

# Trends in the European and global solar industry

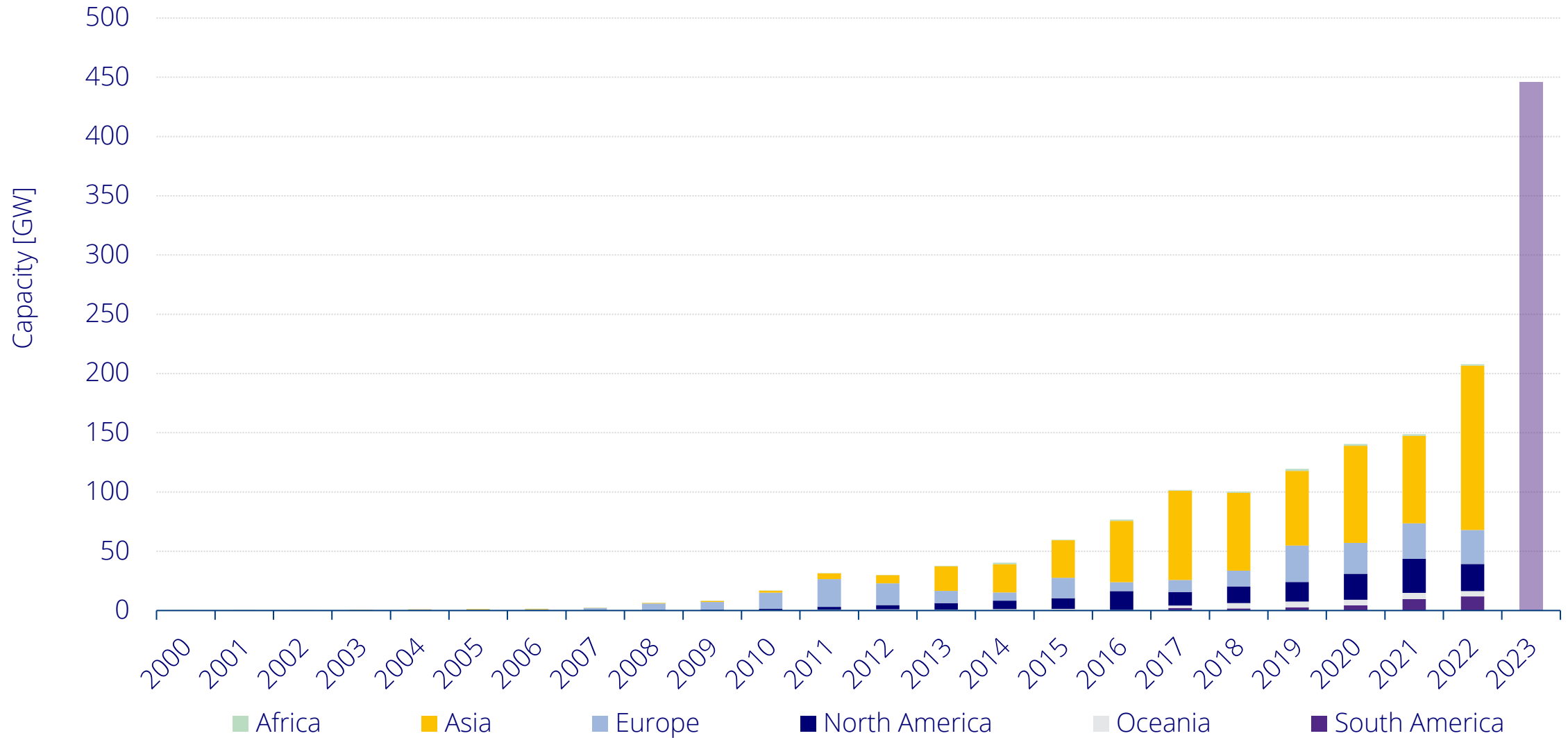
**Dr. Johan Lindahl, Secretary General of ESMC**

Aktuellt inom solcell 5/12, December 2024

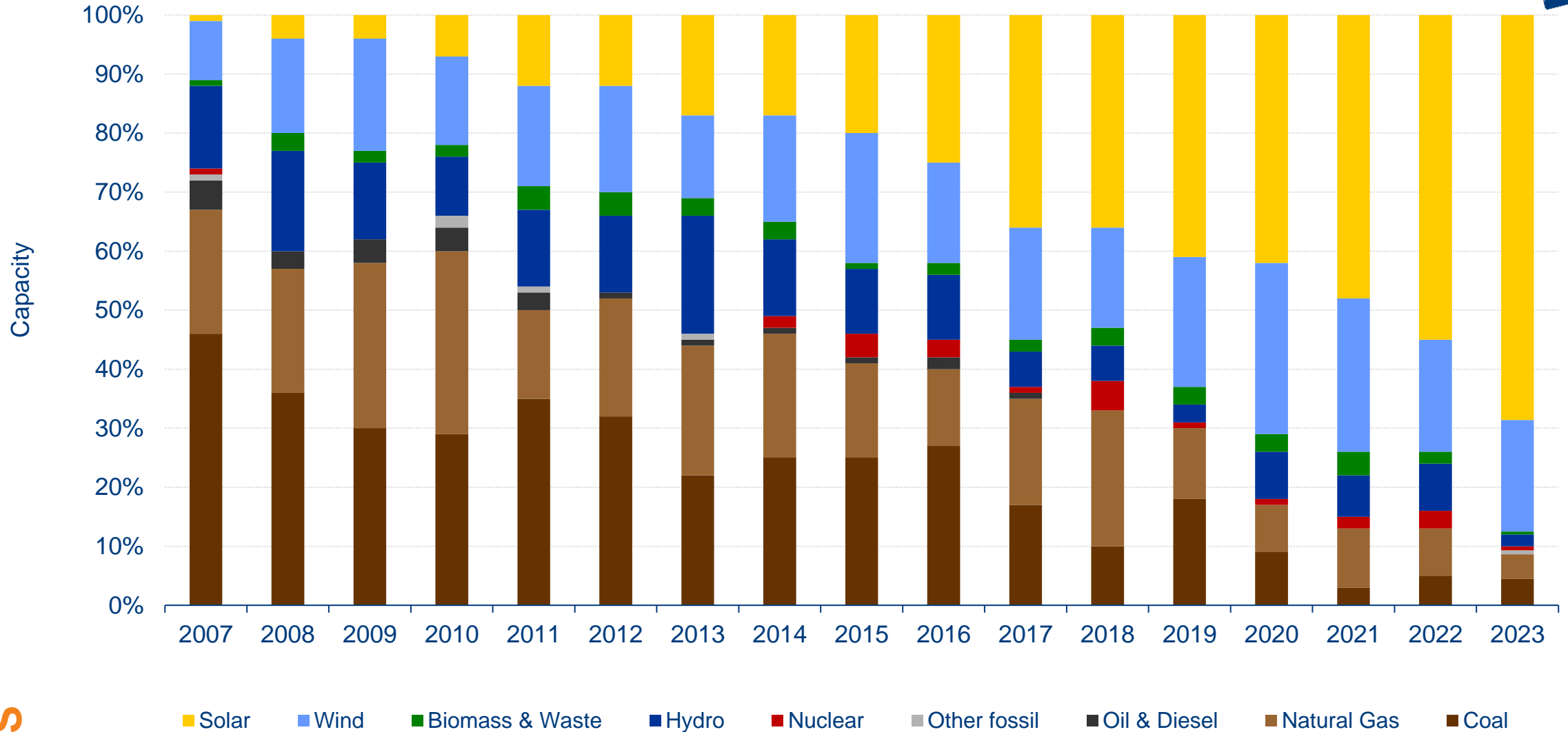
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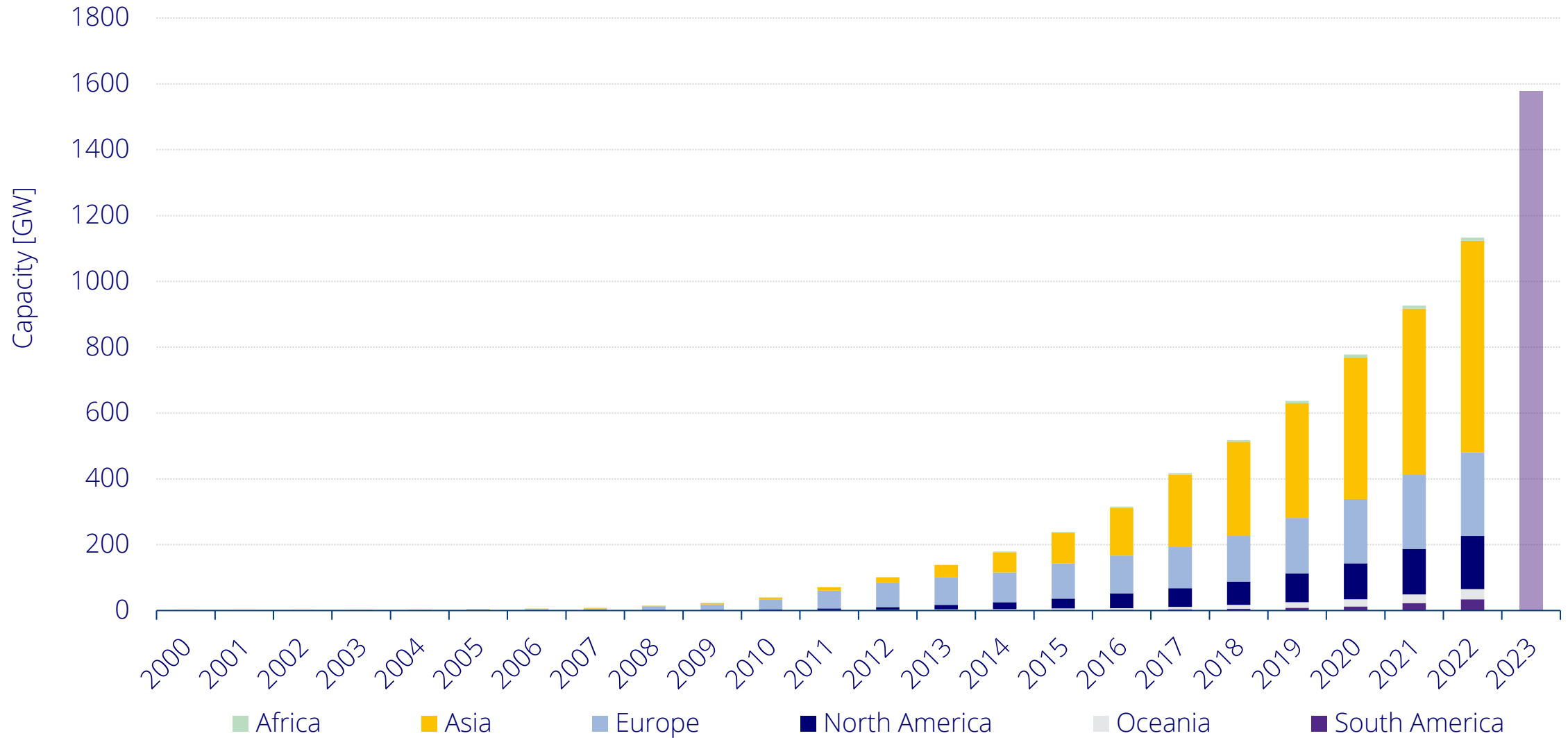
# ANNUAL INSTALLED PV CAPACITY IN THE WORLD



