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BRIEF

Robotics as a strategic lever for Europe and the key role of Italy

Key Messages

This document was coordinated by Andrea Montanino and Simona Camerano and prepared by: Alberto Carriero, Livio Romano, Azzurra Tavelli, and Sofia Torreggiani. The data reported refers to the information available as of December 18, 2025. The opinions expressed and the conclusions are solely attributable to the authors and do not in any way engage the responsibility of CDP.

- **Robotics** plays a decisive role in industrial applications and, increasingly, in the provision of services to businesses and end consumers.
- **Europe and Japan** dominate the **segment with the highest added value** in the value chain (super assembly); **China and the United States**, on the other hand, are more prominent in the **upstream stages** (raw materials and components) **and assembly**.
- In a market worth around **$80 billion in trade (2024)**, the European Union is the world's leading exporter and second largest importer of robots for industrial and professional use.
- **Italy** plays a leading role, **ranking second** in Europe after Germany in terms of **production value, installations, and exports**, with a slight trade surplus.
- This is an Italian production system with **650 specialized companies** and **12,000 employees**, as well as a **complex research and innovation ecosystem** that ranks us fourth in the world for scientific publications in advanced robotics and third in Europe for patents.
- **Current and future technological developments** aim to bring **increasingly autonomous and adaptive robots** to market, capable, thanks to AI, of interacting with humans and the surrounding environment, learning from experience, and acting autonomously and safely in the physical world.
- These **advanced robotics solutions** are **strategic levers for responding to the main structural challenges facing the European Union**: from strengthening competitiveness in a context of progressive aging and workforce reduction, to new care needs for a growing elderly population, to new priorities related to defense, strategic autonomy, and economic security.
- However, there are still **structural issues to be addressed** by the EU and consequently by Italy:
  - **accumulated delay in the field of artificial intelligence**, which is crucial for new-generation robotics, risks compromising the competitive advantage acquired in recent decades and thus delaying the development of robotics of the future;
  - a **fragmented European innovation ecosystem**, which does not allow for the full exploitation of European inventive potential and does not enable the EU to match the scale of investment of its international competitors;
  - lack of a **comprehensive industrial policy for the sector**, which could support the most promising projects throughout all stages of technological development and market growth.

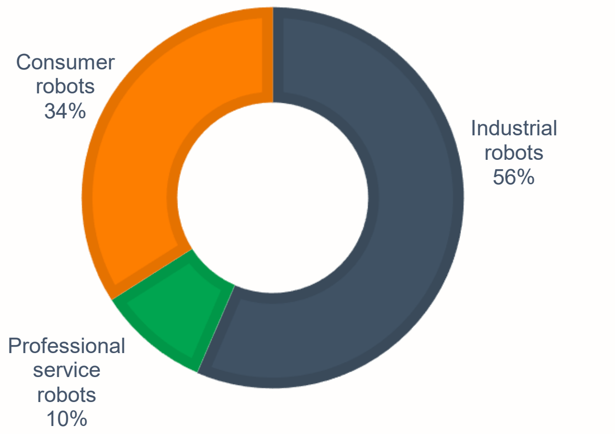
THE 10 FIELDS OF ACTIONS OF CDP 2025-2027 STRATEGIC PLAN

1 ENERGY TRANSITION
2 CIRCULAR ECONOMY
3 SAFEGUARDING THE TERRITORY
4 SOCIAL INFRASTRUCTURE
5 CAPITAL MARKET
6 DIGITISATION
7 TECHNOLOGICAL INNOVATION
8 SUPPORT TO STRATEGIC SUPPLY CHAINS
9 INTERNATIONAL COOPERATION
10 TRANSPORT / LOGISTICS NODES

