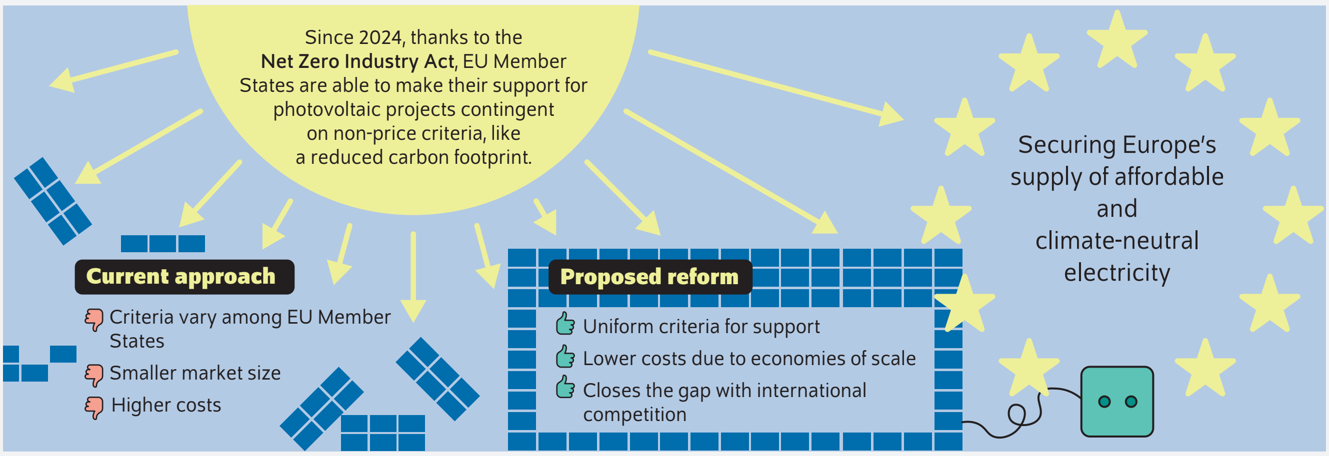
AT A GLANCE

Photovoltaic manufacturing in the EU requires a unified industrial strategy

By Thibault Deletombe and Karsten Neuhoff

- The EU aims to make PV manufacturing more resilient and independent through new legislation
- EU Member States may make funding for PV projects contingent on non-price criteria—like a reduced CO_2 footprint of solar modules
- Approaches can vary widely across the EU: a model-based analysis shows that this results in higher costs
- EU-wide harmonization of non-price criteria would reduce PV manufacturing costs
- A uniform framework improves the competitiveness of EU manufacturers and closes the gap with international competitors

Harmonizing EU Regulations: The Manufacturing Industry Needs Uniform Rules



Source: Own depiction.

FROM THE AUTHORS

"Currently, Chinese PV modules have a cost advantage. To offset this disadvantage, European manufacturers need clear and uniform conditions. To this end, coordinated implementation of the EU Net Zero Industry Act and the Industrial Accelerator Act across EU-Member States is crucial." — ***Thibault Deletombe*** —

MEDIA

Audio Interview with Thibault Deletombe (in English)
www.diw.de/mediathek

Photovoltaic manufacturing in the EU requires a unified industrial strategy

By Thibault Deletombe and Karsten Neuhoff

ABSTRACT

Solar photovoltaic (PV) electricity is critical for providing Europe with a steady supply of decarbonized energy at competitive prices. To ensure the supply of solar PV modules, the European Union (EU) aims to meet 40 percent of its demand with domestic products by 2030. To achieve this goal, EU Member States no longer need to base their support for PV projects solely on price under the NZIA, but can also link funding to non-price criteria such as energy efficiency or the carbon footprint. Furthermore, in the Industrial Accelerator Act, the European Commission also proposes specific Made-in-EU criteria for subsidized PV systems. Yet these non-price criteria can vary across EU Member States. This fragmentation is investigated with a model of the European solar PV module manufacturing sector. The harmonization of the criteria across Europe would harness the full potential of the common market by reducing costs and improving competition.