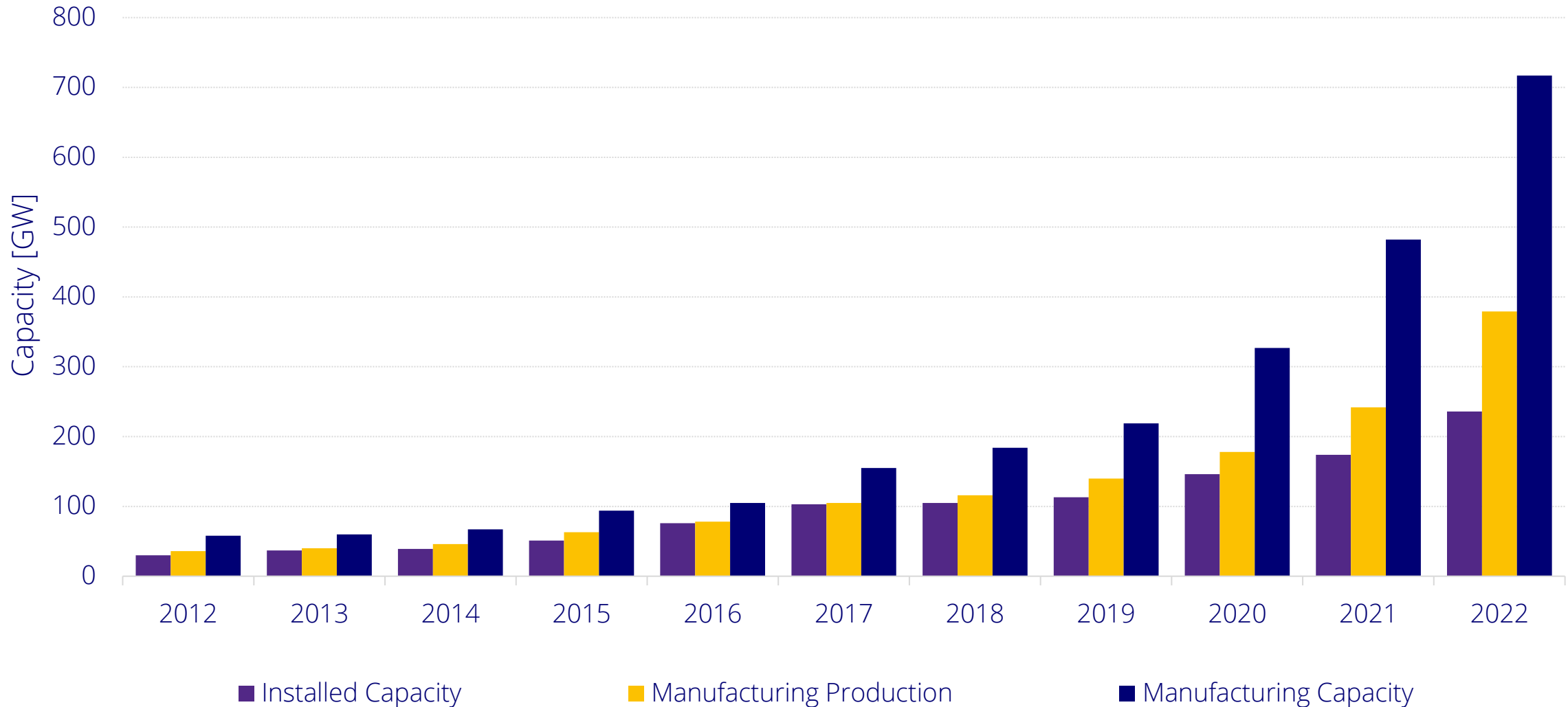
# Annual installed Power capacity in the world