1. The evolution of the global robotics market

- **Robotics** is the **branch of mechatronics** that deals with developing devices capable of "performing movements, manipulations, or positioning with a certain level of autonomy"[1], replacing actions or entire tasks otherwise performed by humans.
- The **robotics market** has historically been dominated by **industrial applications**, driven by the push for automation of process functions (including welding, assembly, and handling of semi-finished products along assembly lines) and the need to set up controlled environments to safely manage human-machine interaction.
- Even today, this segment is estimated to account for **nearly 60% of global sales value**, thanks to 540,000 installations in 2024[2], driven by demand in the electronics, automotive, and metalworking sectors[3].
- Alongside industrial robots, the **service robotics** market has also developed in parallel with the tertiarization of the economy and technological developments in the fields of miniaturization and sensor technology. This market is, in turn, divided, depending on the type of use, into **professional** (which requires ad hoc staff training) and **domestic** (which does not require specific skills).
- The **first type**, which is currently estimated to account for around **10% of global sales** with approximately 200,000 installations in 2024, includes, among others, robots for logistics, cleaning, hospitality, but also robots used in surgery and agriculture.
- The **second type**, also known as **consumer robotics**, which accounts for the remaining **30% of the market**, includes robots used for typical household services (cooking, cleaning, entertainment) or for surveillance tasks and are comparable to modern household appliances (graph 1).
- Over the next five years, **the global robotics market is expected to accelerate sharply**, with turnover volumes likely to more than double compared to current levels, driven mainly by applications in services.

Graph 1 – Global robotics market by device type (value, 2024)



Source: CDP elaborations based on IFR data and with the help of AI software

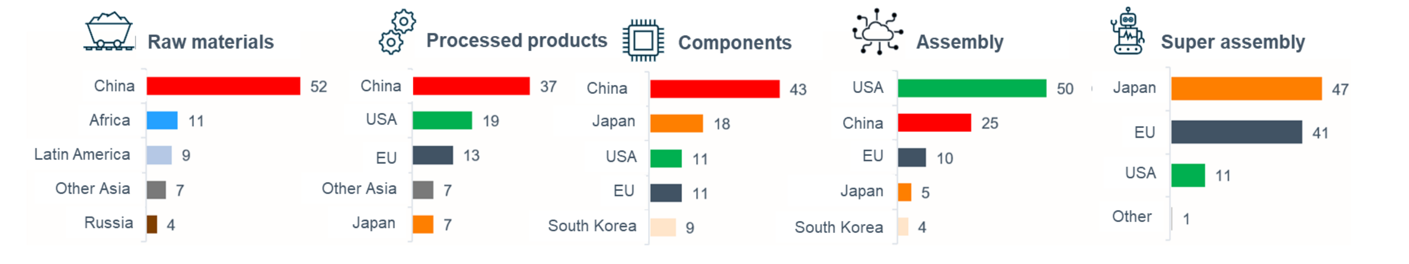
- The **European Union** and **Japan** hold a leading position downstream in the global value chain for non-consumer robotics, thanks to their strong specialization in the **most technologically advanced segments**, particularly in the so-called super assembly[4] (or system integration).
- **China** has secured a strong foothold in the upstream stages, being the main supplier of **raw materials**, **processed products[5]**, and **components[6]**. The **United States**, on the other hand, plays a prominent role in the

[1] Source: ISO 8373:2021.
[2] This refers to new robots installed and made operational in production facilities. Source: International Federation of Robotics.
[3] CDP elaborations based on data from the International Federation of Robotics and with the support of Copilot AI. The market is estimated to be worth a total of approximately $75 billion in 2024.
[4] Industrial robots and service robots.
[5] Metal alloys, magnetic alloys, and steel.
[6] Magnets, lithium-ion batteries, semiconductors.

assembly and supply of **certain semi-finished products** (specific aluminum alloys)[7] (figure 1).

- In 2024, the sector recorded **international trade worth $78 billion** worldwide[8]. The **European Union** ranks **first among exporters**, with approximately $18 billion in extra-EU sales, ahead of the US ($13 billion) and China ($9 billion).
- In terms of **imports**, the **US ranks first** worldwide, with a value of $24 billion, followed by the EU ($17 billion) and China ($6 billion).
- **Changes in international trade flows** over recent years show:
  - on the one hand, strong growth in robotics exports almost everywhere (in the EU +17% between 2022 and 2024), demonstrating the **growing importance of automation on a global scale**;
  - on the other hand, a reduction in robotics imports by **China** (-9% between 2022 and 2024), unlike all other major world economies, in line with the objectives of the "**Made in China 2025**" industrial policy strategy launched in 2015 with the aim of making the country a world leader in advanced manufacturing, and with those of the 15th Five-Year Plan, which aims to promote advanced robotics as an emerging sector[9].