Energy costs, decarbonization, and global overcapacity are unprecedented challenges for European manufacturing. In this competitive landscape, the European Union (EU) set the direction through the Net Zero Industry Act (NZIA) and the Industrial Accelerator Act (IAA).

Implemented in June 2024, the NZIA aims to scale up the manufacturing of clean technologies in Europe, such as solar photovoltaic (PV), batteries, and heat pumps. For this, it regulates EU Member States aid to these manufacturing industries. It allows Member States to include non-price criteria in their renewable support programs. Possible non-price criteria relate to the carbon footprint or energy efficiency of the installed solar modules.

Subsequently, in March 2026, the European Commission proposed the IAA to boost the EU's manufacturing, which specifies Made-in-EU criteria. These allow supporting renewable projects if the technological components are manufactured in the EU. Further, it is important to note that products produced not only in the EU but also in third-countries with which the EU has a free trade agreement are deemed to be of EU origin.

Currently, each EU Member State can individually determine how these non-price criteria are applied within its borders. In this context, heterogeneous implementations of these criteria at the national level are already observable. By using the solar PV manufacturing sector as an example, we analyze how harmonizing their designs could leverage the common market and benefit Europe.

Solar PV is strategic for the EU, but high concentration is problematic

The NZIA recognizes the strategic importance of solar PV electricity for the decarbonization and the competitiveness of the European economy. This may be threatened, because solar PV manufacturing capacities are currently scarce in Europe (Box 1) and the global supply chain is highly concentrated (Figure 1). A prolonged supply disruption could substantially impact European energy bills and decarbonization

DOI: https://doi.org/10.18723/diw_dwr:2026-22-1

targets.[1] To improve supply security, the NZIA confirms the EU objective to develop at least 30 gigawatts (GW) of manufacturing capacity in Europe by 2030 for each step of the PV value chain: polysilicon, ingots, wafers, cells, and modules.

The solar PV value chain and its related global manufacturing capacity has shifted over time (Figure 1). In 2010, Europe accounted for 80 percent of global demand. Across the value chain, it held between three percent (in the wafers segment) and 19 percent (in the polysilicon segment) of global manufacturing capacity. Leveraging its competitive edge in labor and energy costs, but also providing capital at limited cost to its industry through state-owned banks, China developed a successful industrial strategy and further grew its market share. In 2021, China accounted for almost 36 percent of the demand and between 75 and 97 percent of manufacturing capacity at each step of the value chain. For this reason, the NZIA deems the solar PV value chain insufficiently diversified and subject to supply security risks.

Developing a 30 GW supply chain allows the European solar PV industry to achieve the critical scale needed to reduce vulnerabilities from changes in Chinese industrial standards, delivering economic resiliency[2] and access to an energy technology crucial for modern warfare.[3]

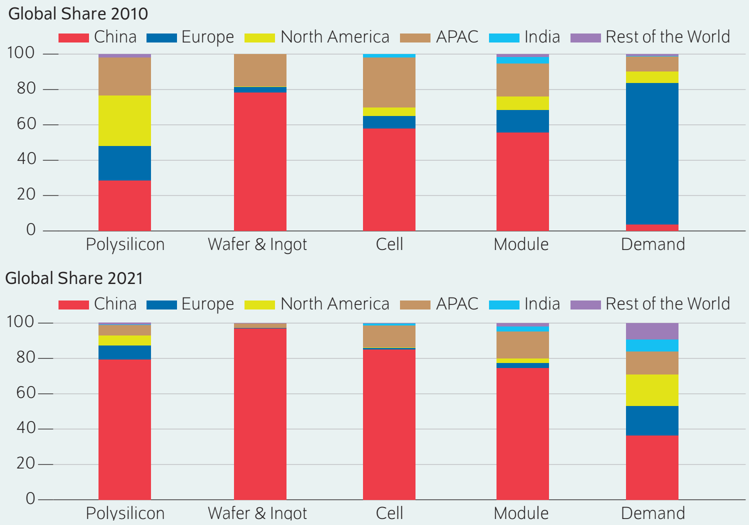
Building knowledge and infrastructure in the PV supply chain is also a prerequisite for Europe to contribute to the next generation of PV modules and to global progress in decarbonization.