# TOTAL INSTALLED PV CAPACITY IN THE WORLD

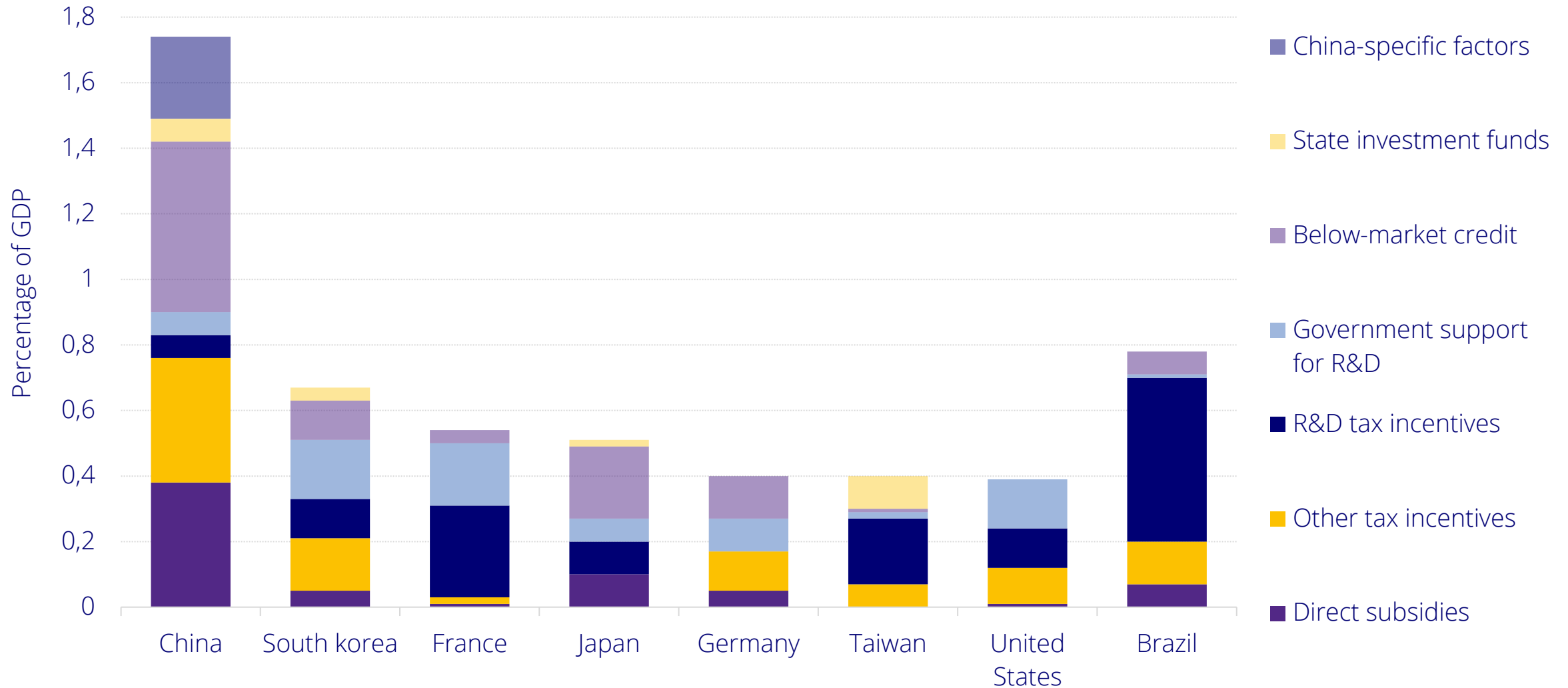


# GLOBAL PV MANUFACTURING OVER-CAPACITY



# CHINA'S SPENDING ON GREEN ENERGY

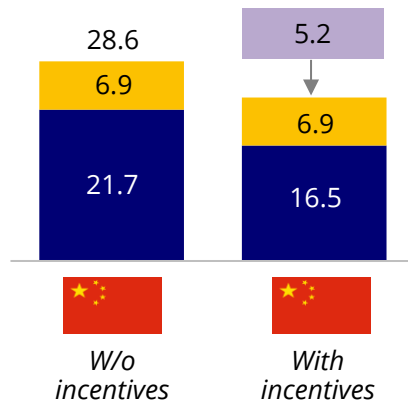
Industrial policy spending in key economics in 2019 in percentage of GDP



# IMPACT OF POLICY INCENTIVES ON LOCAL SOLAR MANUFACTURING COST ACROSS THE REGIONS

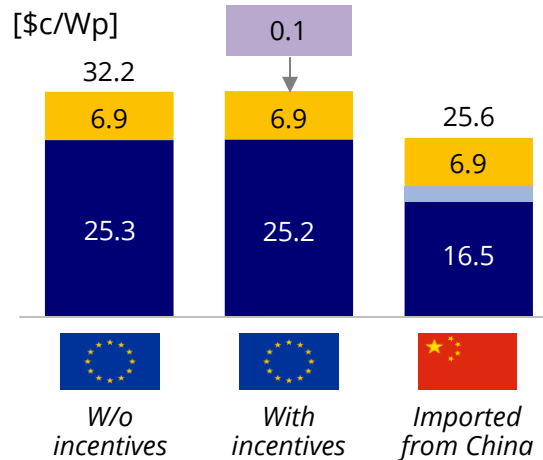
## Delivered cost of modules in China

[\$c/Wp]



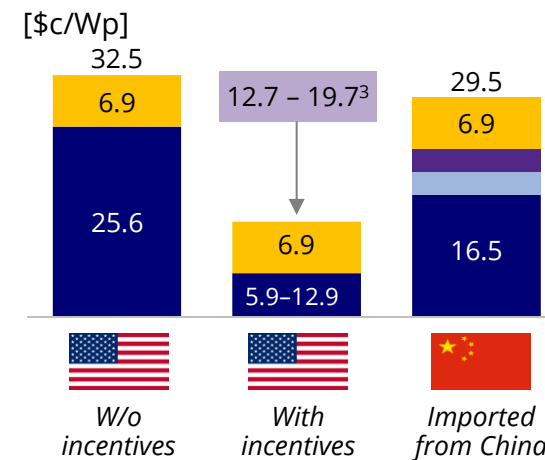
## Delivered cost of modules in the EU<sup>1</sup>

[\$c/Wp]



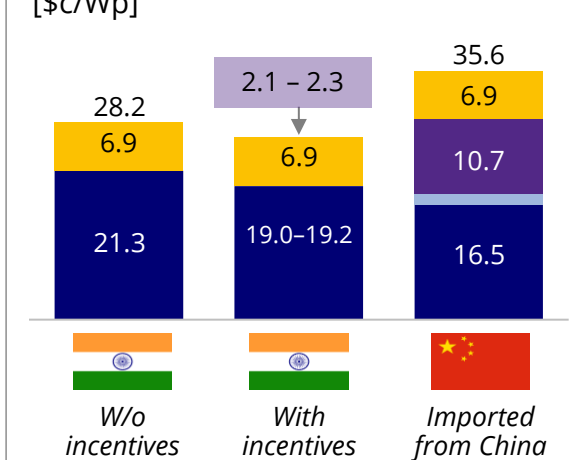
## Delivered cost of modules in the US<sup>1,3</sup>

[\$c/Wp]



## Delivered cost of modules in India<sup>1</sup>

[\$c/Wp]



### Key policy actions

- Capital subsidies:** cheap/free land, subsidized loan rate
- Utility subsidies:** on electricity and water
- Indirect supply incentives:** relaxed labor laws, no input credits

### Impact

- 2.1 c/Wp
- 2.0 c/Wp
- 1.1 c/Wp

### Key policy actions

- Capital subsidies & grants** (such as EU Innovation Fund<sup>1</sup>, regional programs)

### Impact<sup>2</sup>

- 0.1 c/Wp

### Key policy actions

- Inflation Reduction Act** incentives: \$48B till 2032; primarily production linked
- State-level investment incentives** (e.g., Arizona's Jobs Credit Schemes)
- Section 201 import tariffs**

### Impact

- 11 - 18 c/Wp<sup>4</sup>
- 1.7 c/Wp
- 14.5 %

### Key policy actions

- Production-linked Incentive (PLI) Scheme:** \$3B for solar manufacturing
- Import tariffs:** Make-in India safeguard duty (14.5 %), Basic Customs Duty (25-40 %)

### Impact

- 2.1 - 2.3 c/Wp<sup>5</sup>
- 40 - 55 %

<sup>1</sup> Assumption: shipping cost = 0, for locally manufactured solar modules

<sup>2</sup> For EU, incentive impact (depreciation spend saved) corresponds to Enel's (€118M) received for 3GW HJT solar mfg. unit through the EU Innovation Fund

<sup>3</sup> Impact range (incl. state incentives) depends on partial localization. Cells & modules: 12.7 c/Wp vs. for full localization: 19.7 c/Wp

<sup>4</sup> IRA to provide 100% of the proposed incentive till 2029, phase-out linearly by 2033. Incentive breakdown: p-Si (1.5 c/W), wafers (5.5 c/W), cells (4 c/W) & modules (7 c/W). IRA's impact (avg NPV) range: 8.8 c/W (US cells & modules) - 14.4 c/W (full US localization) till 2033