Figure 1 – Non-consumer robotics value chain (market share by stage, 2023)



Source: CDP elaborations based on JRC European Commission data

2. Italian excellence in robotics

- The presence of an **extremely diversified manufacturing base** in terms of industrial applications[10] and the historical **vocation** of certain areas of the country in **mechanical engineering**[11] create the ideal conditions for the industrial robotics market in Italy to develop both in terms of demand (with applications ranging from metalworking to automotive, from chemicals to food) and supply.
- **Italy** occupies a position of absolute importance in the non-consumer robotics sector. In 2023, it was the **second largest producer of industrial robots in the European Union**, accounting for almost a quarter of the area's total production[12].
- The country is also the **second largest European market in terms of the number of industrial robot installations**, with over

[7] European Commission Joint Research Center, *Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study*, 2023.

[8] Source: WITS. Data referring to 2024 for product codes HS "842710, 842870, 847950, 880691, 901890".

[9] Advanced robotics appears in the Plan as *embodied intelligence*, indicating the progressive integration of artificial intelligence into the physical dimension. Source:: Proposal by the CPC Central Committee on the formulation of the 15th Five-Year Plan for National Economic and Social Development.

[10] Looking at the inverse of the Herfindahl-Hirschman Index (HHI), which measures sector concentration. Source: : Centro Studi Confindustria, *Manifattura in trasformazione: rimarrà ancora competitiva?*, 2025.

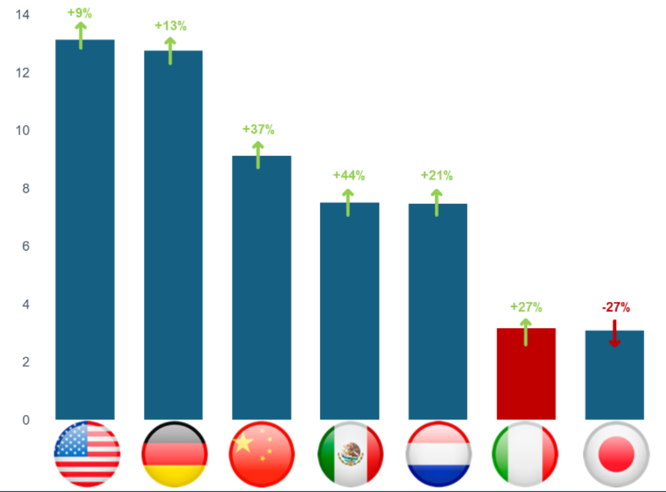
[11] Cassa Depositi e Prestiti, *La meccanica strumentale italiana tra eccellenza, innovazione e sfide globali*, 2025.

[12] Source: Eurostat. Data expressed in value terms for reference product code "28993935" (industrial robots for multiple uses, excluding robots designed to perform a specific function, such as lifting, handling, loading, or unloading goods).

10,000 units out of 73,000 in Europe (14%) and volume growth of 6% from 2019 to 2023, ranking behind only Germany[13].

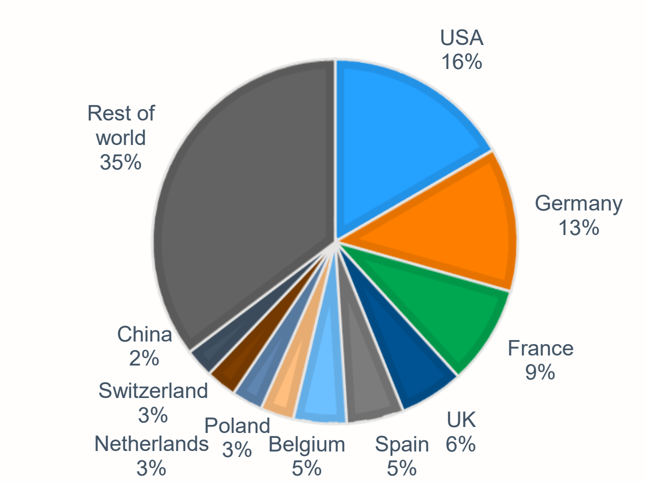
- Italy's leadership in the production of industrial robots is also evident in relation to exports: the country ranks **sixth in the world in terms of sector exports** (over $3 billion in 2024, with a trade surplus of $360 million), having overtaken Japan in the last year[14]. The outlet markets are highly diversified, led by the US (16%), Germany (13%), and France (9%) (graphs 2 and 3).