Support needed to achieve EU manufacturing target

Rapid innovation and economies of scale enabled Chinese PV manufacturers to achieve large cost reductions. Yet, China's PV manufacturing strategy also aggravated global overcapacity, with demand accounting for 50 percent of module production capacity in 2024 (Figure 2). Ultimately, this drove global prices down to levels likely insufficient to recover fixed costs. Indeed, in 2025, solar module prices ranged from about 0.06 euros per watt for low-quality modules to 0.12 euros per watt for high-quality modules.[4] Recent estimates by the International Renewable Energy Agency place the production cost in 2025 of Chinese modules at around 0.18 euros per watt and that of German modules at around 0.28 euros per watt.[5]

Figure 1

Share of solar PV manufacturing capacity by country and region in 2010 and 2021



Note: APAC = Asia-Pacific region excluding India. ROW = rest of world

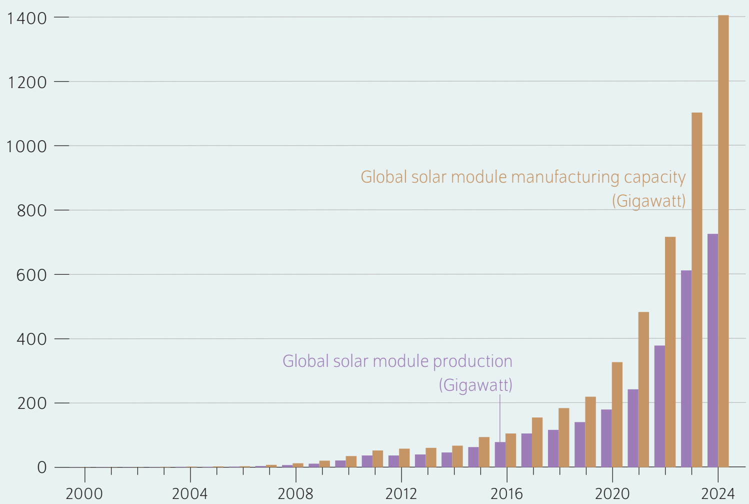
Source: IEA (2022): Solar PV Global Supply Chains, IEA, Paris (available online)

China's share in global solar PV manufacturing increased at each step of the supply chain between 2010 and 2021.

Figure 2

Global PV module manufacturing capacity and actual production

In gigawatts



Source: IEA PVPS (2025): Trends in Photovoltaic Applications 2025 (available online)

In 2024, actual solar PV module production represents only 50 percent of global manufacturing capacity.

1 Andrew Yeh and Michaels Woods, "Building a green, fair and resilient solar PV supply chain." (2023) Friedrich Naumann Foundation for Freedom. (available online. Accessed on May 9, 2026. This applies to all online sources in this report unless stated otherwise.)

2 Oscar Ortega and Johan Lindahl, "Current state of the EU photovoltaic industry. An in-depth look at the ingot-wafer supply chain," ESIA (2024). (available online)

3 Iryna Doronina, "Why renewables should be at the center of rebuilding the Ukrainian electricity system," *Joule* (2024). (available online)

4 Solar Power Europe, "EU solar market outlook 2025-2030" (2025). (available online)

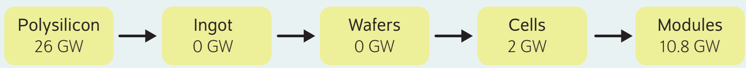
5 IRENA: "IRENA Solar PV Supply Chain Cost Tool" International Renewable Energy Agency, Abu Dhabi. (2026) (available online)

Box 1

The solar PV value chain and associated European manufacturing capacity in 2025

Figure

Manufacturing Process and Current Production Capacities in the EU



Source: Solar Power Europe (2025): EU Solar Market Outlook 2025–2030 (available online)

The solar PV value chain comprises five main steps that transform raw materials into finished solar modules.

In the first step of the value chain, polysilicon is produced from purifying metallurgical-grade silicon to achieve the purity levels required for solar applications. This step requires high levels of technical knowledge, energy consumption, and investments. The European industry possesses a production capacity of 26 GW, concentrated in one German firm, partly dedicated to the semiconductor industry. Currently, most European solar-grade polysilicon production is exported to the United States. However, the utilization rate of this manufacturing capacity does not reach a sustainable level, and present European demand for solar-grade polysilicon is insufficient to ensure that production is maintained in the long term.

