



CAFEIN

CLUSTER ACTION FOR ECOSYSTEM INNOVATION NETWORK

Europe facing the twin green and digital transition: challenges and opportunities

March 2024

Europe facing the twin green and digital transition: challenges and opportunities

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Summary

In the rapidly evolving landscape of digital and green industrial transitions in Europe, the CAFEIN project ¹ seeks to develop a collaborative effort aimed at fostering synergies between member states, with a keen focus on nurturing Small and Medium Enterprises (SMEs) with the support of clusters and business networks. This project is rooted in an inclusive approach, encapsulating the dynamism of the industry-government-public-university collaborations – quadruple helix- and seeking to enhance interconnections within and across European innovation ecosystems.

Funded by the European Union, CAFEIN aims to prepare a joint action plan, based on a five-year programme, to address green and associated industrial transition challenges through national clusters associations (the project partners) and national innovation funding agencies (seating at CAFEIN's Innovation Funding Advisory Board – IFAB) within five European countries (France, Italy, Sweden, Spain and Poland).

Based on the analysis of the green industrial transition performance both at European level and at the (5) country level, this policy brief provides an overview of an in-depth study made on several dimensions: industrial context and performance, innovation context and performance, and green and digital transition context and performance.

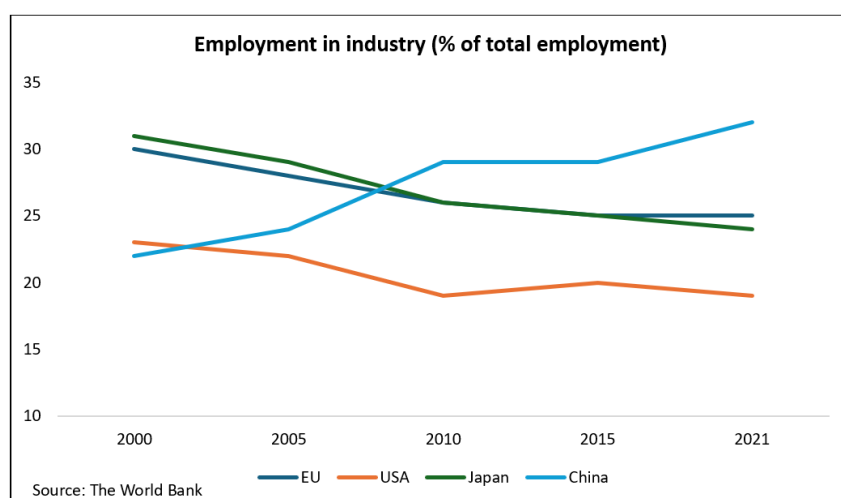
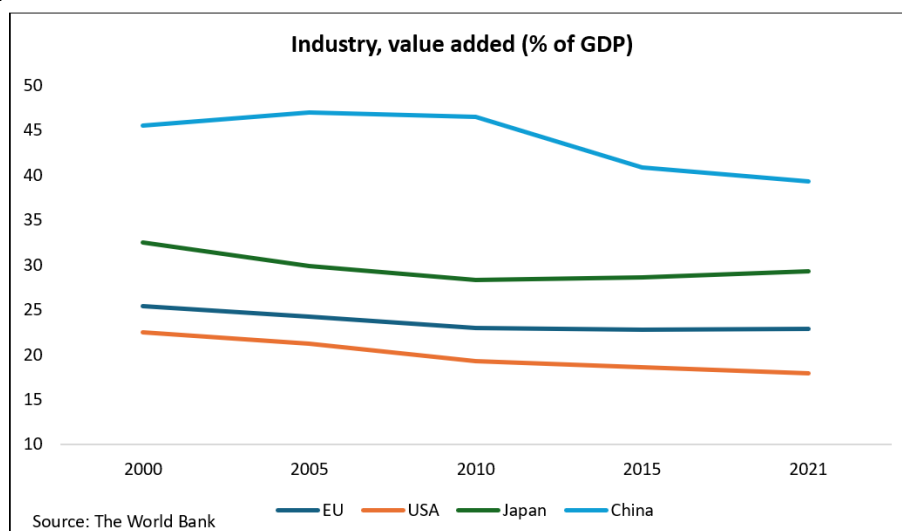
¹ CAFEIN has received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement N° 101070768

1. The European industrial context

If Europe is a historic cradle of industry, global competition is reshuffling the cards and shifting influences.

According to The World Bank², the European Union remains today the world's third-largest industrial power,

and European industry continues growing (7.3% growth in 2021, according to the World Bank). However, these positive results should not conceal the fact that deindustrialization has been underway in Europe since the 1980s: the industry's share on the GDP is gradually diminishing³, the industry growth has been slower over the past 10 years in Europe compared to China and the USA⁴, and industry accounts for 25% of employment in 2021 when it was 30% twenty years ago in 2000⁵.