Graph 2 – Exports of non-consumer robots by country of origin (billion dollars, 2024; % change 2022-2024)



Source: CDP elaborations based on WITS data

Graph 3 – Italian exports of non-consumer robots by destination (% of total exports, 2024)



Source: CDP elaborations based on Istat data

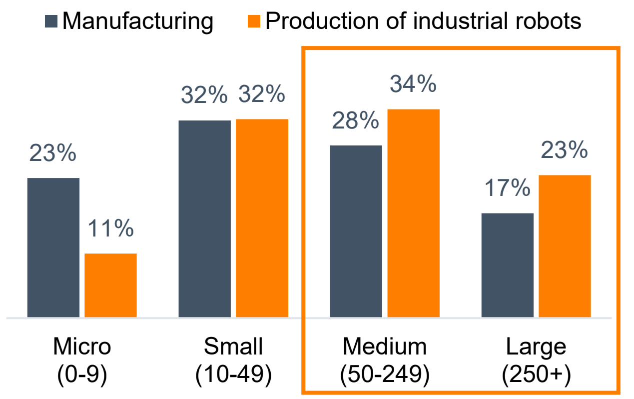
- Italy's leading role in robotics is supported by a solid and highly specialized national production network. The sector comprises **over 650 firms** and approximately **12,000 direct employees**, with an average company size greater than that recorded for the manufacturing sector (18 vs. 10) (graph 4)[15].
- **Production activities** are mainly concentrated in **Northern Italy in areas with a high level of manufacturing specialization**, where mechanical, electronic, and digital skills are integrated.
- **Turin** (home to one of the world's leading robotics companies) accounts for just under a quarter of total employment, followed by **Reggio Emilia**, **Brescia**, **Milan**, **Modena**, **Cremona**, and **Bari**, the only province in southern Italy in the top 10 (graph 5).
- In support of a sector with high strategic potential, Italy can also count on **solid national research specialization in the field of engineering**, which in turn fuels a **complex innovation ecosystem** made up of universities, centers of excellence, and technology transfer centers, some of which are internationally renowned.

[13] Source: UCIMU and International Federations of Robotics. Data referring to 2023.

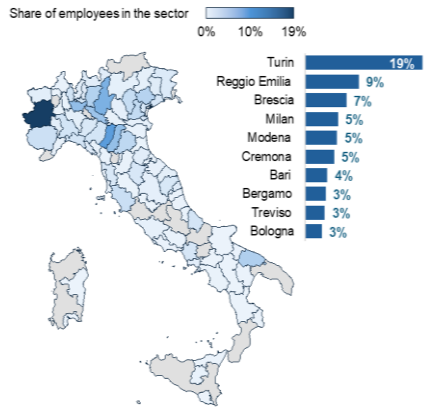
[14] Source: WITS. Data referring to 2024 for product code "847950" (industrial robots).

[15] Fonte: Istat. Dati riferiti al 2022.

Graph 4 – Distribution of employees by company size class (%, 2022)



Graph 5 – Distribution of employees by province (%, 2022)