<sup>5</sup> PLI incentive value (range) primarily depends on module efficiency: 0 (< 19.5%), 2..25 INR/Wp (19.5-20%), & 2.75 INR/Wp (>20%)



# OVERSUPPLY OF MODULES IN EUROPE

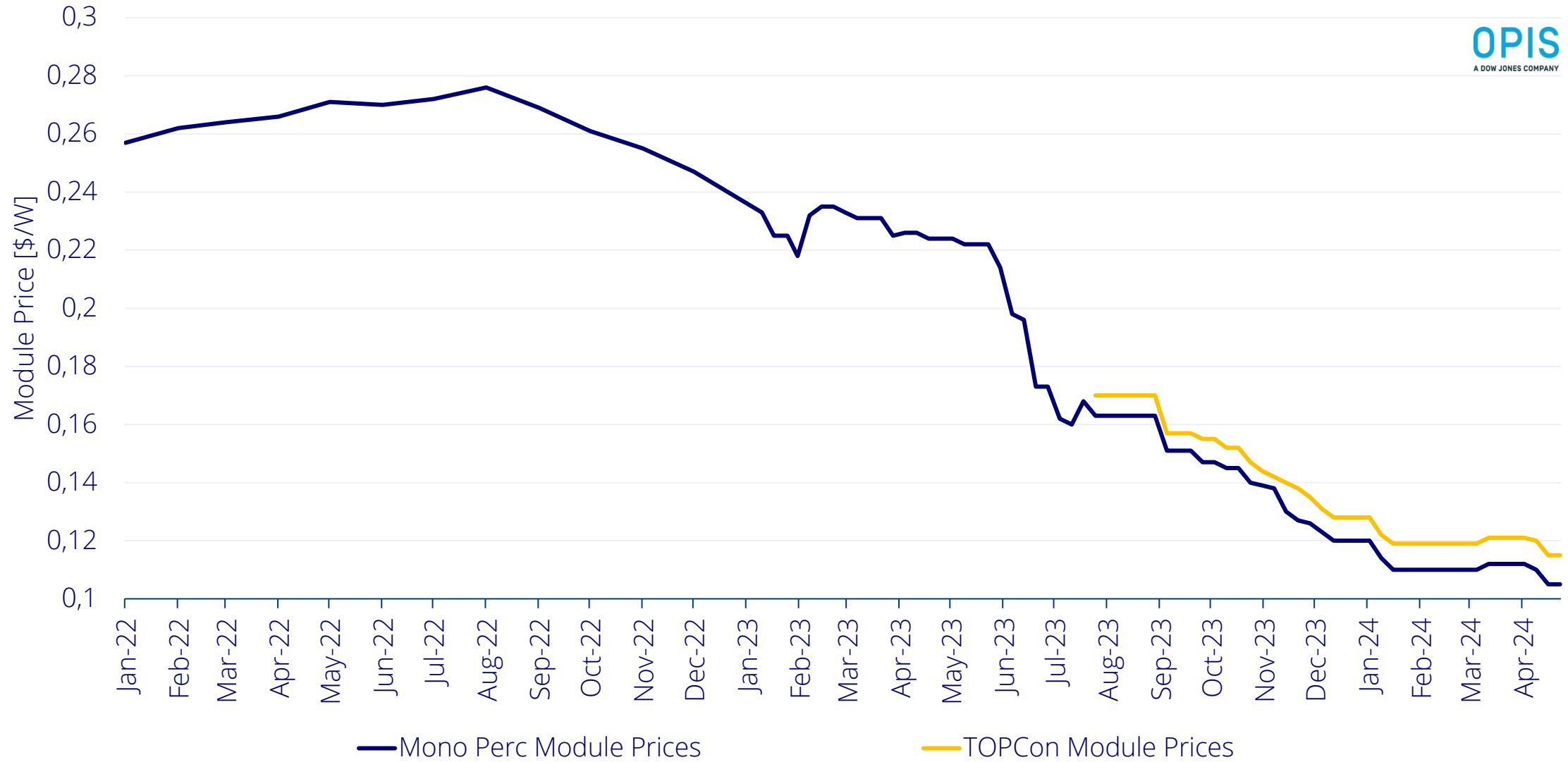


In 2022 and 2023, the world's leading solar manufacturing nations exported modules worth \$22.9 billion and \$19.4 billion to EU countries, with the majority originating from China. **Consequently, between 80–100 GW of solar modules were imported to the EU in both 2022 and 2023 respectively, possibly more, while installations amounted to approximately 41 GW in 2022 and 57 GW in 2023** (source: SolarPower Europe). This means that approximately **85 GW of imported module capacity** is currently sitting in stock in EU.





# PV MODULE PRICE COLLAPSE IN 2023



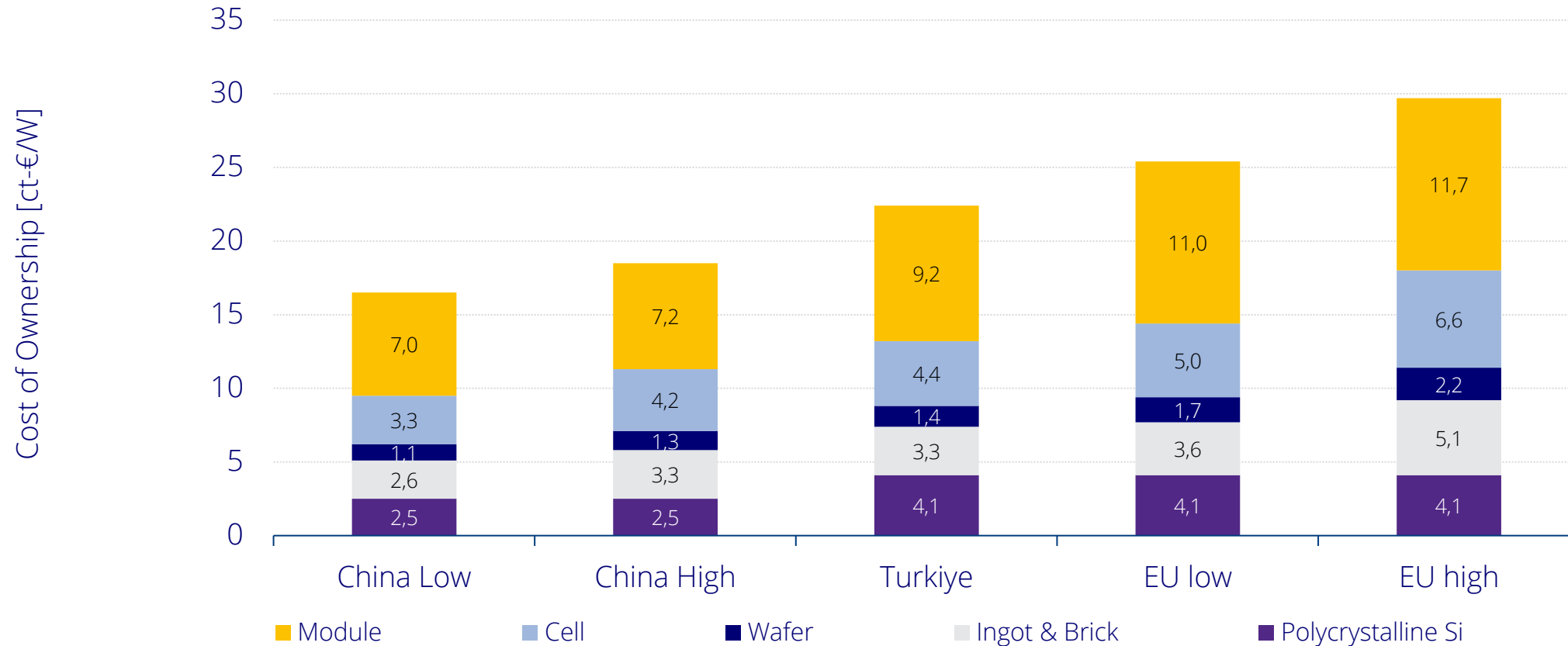
# PV MANUFACTURING COSTS — JINKO

| Disclosed by Jinko Solar         | Q1              | Q2              | Q3              | Q4              |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|
| <b>Revenues</b>                  | \$3 396 974 000 | \$4 224 860 000 | \$4 350 030 000 | \$4 603 769 000 |
| <b>Costs</b>                     | \$2 808 557 000 | \$3 572 108 000 | \$3 522 622 000 | \$4 047 865 000 |
| <b>Sales of Modules</b>          | 13 308 MW       | 17 763 MW       | 21 384 MW       | 26 335 MW       |
| <b>Sales of cells and wafers</b> | 1 452 MW        | 850 MW          | 1 213 MW        | 1 528 MW        |