This deindustrialisation is due to micro-economics phenomena at work all over the world: the diminution of the industry's shares of GDP and employment is an automatic phenomenon due to the automation of industrial tasks, productivity gains through innovation, loss

of certain activities, and outsourcing of others. It is also due to macro-economic trends linked to the globalization of trade and the global competition it engenders (relocation of

² The World Bank: [Industry \(including construction\), value added \(current US\\$\) | Data \(worldbank.org\)](https://data.worldbank.org/IS/VS)

³ The World Bank: [Industry \(including construction\), value added \(% of GDP\) | Data \(worldbank.org\)](https://data.worldbank.org/IS/VS)

⁴ The World Bank: [Industry \(including construction\), value added \(annual % growth\) | Data \(worldbank.org\)](https://data.worldbank.org/IS/VS)

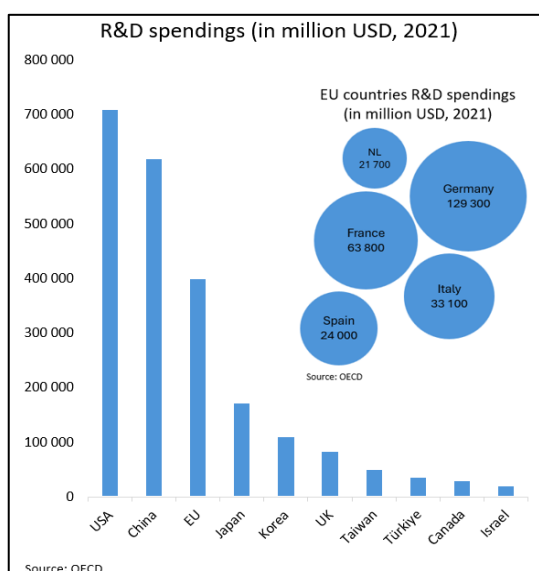
⁵ The World Bank: [Employment in industry \(% of total employment\) \(modeled ILO estimate\) | Data \(worldbank.org\)](https://data.worldbank.org/IS/VS)

industries in developing countries) and new economic powers (especially the BRICs: Brazil, Russia, India and China) where wage costs are lower.

European States and the European Union have recently seized the imperative need of re-industrialisation. This awareness has accelerated since 2020 by the crisis (COVID-19, Ukrainian...) highlighting the sovereignty challenges. New national and European policies regarding reshoring industry have been designed. All pointed out the ability of Europe's industry to lead the twin (green and digital) transitions as a key accelerator and enabler for the European competitiveness.

To achieve this, Europe must be able to rely on its research and innovation ecosystem, which produces the necessary know-how and technologies, and on its ability to disseminate technologies and drive changes in practices within companies, regardless of their sector, size or geographical location.

2. The European innovation context



The analysis of the European innovation context shows that the strength of European research and innovation capacity is recognized worldwide and identified as a lever for European economic success. With \$400 billion, the European Union ranked 3rd in terms of R&D expenditures ⁶. In 2020, the European Union is still the first contributor to scientific publications ⁷. And **Europe is catching up at speed and facilitating the creation of unicorns ⁸ faster than the US ever did: in 2023, the 103 Unicorns located in the EU-27 represent an overall value of 3 803 bn\$, and 38,6 bn\$ of venture capital (VC) have been raised to date ⁹.**

However, the European Union is facing increasing global competition in research and technology production. According to the OECD, its R&D expenditure represents only 2.16% of GDP in 2021, behind the European objective of 3% and the OCDE average (2.72%). In the last decade, we have seen the rise of the countries of East and Southeast Asia (China, Japan, Malaysia, Singapore, South Korea, Taiwan and India), which are taking a growing share of the R&D spending increase worldwide. Same observation about scientific publications' catch-up in East and Southeast Asia. As regards to unicorns, United

⁶ OECD: [Research and development \(R&D\) - Gross domestic spending on R&D - OECD Data](#)

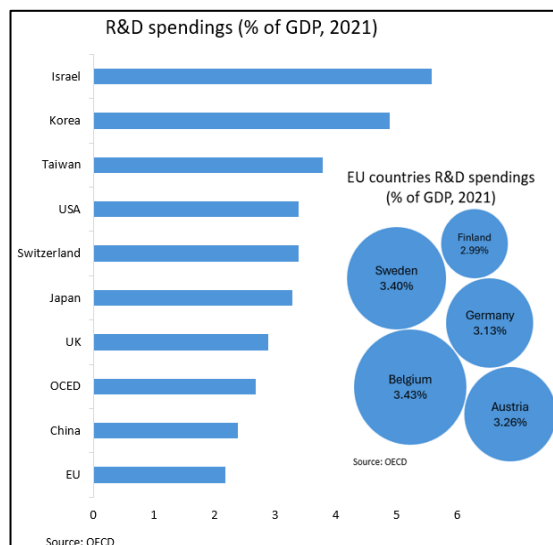
⁷ [SJR - International Science Ranking \(scimagojr.com\)](#)

⁸ The term unicorn refers to a privately held startup company with a value of over \$1 billion.