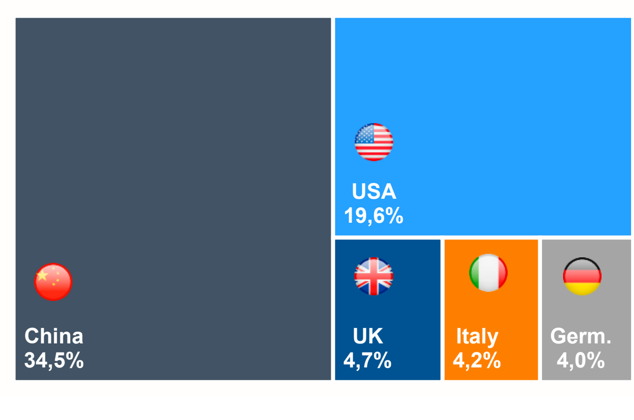


Source: CDP elaborations based on Istat data

- This is evidenced first and foremost by data on scientific publications in the world's most cited journals for advanced robotics research: between 2019 and 2023, **Italy was the fourth most prolific country in the world and the first in the EU** with a 4.2% share of publications, behind China, the US, and the UK[16] (figure 6).
- Furthermore, in the decade 2013-2022, with 526 **patents registered** with the European Patent Office, Italy ranks **third in the EU** and **among the top ten inventors in the world in robotics**. Unlike what happens globally, Italian inventors include not only **medium and large companies** but also **universities**, **public research centers**, and **start-ups** (table 1)[17].
- Italy is also supporting the development of the robotics sector through **targeted innovation policies**. The National Research Program (PNR) 2021-2027[18] in particular dedicates an entire section to **strengthening the national robotics ecosystem**, with a focus on developing technologies for continuous learning, increasing the intuitiveness, usability, and ergonomics of human-robot interfaces, facilitating physical interaction with the environment and humans, reducing the ecological footprint, improving energy autonomy, and using new materials typical of soft robotics[19]. **Six priority areas for investment** have also been identified: robotics in hostile and unstructured environments, Industry 4.0, infrastructure inspection and maintenance, agri-food, health, mobility, and autonomous vehicles.

[16] CDP elaborations based on Critical Technology Tracker of Australian Strategic Policy Institute data.
[17] The analysis focuses in particular on patent codes that are most directly related to robotic applications: "B25J" (manipulators; chambers provided with manipulation devices), "A61B034/00" (computer-aided surgery; manipulators or robots specially adapted for use in surgery), "A61B034/30" (surgical robot) e "A01D046/30" (robotic devices for individually picking crops).
[18] https://www.mur.gov.it/sites/default/files/2021-01/Pnr2021-27.pdf.
[19] Latest-generation robotics built with flexible and adaptable materials.

Graph 6 – Scientific publications in robotics for the TOP 5 countries of origin (percentage of total, 2019-2023)



Source: CDP elaborations based on Australian Strategic Policy Institute data

Table 1 – Leading inventors in robotics in Italy (% of Italian patents between 2013 and 2022)

Holder	Type	Province	Share
COMAU	Company	Turin	9%
I.M.A.	Company	Bologna	5%
Faspar	Company	Milan	4%
Medical Microinstruments	Company	Pisa	4%
Scuola Superiore Sant'Anna	University	Pisa	3%
Iuvo^	University spin-off	Pisa	2%
Istituto Italiano di Tecnologia	Research institute	Genoa	2%
Fameccanica	Company	Chieti	2%
Centro Ricerche Fiat*	Company	Turin	2%
Università di Siena	University	Siena	2%

*Notes: ^University spin-off of Scuola Superiore Sant'Anna; *part of Stellantis Group*
Source: CDP elaborations based on OECD REGPAT Database

3. Robotics as a response to key challenges faced by the European Union

- Robotics represents a strategic lever that enables the EU to address some key challenges to the economic and social sustainability of its development model:
  1. **Demographic decline and the challenge of competitiveness.** In the coming decades, the EU will experience an absolute decline in population, with a reduction in the workforce of 2 million per year until 2040[20]. Robotics, which has already proven to have a significant positive impact on productivity in the past[21], can help counteract the growing shortage of workers at all skill levels when accompanied by appropriate training policies[22];
  2. **The aging population and new care needs.** With people over 80 accounting for 12% of the European population in 2050[23] and a growing shortage of workers in the care sector, it is becoming increasingly difficult to ensure adequate and sustainable services for European welfare systems[24]. The adoption of ad hoc robotic technologies (care robots) can offer a concrete solution for improving the quality of life of the elderly, enhancing the work of care workers, and containing public healthcare costs[25];
  3. **European defense.** In an increasingly fragmented geopolitical scenario, Europe is called upon to strategically rethink its innovation policies in the field of defense. The use of specific robotic technologies (many of which are dual-use) will be essential for the technological modernization of the sector and to ensure