Since cells and wafers production (sold outside of Jinko) represents a only bit more than 10% of the total production, with a lower price than modules, one assigns an average market price to the cells/wafers to estimate the revenues from the modules sales with less risk of influencing the end result significantly.

| Calculation                                  | Q1               | Q2               | Q3               | Q4              |
|--|------------------|------------------|------------------|-----------------|
| <b>Cell prices from OPIS</b>                 | ~0,14 \$/W       | ~0,12 \$/W       | ~0,09 \$/W       | ~0,07 \$/W      |
| <b>Assumed Cell manufacturing costs</b>      | ~0,10 \$/W       | ~0,08 \$/W       | ~0,07 \$/W       | ~0,06 \$/W      |
| <b>Market price Cells &amp; wafers</b>       | ~\$203 280 000   | ~\$102 000 000   | ~\$109 170 000   | ~\$106 960 000  |
| <b>Manufacturing cost Cells &amp; wafers</b> | ~\$145 200 000   | ~\$68 000 000    | ~\$84 910 000    | ~\$91 680 000   |
| <b>Revenues Modules</b>                      | ~\$3 193 694 000 | ~\$4 122 860 000 | ~\$4 240 860 000 | \$4 496 809 000 |
| <b>Costs Modules</b>                         | ~\$2 663 357 000 | ~\$3 504 108 000 | ~\$3 437 712 000 | \$3 956 185 000 |
| <b>Market price Modules</b>                  | ~0,240 \$/W      | ~0,232 \$/W      | ~0,198 \$/W      | ~0,171 \$/W     |
| <b>Manufacturing cost Modules</b>            | ~0,200 \$/W      | ~0,197 \$/W      | ~0,161 \$/W      | ~0,150 \$/W     |

# PV MANUFACTURING COSTS — SIMULATED



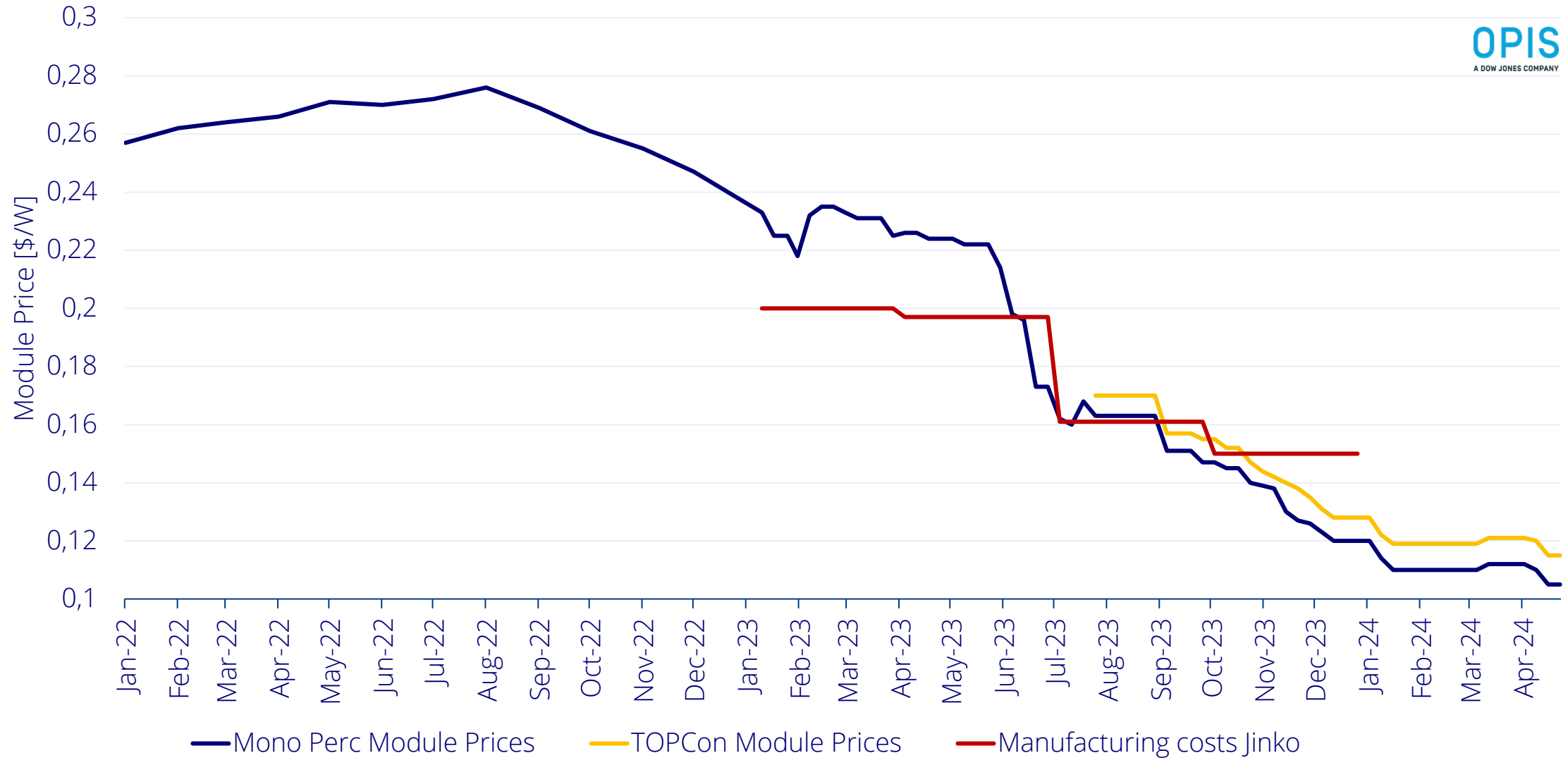
## From production costs to Average Selling Price (ASP)

Manufacturing costs must be augmented with Selling General and Administrative (SG&A) costs of approximately 7%, Research and Development (R&D) costs of up to 5% and transport costs — around 0,01 EUR/W<sub>p</sub>.

In the case of Jinko Solar again, this positions the sales prices around 0.198 in USD/W<sub>p</sub> Q3 2023.