Polysilicon is then melted and slowly solidified into cylindrical crystals (ingots) that are then sliced into thin slices (wafers). These stages are capital-intensive, requiring large investments to achieve economic viability. Europe does not have any manufacturing capacity for these production steps, but still has some knowledge from neighboring industries (semiconductor) and past production capacities.

Wafers are then transformed through various chemical and physical production processes into solar cells, the core component that generates electricity. Cell manufacturing requires high investments, comparable to those for polysilicon, wafers, and ingots. In 2025, manufacturing capacity in Europe only reached 2 GW.

Cells are then assembled into modules, the element for outdoor exposure. Module manufacturing requires significantly less technical knowledge and lower minimum investment costs than the previous supply chain steps. In 2025, European manufacturing capacity amounted to 10.8 GW. Wafers used in European cells and modules are largely imported from China and based on Chinese polysilicon. (Figure)

Given the current cost gap with international competition, investment support for PV manufacturing capacity alone is considered insufficient to achieve the 30 GW manufacturing target set by the EU. Therefore, the NZIA and the IAA aim to create demand for European PV manufacturing output in the different market segments by conditioning PV support schemes on non-price criteria for PV systems (Box 2).

As a result of these criteria, at least in the initial years, a share of PV modules may be purchased at a higher price. However, this will only have a limited impact on electricity generation costs. In utility-scale PV systems, which are the projects most sensitive to solar panel prices, modules account for about 34.5 percent of total investment costs (Figure 3). An initial 50 percent price increase for solar modules would translate into a 17 percent increase in investment and levelized cost of energy. If this applies to 40 percent of modules, the overall levelized costs of new PV electricity production would only increase by 7 percent.

Measures to support PV module demand will only be successful if they allow European manufacturers to develop at scale and innovate in order to close the gap with global competitors. Market size and competition are crucial for achieving this transformation.[6]

The NZIA sets a common framework, but national support schemes are heterogeneous

NZIA Articles 25 to 28 set guidelines for EU Member States to integrate non-price criteria into the design of public procurements, renewable auctions, and other forms of public intervention.[7] Four categories of non-price criteria are defined: innovation, system integration, environmental, and resilience. For example, environmental criteria include reduced carbon footprint or increased recyclability, while resilience encompasses sourcing products outside the dominant supply source. This latter category is further reinforced by the IAA, which proposes including Made-in-EU criteria in solar PV support schemes. The goal of such measures is to secure a demand share for European manufacturers.

However, the first support schemes aligned with the NZIA present heterogeneous designs across European countries. For example, France and Italy envision resilience in solar auctions as a prequalification criterion, that is a minimum standard necessary to participate to the auction. Spain emphasises

6 Florian Münch and Fabian Scheifele, "Nurturing national champions? Local content in solar auctions and firm innovation," *Energy Policy* (2023): (179) 113574 (available online); Elmer Hansen et al., "The effects of local content requirements in auction schemes for renewable energy in developing countries: A literature review," *Renewable and Sustainable Energy Reviews* (2020): (127) 109843 (available online)

7 European Union Law, "Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724 (Text with EEA relevance)," (2024). (available online)

resilience as an award criterion and grants additional points for ranking bids that increase performance in this domain.[8] Spain and Italy mostly define environmental criteria as a prequalification criterion in solar auctions, while France defines carbon footprint reduction as an award criterion.[9] This disparity is also reflected in residential PV support schemes. Italy conditions tax rebates for solar panels on energy efficiency.[10] France conditions similar support schemes on environmental standards related to carbon footprint, as well as reduction of silver, cadmium, and lead.[11] Thus, the same solar panel will have different values in different countries, leading to a fragmented European market.