[20] Draghi, M. (2024), *The future of European competitiveness.*
[21] Klenert et al (2023), “Do robots really destroy jobs? Evidence from Europe”, Economic and Industrial Democracy, 44(1), 280–316 (previous JRC Working Paper).
[22] European Commission (2024), *European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience*.
[23] Source: Eurostat, 2024.
[24] Bruegel, 2025, Prepare now: Europe must get ready for the coming long-term care surge, Policy Brief, https://www.bruegel.org/policy-brief/prepare-now-europe-must-get-ready-coming-long-term-care-surge.
[25] Lee, Y.S., T. Iizuka and K. Eggleston (2024) “Robots and Labor in Nursing Homes”, NBER Working Paper 33116, National Bureau of Economic Research, available at https://www.nber.org/papers/w33116.

adequate military capability, in line with new operational requirements;

4. **Economic security and strategic autonomy.** The growing uncertainty of the international landscape makes it necessary to rethink supply chains with a view to greater European independence and strategic autonomy in key industrial sectors. In particular, by replacing labor previously outsourced to low-cost countries, robots can facilitate the reshoring of certain production activities to advanced economies[26], while ensuring greater control over quality and production times[27].

- Therefore, considering also the growing threats of geopolitical use of trade dependencies and the risks related to cybersecurity, it becomes a priority for Europe to strengthen its technological and industrial development capacity in the field of advanced robotics.

4. The robotics of the future: technological trajectories and policy priorities

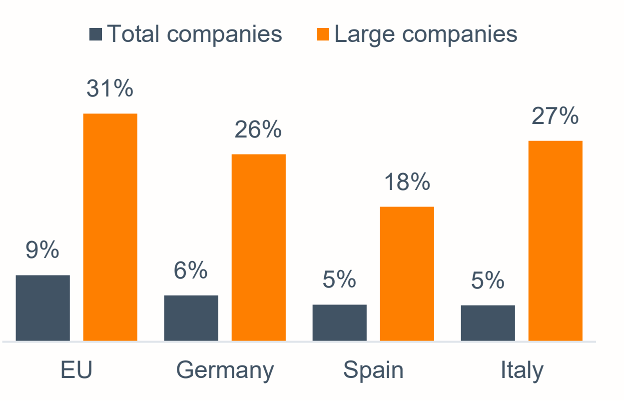
- The robotics of the future will be characterized by **increasingly smart devices with greater functional capabilities** thanks to so-called ***physical or embodied AI***, which integrates into physical systems, such as robots, the ability to perceive, analyze, and act in the surrounding environment, enabling dynamic and increasingly sophisticated actions. In this scenario, there are increasingly concrete prospects for creating industrial-scale **humanoid robots** in the near future.
- This progress will be possible thanks to the integrated optimization of software and hardware components: starting with ***rule-based*** systems, in which robots perform only simple and rigidly programmed tasks, moving on to ***training-based*** systems, in which robots are able to adapt to environments and manage unexpected events autonomously, and finally to ***context-based*** systems[28], in which machines analyze the context in real time and act autonomously based on the instructions received and the surrounding environment.
- **There are many challenges to be addressed,** including improving performance[29], using new materials, ease of object manipulation, ease of use and interaction with humans, as well as the ability to ensure cybersecurity and the need for investment in the technological ecosystem to support the sector[30].
- The evolution toward advanced robotics depends, in particular, on **four key areas of development**:
  1. **Adaptation and learning:** the evolution of robots will require continuous and non-linear learning processes, capable of cyclically remodeling the actions and behaviors of machines based on the context and user needs;
  2. **Perception and physical interaction:** future robots will need to be able to rely on advanced perception of their environment, identify objects and physical characteristics, and interact smoothly and safely with humans;
  3. **Manual skills and dexterity:** increasingly sophisticated gripping, manipulation, and coordination capabilities will enable robots to handle even complex and flexible objects and achieve levels of dexterity comparable to those of humans;

[26] Chen and Frey (2024), "Robots and Reshoring: A Comparative Study of Automation, Trade, and Employment in Europe." Industrial and Corporate Change, 33 (6): 1331–1377.
[27] Ancarani et al. (2019), "Backshoring Strategy and the Adoption of Industry 4.0: Evidence from Europe." Journal of World Business 54 (4): 360–371.
[28] This type is still in the development and testing phase.
[29] In terms of speed, agility, lightness, and strength.
[30] Ad esempio connettività, IA, infrastrutture cloud, sistemi per la governance dei dati, competenze e formazione della forza lavoro. Fonte: The European House Ambrosetti, *InnoTech Report 2025: Harnessing innovation in the global scenario.*

4. **Autonomy and control:** the degree of autonomy defines how much a robot can operate with minimal supervision, managing complex tasks without constant external intervention.