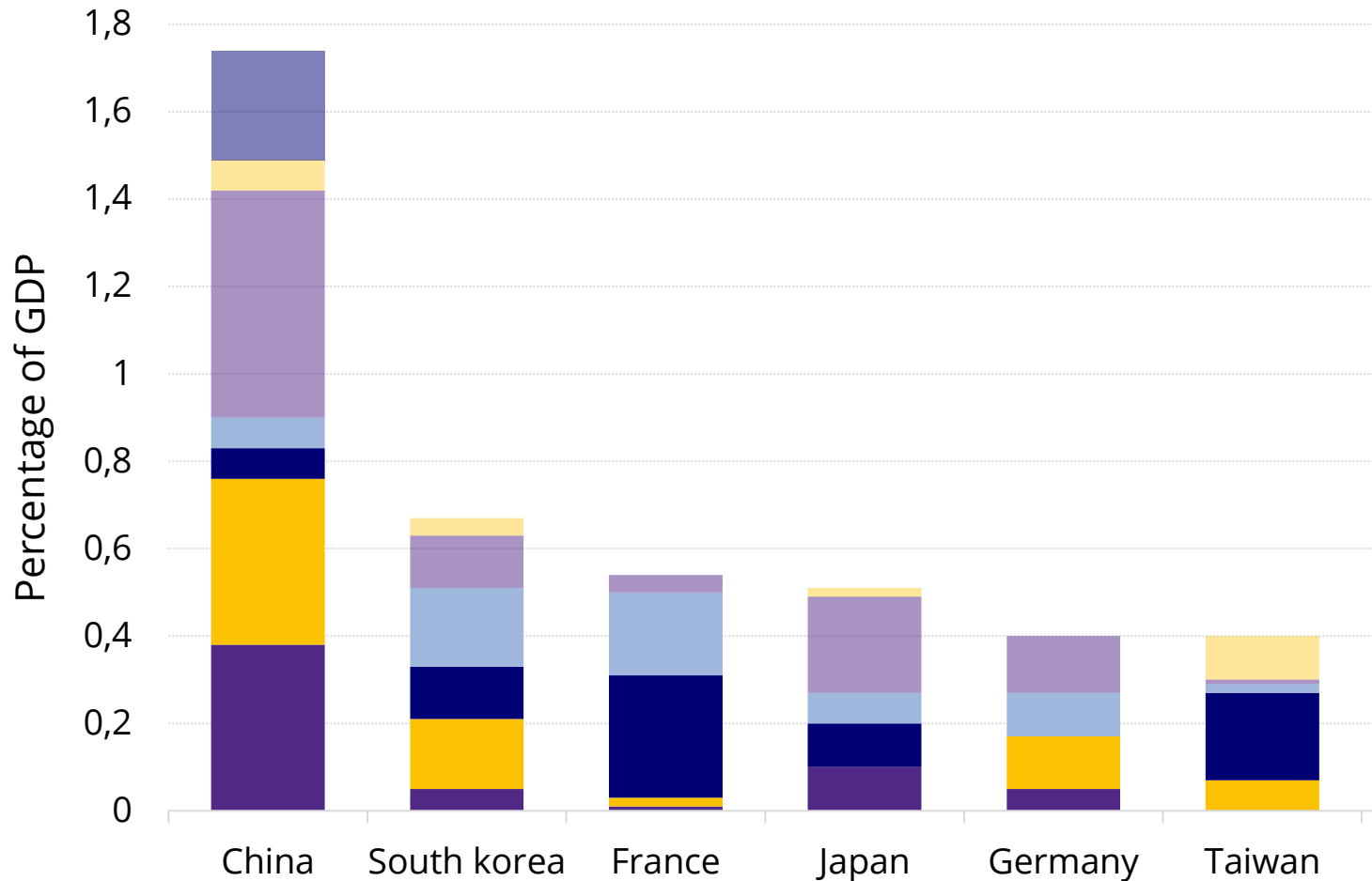


# MODULES ARE SOLD BELOW MANUFACTURING COSTS



# MAJOR STRUCTURAL DISADVANTAGE TO BE A WESTERN MANUFACTURER

Industrial policy spending in key economics in 2019 in percentage of GDP



Weak labour laws and slave work in Xinjiang



Weak environmental laws  
Government support for R&D



States

# FORCED LABOUR IN THE CHINESE PV VALUE CHAIN

The Xinjiang region accounted for 42 % and 50 % of the national metallurgical-grade silicon and polysilicon production capacity in 2020. **On a global scale, in 2020 around 45% of the world's polysilicon originated in Xinjiang.** In Xinjiang the local population of Uyghurs have been subjected to arbitrary detention and forced labour by the Chinese government.

In the Xinjiang Uyghur Autonomous Region, the **United Nations (UN)** have reported **detention of large numbers** of ethnic Uyghurs and other Muslim minorities without being charged or tried, under the pretext of countering religious extremism. Estimations suggest that over the last few years, Chinese authorities have built or expanded over **380 re-education camps, detention centres and prisons.** **Up to 1.5 million Turkic Muslims are arbitrarily detained** in internment camps of various security levels while an additional **880,000 Uyghur children** had been placed in boarding facilities at the end of 2019.

During imprisonment in the camps, detainees are exposed to **physical and psychological torture, sexual violence,** and other forms of ill- treatment. Detainees have reported being forced to stay in **stress positions for hours every day, sleep deprivation,** lack of access to food, water, and sanitary conditions, being subjected to health-related procedures without their consent, **including mass sterilisation**

The situation extends beyond the geographical region of Xinjiang. According to civil society research, **more than 80,000 Uyghurs were transferred out of Xinjiang to work in factories across China** between the years of 2017 and 2019.

The extent of violations has prompted parliaments around the world to launch debates on the question of genocide. The French, Dutch, American, British, Canadian and Lithuanian **parliaments have voted to call it a genocide.**

| Exposure          | Company                                       |
|-------------------|---|
| HIGH              | Canadian Solar                                |
| VERY HIGH         | JA Solar—Southeast Asia/US                    |
| VERY HIGH         | JA Solar—China                                |
| HIGH              | Jinko Solar—Southeast Asia/US                 |
| HIGH              | Jinko Solar—China                             |
| VERY HIGH         | LONGi Solar—Southeast Asia                    |
| VERY HIGH         | LONGi Solar—China                             |
| NONE (UNVERIFIED) | Maxeon 3/5/6 Module / Sunpower X-/A-/M-Series |
| NONE (UNVERIFIED) | Maxeon / Sunpower Performance Series          |
| NONE (UNVERIFIED) | Meyer Burger Technology                       |
| VERY HIGH         | QCells  |
| NONE (UNVERIFIED) | REC Group N-Peak and Alpha                    |
| VERY HIGH         | REC Group TwinPeak 4                          |
| HIGH              | Tongwei Solar                                 |
| NONE (UNVERIFIED) | Trina Solar—Southeast Asia                    |
| VERY HIGH         | Trina Solar—China                             |



# EUROPEAN MANUFACTURES UNDER SEVERE PRESSURE

In 2023, the EU's estimated PV module production capacities reached approximately 11 GW, with actual operational capacities accounting for roughly **6 GW of PV module production**. The additional 5 GW are assessed to be unmodern sleeping module lines, that have not been operational in 2023. **Only around 2 GW of PV modules have actually been produced in 2023, leaving 0.8–1 GW languishing in the inventories of European PV module producers.** Unfortunately, these stocks remain unsold due to the prevailing market conditions characterized by ultra-low pricing, a situation expected to persist at least throughout 2024.

The concerns we've been expressing for nearly a year are now becoming reality. In total, Europe has now officially lost 3,07 GW of the **6 GW of PV** module manufacturing capacity that existed in autumn due to the bankruptcy or closure of PV module production by the following companies:

|                            |         |             |
|----------------------------|---------|-------------|
| Flisom AG                  | 55 MW   | France      |
| Energetica S.p.A.          | 250 MW  | Austria     |
| Exasun                     | 125 MW  | Netherlands |
| Grenzebach ENVELON         | 80 MW   | Germany     |
| Meyer Burger Technology AG | 1400 MW | Germany     |
| SYSTOVI                    | 110 MW  | France      |
| Recom-Sillia               | 470 MW  | France      |
| SOLARWATT Germany          | 300 MW  | Germany     |

# TEMPORARY CRISIS AND TRANSITION FRAMEWORK

On the 9th March 2023, the European Commission adopted the Temporary Crisis and Transition Framework (TCTF) to support Net-Zero industries during times of crisis.

While one of the key conditions for the aid is that it should be granted by 31 December 2025, it's important to note that the end of 2025 marks the final date for the Member States to inform the European Commission about the actual aid framework decided. The actual aid payments for **CAPEX expenditures** or tax advantages, loans, and state guarantees have no defined time limit.

Some EU Member States have already decided or started to consider distributing extensive REPowerEU financing for Net-Zero Industries, including PV manufacturing. For example, Spain has announced a national call for interest for Net-Zero Industries to design concrete financing for already allocated €1 billion using REPowerEU chapters of RRP and the Netherlands allocates €412 million through the National Growth Fund for the PV program SolarNL, which aims at large-scale production of circular solar cells and solar panels in the Netherlands.