Fragmentation is costly in many ways

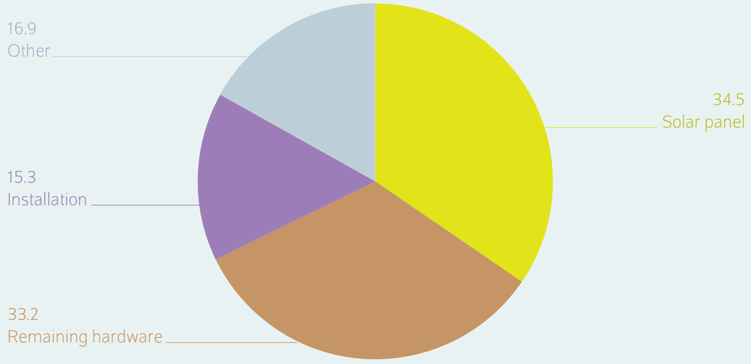
To analyze the impact of regulatory fragmentation, a model of the European solar module manufacturing sector was developed, emulating demand from solar PV auctions (Box 3). Specifically, the model is calibrated to fulfil the target of building 30 GW of manufacturing capacity by 2030. Demand for European modules in renewable auctions is distributed across EU Member States proportionally to their PV development targets. A variety of solar module types is considered to supply demand, subject to increasingly divergent valuations and scoring by non-price criteria across countries. The resulting impact on investment choices is then investigated. Costs are assumed to be uniform across solar module technologies.[12] However, cost differentiation occurs through economies of scale at the plant level.

Modelling the European PV manufacturing industry, we find that common design of non-price criteria across Europe helps to achieve the 30 GW target at minimal cost. In this optimal configuration, the cost of domestic module manufacturing amounts to six billion euros per year. When compared to the price of imported panels, here assumed at around 0.1 euros per watt, this results in an incremental cost of three billion euros, ultimately passed on to electricity consumers or taxpayers. In exchange, they benefit from reduced

Figure 3

Cost breakdown of solar panels and utility-scale solar PV projects

Percent of utility-scale solar PV project cost



Notes: Main cost components of remaining hardware comprise the inverter, racking and mounting, grid connection, and cabling –Other costs comprise mainly margin, financing costs, system design, and permitting

Source: IRENA (2025): Renewable power generation costs in 2024, International Renewable Energy Agency, Abu Dhabi (available online)

In Germany, solar panels represent 34.5 percent of utility-scale solar PV project cost.

Box 2

Three categories of Solar PV demand support schemes

The European solar PV market can be divided into three segments: public buildings (five percent), private buildings (55 percent), and utility scale (40 percent).[1] Each segment is supported with dedicated demand policies. The first segment – covering public buildings, such as schools and hospitals – is fully organized through public procurement. The second segment, private buildings, receives support through various instruments and demand incentives, including tax rebates, grants, loan support or feed-in tariffs. The third segment is mainly driven by solar PV auctions. These are competitive bidding processes where developers submit projects and the winners receive a long-term contract that secures revenue, thus reducing financing costs and electricity price risk.

In Germany, utility-scale and rooftop systems account for, respectively, 35 and 65 percent of solar PV capacity installed in 2024.[2] A reform of Germany's Renewable Energy Sources Act, which takes into account non-price criteria, is currently under discussion and expected to come into force in 2027.

1 Solar Power Europe (2025): Reshoring Solar Module Manufacturing to Europe: A Cost Gap Analysis and Policy Impact Simulation (available online)

2 Fraunhofer ISE (2025): Photovoltaics Report (available online)

8 CRE, Cahier des charges de l'appel d'offres portant sur la réalisation et l'exploitation d'Installations de production d'électricité à partir de l'énergie solaire « Centrales au sol » (2026). (In French, available online)
MASE, Decreto direttoriale del Ministero dell'ambiente e della sicurezza energetica 3 settembre 2025 n. 36 recante "Aggiornamento delle Regole operative del DM 30 dicembre 2024" c.d. FER X Transitorio (2026) (In Italian, available online)
Boletín Oficial del Estado: Orden TED/1444/2025, de 11 de diciembre, por la que se modifican las bases reguladoras de varios programas de ayudas, en el marco del Plan de Recuperación, Transformación y Resiliencia, financiado por la Unión Europea-Next Generation EU. (2025) (In Spanish, available online)