- Despite its current competitive advantage in the sector, the European Union is facing many **factors** that could **compromise its position**.
- Firstly, the EU is lagging far behind in the development of **artificial intelligence** solutions and related digital infrastructure.
- The **volume of investment in the sector** is currently an order of magnitude **lower than that of other major international players**: over the last decade (2013-2024), the EU has invested a total of $49 billion in AI solutions, compared to $119 billion in China and $470 billion in the United States[31].
- Only in the **last year** has there been significant progress for the EU, with investments of over **$14 billion**, surpassing China (at $9 billion) in **second place in the world rankings**, although still far behind the US ($109 billion).
- **Italy**, in turn, has a significant **gap** in the field of AI **compared to its main European peers**: in 2024, 14 new start-ups specializing in AI were created (compared to 67 in Germany and 59 in France) and $900 million was invested (less than half of France and Germany)[32].
- The second risk factor for Europe's robotic leadership is linked to the **fragmentation** of its **innovation ecosystem**. Unlike its main international competitors (China and the United States), which have centralized research and innovation policies, **each Member State outlines its own innovation strategies** according to national economic needs and priorities.
- **Funding** for research and innovation is therefore highly **dispersed** and often **misaligned between different territories**, thus creating duplication in investment[33].
- **European collaboration networks** for research and innovation **rarely extend beyond national or even regional borders**, with the result that technological and industrial complementarities are not fully exploited[34]. On average across EU countries, only 9% of innovative companies systematically collaborate with partners from other Member States for their research and development activities, a figure that falls to 5% in Italy. Among large European companies, the percentage stands at 31%, while in Italy it is 27% (graph 7)[35].
- Finally, despite the fact that since 2020[36] the EU has implemented **various policy initiatives in support of robotics**, including dedicated funding lines within the Horizon Europe program, there is still no **comprehensive industrial policy strategy for the sector** that is capable of:

Graph 7 – Share of innovative companies collaborating in research with EU partners (2022)



Source: CDP elaborations based on Eurostat data.

[31] Source: Stanford University, Artificial Intelligence Index Report 2025.
[32] Source: Stanford University, Artificial Intelligence Index Report 2025.
[33] European Commission, *Divided We Fall Behind: Why a fragmented EU cannot compete in complex technologies*, 2025.
[34] As also highlighted in the Letta Report, the fragmentation of the innovation ecosystem reflects the incomplete nature of the single market in this knowledge-related dimension as well.
[35] Elaborazioni CDP su dati Eurostat – CIS, riferiti al 2022.
[36] This refers in particular to the launch of the Strategic Research, Innovation and Deployment Agenda (SRIDA), a public-private partnership aimed at strengthening the European robotics and artificial intelligence ecosystem, and the launch of SPARC, the first program on this topic funded at the European level. More recently, robotics has been included among the critical technologies within the STEP platform and among the funding lines promoted by the European Innovation Council.

- ensuring **continuous public funding that is adequate** to meet the financial needs of the most promising projects throughout **all stages of technological development** (from applied research to initial industrialization). Robotics is characterized by a **particularly long innovation cycle**, which lasts on average 15-20 years from the laboratory to the product on the market (i.e., twice or three times the typical innovation cycle in the software world), with investment requirements that grow at each stage of development due to the need to integrate innovations into complex physical systems, depending on the areas of application in which they are used[37];
- **stimulate private investment** to enable these projects to subsequently reach the **large-scale production phase**, thus preventing the most promising continental companies from losing the technological race or being acquired by non-European competitors.

- Future progress in the field of robotics and its applications in economic and social systems at national and European levels will therefore be strongly linked to the amount of financial resources and venture capital allocated to the sector. The greater public and private commitment in this area, the greater the likelihood that Europe and Italy will secure an industrial future in robotics.

[37] EU Robotics (2024), A unified vision for European robotics.

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