# THE NET-ZERO INDUSTRY ACT

The 25<sup>th</sup> of April 2024 the European Parliament adopted the Net-Zero Industry Act (NZIA), which is an initiative aimed at bolstering European manufacturing capacity for net-zero technologies and overcoming barriers to scaling up production. The measures outlined in the regulation intend to enhance the competitiveness of the industrial base for net-zero technologies and strengthen the EU's energy resilience. **NZIA will be an EU-wide mandatory legislative initiatives towards reaching the targeted manufacturing capacity to cover 40% of EU's deployment of strategic technology products, such as solar PV modules, wind turbines, batteries and heat pumps.**

The provisions of the NZIA states certain non-pricing (resilience and sustainability) criteria and tolerance of price difference for public procurements. Additionally, there are concrete pre-qualification criteria to be applied in **public procurements of environmental sustainability and resilience** once more than **50% of the EU's supply from a single source of supply** is identified. There are also three selective criteria, of which at least one must be chosen: (1) social or employment-related considerations; (2) cybersecurity requirements; (3) delivery on time. Concerning the **cost difference, up to 20%**, based on objective and transparent data, will be presumed proportionate.

Similar **resilience, sustainability** and other criteria applies to auctions, where up to **15% price difference** will be presumed proportionate.



# EUROPEAN SOLAR CHARTER

In response to the challenges for the European solar manufacturing industry, the European Commission, 23 EU Member States, the European Commission, European Solar Manufacturing Council (ESMC) and SolarPower Europe (SPE) signed on the 15<sup>th</sup> of April 2024 the European Solar Charter (ESC), aimed at strengthening the industry through Member States commitments and the support of the European Commission.

Four Member States did not sign it: Ireland, Cyprus, Malta and **Sweden**.



# THE FORCED LABOUR BAN

On the 23<sup>rd</sup> of April, the European Parliament adopted, with a broad majority, the long-awaited regulation to prohibit products made with forced labour. This new law could have a significant impact on the PV manufacturing industry, as it mandates the banning of all products made with forced labour from the European market. It is widely acknowledged that a significant portion of the global production of metallurgical silicon and polysilicon, which is used in PV modules originate from the Xinjiang province in China, where state-imposed forced labour is prevalent.

As some of the upsides with the final agreement is that the Commission will take on a more robust role in conducting investigations beyond the EU territory. Special attention will be given to products originating from regions with state-imposed Forced Labor (FL), such as Xinjiang, which is of course very relevant for the solar PV industry. A comprehensive database will be established within 18 months, and hopefully, it will be modelled after/based on the U.S database for the Uyghur forced labour prevention act. This is likely since emphasis will be placed on fostering international cooperation, including with third countries that have enacted similar legislation.

However, there are some drawbacks to consider. The full implementation of the agreement is expected 36 months after its adoption by the EU Council after summer.

There is no provision for a reversed burden of proof, nor is there explicit mention of remediation measures.

A documentary about the genocide of the Uyghur minority:

<https://www.capuseen.com/films/8173-chine-le-drame-ouighour>

Trilogue focused on state-sponsored forced labour in the clean energy supply

<https://esmc.solar/esmc-joined-by-eu-parliamentarians-and-ngos-to-call-for-an-end-on-forced-labor-practices-in-solar-supply-chains/>



Reinhard Bütikofer — Member of European Parliament,  
Adrian Zenz — Victims of Communism Foundation,  
Patricia Carrier — Coalition to End Forced Labour in the  
Uyghur Region, Rushan Abbas — Campaign for  
Uyghurs, and Johan Lindahl — European Solar  
Manufacturing Council.

# ECODESIGN AND ENERGY LABELLING

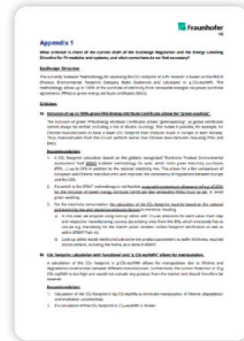
For several years, ESMC has been closely monitoring the progress of introducing Ecodesign and energy labeling for PV modules and inverters. Ecodesign entails establishing a minimum set of criteria that both imported, and EU-made PV modules must meet. Energy labeling involves affixing consumer labels on products to inform consumers about energy performance and assist them in making more sustainable choices.



**April 2023**  
Feedback on Ecodesign and Energy labeling for PV modules, inverters and systems.



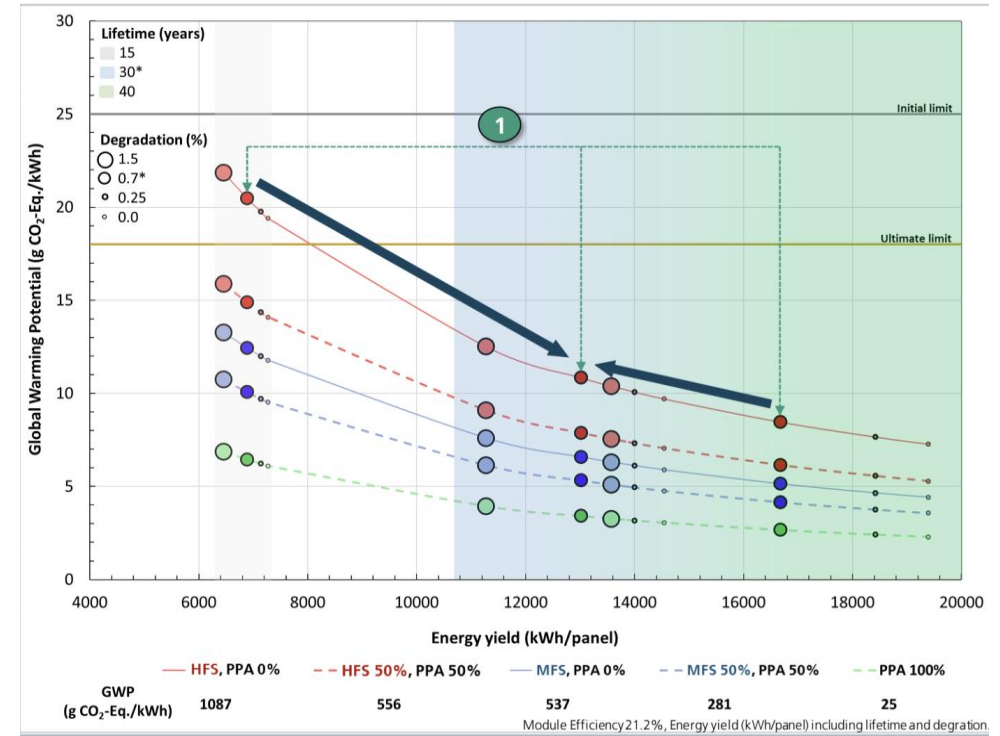
**October 2023**  
ESIA Webinars – Carbon Footprint Calculation Methodologies. A presentation of the study performed by Fraunhofer ISE, initiated by ESMC.



**February 2024**  
APPENDIX: *What criticism is there of the current draft of the Ecodesign Regulation and the Energy Labeling Directive for PV modules and systems, and what corrections do we find necessary?* Prepared by Fraunhofer ISE.



**February 2024**  
Letter from the European PV manufacturing industry: A request for Ecodesign and Energy Label legislation that serves the environment and European solar PV manufacturing.














The notable successes during this period include the advancement of an informational requirement for antimony in solar glass within the Ecodesign legislation and around discussions on potentially utilizing the EPEAT methodology instead of the PEFCR methodology for calculating the CO2 footprint of solar PV modules.