9 CRE, Cahier des charges de l'appel d'offres portant sur la réalisation et l'exploitation d'Installations de production d'électricité à partir de l'énergie solaire « Centrales au sol ». (2026) (In French, available online)

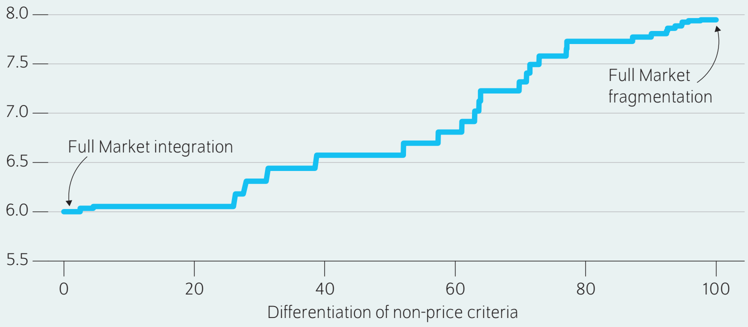
10 MASE, Decreto interministeriale 24 luglio 2024 – Modalità attuative Piano Transizione 5.0 (in Italian, available online); Agenzia Entrate (2026): Ristrutturazioni edilizie: le agevolazioni fiscali (2024) (in Italian, available online)

11 Journal Officiel de la République Française, Arrêté du 8 septembre 2025 fixant les critères applicables à la livraison et à l'installation, dans les logements, des équipements de production d'électricité utilisant l'énergie radiative du soleil, d'une puissance installée inférieure ou égale à 9 kilowatts-crête, ouvrant droit à l'application du taux réduit de la taxe sur la valeur ajoutée mentionné à l'article 278-0 bis du code général des impôts (2025) (in French; available online)

12 ETIP PV, "Ensuring resilience through industrial policy White Paper" (2024) (available online)

Figure 4

Total cost of producing 30 GW of European modules considering increased fragmentation of solar PV auctions design in the EU
In billion euros



Note: The wider the differences in the evaluation criteria of EU Member States are, the more expensive European PV manufacturing becomes. The y-axis shows the total cost necessary to supply 30 GW of European modules per year. The x-axis reflects increasing divergence in scoring criteria across national solar PV auctions. In addition to price, each country values solar modules according to a different non-price criterion, whose relative weight to price is expressed in percentage in the x-axis and increases gradually.

Source: authors' calculation

Regulatory fragmentation increases the cost of European solar PV manufacturing.

Box 3

Modelling European solar PV auctions and manufacturing

The model uses the scoring formula of French solar PV auctions to build an equilibrium model of the European solar module manufacturing sector. The resulting equilibrium determines investment choices and module consumption in 2030, depending on the potential for economies of scale and on reductions in production costs. Key data inputs include national solar PV targets, auction specifications, and economies of scale in module manufacturing.[1]

National auctions select solar PV projects with the highest scores, given national preferences and a fixed constraint on volume. Increasingly differentiated scoring is then considered. This reflects heterogeneous implementation of non-price criteria at the national levels, such as carbon footprints or energy efficiency. Assuming competitive auctions, bidders follow the auctioneer's preferences and adapt their module sourcing strategy to maximize their project scores. Ultimately, this module demand shift shapes manufacturers' plant-level investment choices. They must serve reduced market segments, hindering economies of scale.

1 Cf. Thibault Deletombe, "Non price criteria in renewable energy auctions and consequences for the European solar PV industry" DIW Discussion Paper no. 2153 (2026) (available online).

exposure to future supply shortages and mark-ups that escalate power prices.

However, countries can, and do, implement different non-price criteria. We model the impact if the relative weight put on these criteria increases gradually (Figure 4). When the differential in non-price criteria reaches a sufficient scale to outweigh the price criterion, the European market is fully fragmented and economies of scale are foregone. In that case, the yearly production cost amounts to eight billion euros. Thus, an integrated policy approach that aligns national demands to leverage the common European market is crucial for harnessing economies of scale that minimize costs to consumers.

Besides cost efficiency, market integration delivers additional benefits. With homogeneous demand, the size of the market and the set of solar module types that can be selected at equilibrium are maximized. Competition intensity in the European market is strengthened.

Made-in-EU criteria design must align with policy objectives

Currently, the EU targets the development of at least 30 GW of manufacturing capacity in Europe across the solar PV supply chain by 2030. Yet, the IAA proposal from March 2026 displays misalignments with this objective. Indeed, in the IAA proposal, the inclusion of Made-in-EU criteria in solar PV auctions is effective three years after the entry into force of the regulation. This delay puts the 2030 manufacturing target at risk. A gradual introduction would help to maintain existing capacity and support market ramp-up. Additionally, the IAA proposal limits the implementation of Made-in-EU criteria to PV cells and PV inverters. The regulation does not provide incentives for the other steps of the PV value chain to be located in Europe. Without such incentives, the current design is unlikely to achieve the manufacturing target throughout the full value chain.

Finally, the IAA proposal deems products from third countries that have a free trade agreement with the EU to be of EU origin. Thus, in this context, for example Vietnamese products would qualify for EU origin. Cost of a solar module fully manufactured in Vietnam in 2030 is estimated at around 0.17 euros per watt, while that of a German module is estimated at around 0.27 euros per watt.[13] With such a cost gap, European manufacturing remains non-competitive and investment to re-establish manufacturing capacity challenging.

This discussion illustrates the challenge policy makers face when balancing the trade-offs between cost efficiency, competition intensity, and investment incentives.

13 IRENA, "IRENA Solar PV Supply Chain Cost Tool," ibid. (2026)

Common support measures would help align environmental, industrial, and competition policy

Solar PV electricity is critical for providing Europe with a steady supply of decarbonized energy at competitive prices. However, the solar PV supply chain is highly concentrated. The NZIA works to improve supply resilience and fulfill EU manufacturing targets. This Weekly Report discusses how to achieve this objective.

A unified framework supporting the solar PV sector will leverage the common market, thus helping to achieve NZIA targets while balancing cost, competition, market size, and investment incentives. This sets the conditions for European manufacturers to innovate and scale, ultimately easing the tensions between industrial, competition, and environmental policies.

Made-in-EU criteria can, in principle, play an important role in the success of the policy. However, to align with manufacturing targets, not only must these address the full value chain, but also, they must provide incentives to produce and invest in EU Member States.

Thibault Deletombe is a Research Associate in the Climate Policy Department at DIW Berlin | tdeletombe@diw.de

Karsten Neuhoff is Head of the Climate Policy Department at DIW Berlin | kneuhoff@diw.de

JEL: L51, L52, L60, Q27, Q40

Keywords: Photovoltaics, solar modules, non-price criteria, renewable auction, market integration

LEGAL AND EDITORIAL DETAILS

DIW BERLIN

DIW Berlin — Deutsches Institut für Wirtschaftsforschung e. V.
Anton-Wilhelm-Amo-Straße 58, 10117 Berlin
www.diw.de
Phone: +49 30 897 89–0 Fax: –200
Volume 15 June 3, 2026

Publishers
Prof. Anna Bindler, Ph.D.; Prof. Dr. Tomaso Duso; Sabine Fiedler; Prof. Marcel Fratzscher, Ph.D.; Prof. Dr. Peter Haan; Prof. Dr. Claudia Kemfert; Prof. Dr. Alexander S. Kritikos; Prof. Dr. Alexander Kriwoluzky; Prof. Karsten Neuhoff, Ph.D.; Prof. Dr. Sabine Zinn

Editors-in-chief
Prof. Dr. Pio Baake; Claudia Cohnen-Beck; Sebastian Kollmann; Kristina van Deuverden

Reviewer
Dr. Wolf-Peter Schill

Editorial staff
Dr. Hella Engerer; Petra Jasper; Adam Mark Lederer; Frederik Schulz-Greve; Sandra Tubik

Layout
Roman Wilhelm; Stefanie Reeg; Eva Kretschmer, DIW Berlin

Cover design
© imageBROKER / Steffen Diemer

Composition
Satz-Rechen-Zentrum Hartmann + Heenemann GmbH & Co. KG, Berlin

Subscribe to our DIW and/or Weekly Report Newsletter at
www.diw.de/newsletter_en

ISSN 2568-7697