# THE EUROPEAN INVERTER MARKET

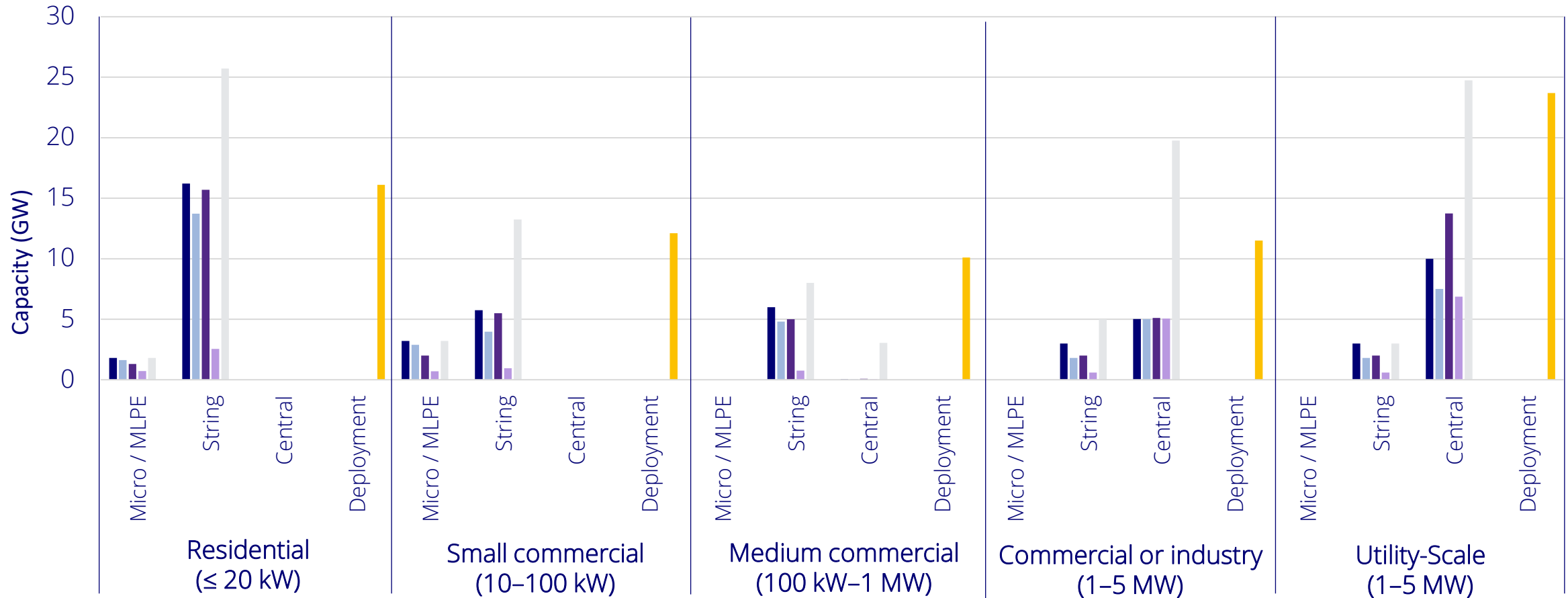
## European manufactures are quickly losing market share

Table 1. S&P Global Inverter Market Tracker from 2023 about the European market inverter market shares.

| Company Name  | 2018         | 2019         | 2020         | 2021         | 2022         |
|---|--------------|--------------|--------------|--------------|--------------|
|  Huawei              | 12.5%        | 24.5%        | 24.2%        | 30.0%        | 24.9%        |
|  Sungrow             | 6.3%         | 7.3%         | 11.8%        | 20.0%        | 21.3%        |
|  SMA                 | 19.7%        | 17.1%        | 18.1%        | 8.1%         | 6.6%         |
|  SolarEdge           | 7.2%         | 7.9%         | 7.8%         | 6.7%         | 6.5%         |
|  Growatt             | <2%          | <2%          | 2.4%         | 3.5%         | 4.8%         |
|  Ginlong             | <2%          | <2%          | 2.0%         | 2.3%         | 4.0%         |
|  SOFAR               | <2%          | <2%          | 2.8%         | 2.9%         | 3.7%         |
|  Fronius             | 5.9%         | 5.1%         | 5.4%         | 4.7%         | 3.7%         |
|  GoodWe              | <2%          | <2%          | <2%          | 2.5%         | 3.5%         |
|  Power Electronics | 4.3%         | 7.5%         | 4.4%         | 3.8%         | 2.5%         |
|  NingBo Deye       | <2%          | <2%          | <2%          | <2%          | 2.2%         |
| Others  | 29.9%        | 19.1%        | 14.1%        | 10.0%        | 16.4%        |
| <b>Total GW Shipped</b>   | <b>21.65</b> | <b>34.61</b> | <b>38.72</b> | <b>55.24</b> | <b>91.88</b> |



# THE EUROPEAN INVERTER INDUSTRY CAPACITY



■ EU PV inverter manufacturing capacities in 2023

■ EU PV inverter manufacturing capacities in 2024

■ Potential swift additional annual PV inverter manufacturing capacities in the EU

■ EU Utilization rate in 2023

■ EU Utilization rate in 2024

■ Annual European market



# EUROPEAN ENERGY SECURITY

European PV inverter companies are quickly losing market shares and 80% of all new inverters are made in China.

The control centres of Inverter companies hold the authority for software-updates and to modify operational performance through grid code configurations, such as:

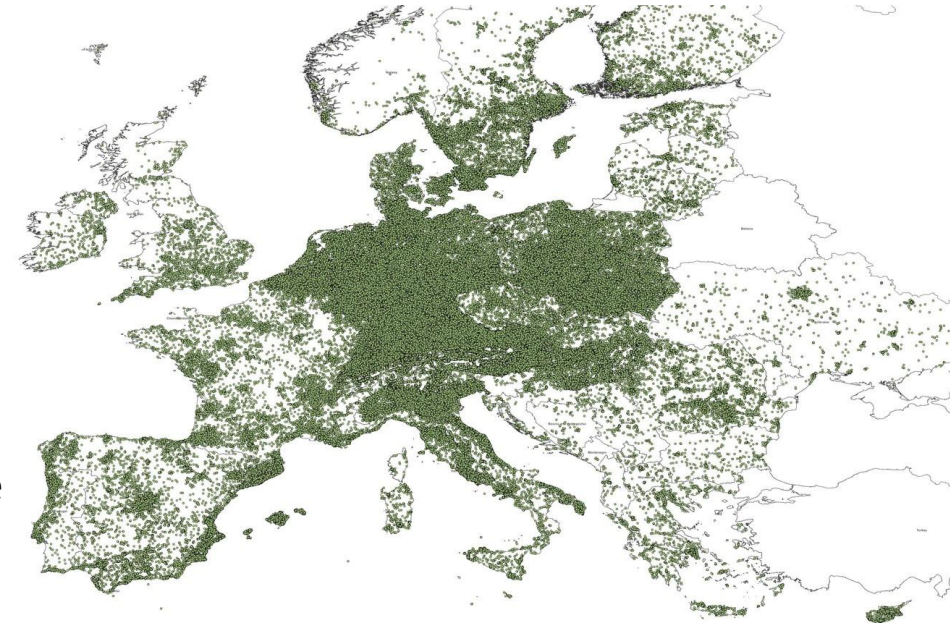
- Shut-down commands
- Charge/discharge commands
- Frequency control
- Grid export limits

China's National Intelligence Services Law requires any organization or citizen to provide assistance when requested by the Chinese government:

*Article 7: All organizations and citizens shall support, assist, and cooperate with national intelligence efforts in accordance with law, and shall protect national intelligence work secrets they are aware of.*

*Article 10: As necessary for their work, national intelligence work institutions are to use the necessary means, tactics, and channels to carry out intelligence efforts, domestically and abroad.*

China could thereby potentially through Chinese inverter manufacturers orchestrate blackouts in Europe. Attacks on inverters could lead to major blackouts that even result in "black starts": a total restart of the entire power grid, which can take a week.



# ENERGY SECURITY – LITHUANIA A FORERUNNER

Lithuania plan to add Article 733. “**Security Requirements for the Control Systems of Electricity Devices**” to their legislation. It is planned to be confirm in a governmental meeting tomorrow and to pass it to the Parliament for adoption. If passed, the National Energy Regulatory Council shall adopt the implementing legal acts of this law by April 30, 2025:

The security of information management systems and production control systems for electricity production and energy storage devices with an **installed capacity greater than 100 kW** must be ensured so that entities from countries that pose a threat to the national security of the Republic of Lithuania, according to the National Security Strategy, **do not have access to these systems**, allowing them to remotely manage the power change parameters of electricity production and/or energy storage devices and turn these devices on or off.

Grid operators shall not connect electricity production and/or energy storage devices to the electricity grids if the security of their control systems does not meet the requirements set out in paragraph 1 of this article.







**Thank you for your  
attention!**

**Dr. Johan Lindahl, Secretary General of ESMC**

Elmia Solar, February 2023