⁹ [Unicorn Companies Tracker | PitchBook](#)

States was still hosting half of the over 1,200 unicorns around the world in June 2023, according to PitchBook.

To maintain its power and global recognition in the field of innovation, Europe still faces the challenge of the many innovation gaps, which persists within the EU. For instance, in terms of R&D expenditure, only 4 countries exceeded the target of 3% of GDP in 2021 - Sweden, Belgium, Austria and Germany. In contrast half of the EU-27 countries spend less than 1.5% of GDP in R&D. Germany is the main driver of European's R&D expenditures with 129M\$ in 2021, representing 32% of the total expenditures in Europe in 2021. In addition, the performance groups tend to concentrate geographically: innovation leaders and most strong innovators are located in Northern and Western Europe, whilst most moderate and emerging innovators are found in Southern and Eastern Europe. Strengthening and better connecting innovation players through Europe, including by bridging the innovation gaps across the EU, is also a key aspect of the New European Innovation Agenda, which ambitions to make Europe a leader in deep tech technologies. Actions also focus on improving access to finance for European startups and scaleups, and on attracting and retaining talent.



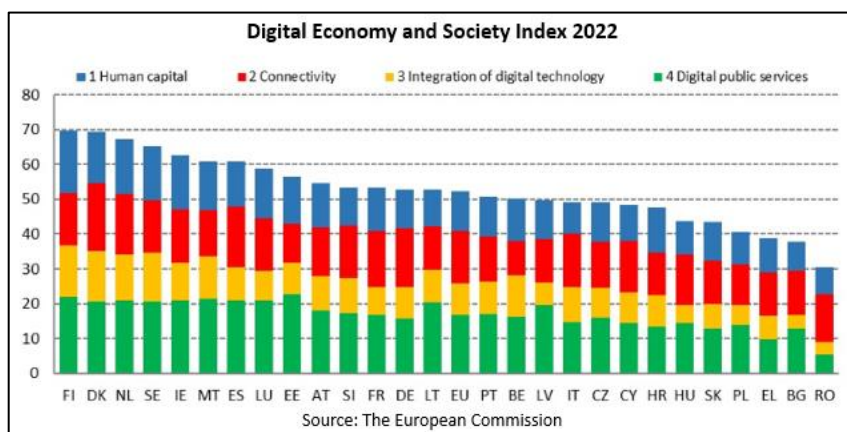
3. The European twin transition context

An analysis of the European green and digital transition context show that the European Union is a proactive area in green transition, considering green economy as a source of prosperity, differentiation, and societal change. According to the United Nations, the



European Union is the SDG¹⁰ leader globally, largely driven by Northern Europe member states¹¹. With the adoption of the European Green Deal in 2019 and related legislations and plans, Europe was the first continent to announce a bold commitment to climate-neutrality by mid-century.

In doing so, Europe acts as a global standard-setter. The European climate tech startup ecosystem is dynamic. The recent Green Deal Industrial Plan wishes to massively increase technological development, manufacturing production and installation of net-zero products and energy supply chains in the next decade, and argues the added value of an EU-wide approach to meet this challenge together. EU should continue to play a leadership role in implementing the SDG goals internally and internationally.



As for digital transition, the global digital transformation is underway, and most of the Member States are making progress. The COVID-19 pandemic has played the role of an accelerator: half of the European businesses reported investing in digitalisation as a response to COVID-19. Nevertheless, digital transition remains a major challenge in Europe. Firstly, only 55% of SMEs reached at least a basic level in the adoption of digital technologies, and the adoption of new key digital technologies by businesses such as artificial intelligence (AI), Internet of Things (IoT) and big data remains low, also among the EU frontrunners¹². In addition, with digitalisation advancing, digital gap in Europe is also increasing, and the adoption of technologies shows wide disparities between EU countries, and also among citizens. Furthermore, the insufficient level of digital skills hampers the prospects of future growth, deepens the digital divide, and increases risks of digital exclusion. Finally, despite its progress, Europe still lags behind the USA in terms of digitalization. Digitalization is still one of the pillars of the European Commission's

¹⁰ Sustainable Development Goals

¹¹ Europe Sustainable Development Report 2023/24 : [europe-sustainable-development-report-2023-24.pdf](#)

¹² Digital Economy and Society Index (DESI) 2022: [Digital Economy and Society Index \(DESI\) 2022 | Shaping Europe's digital future \(europa.eu\)](#)

action, notably through its Digital Agenda and considering digitalisation as a source of prosperity for people and companies.

4. Country level's context and performances

At a country level, hereunder is an overview of the industrial, innovation and green and digital transition context and performances, within the 5 countries covered and prepared by CAFEIN project members: France, Italy, Sweden, Spain and Poland.

France

France, as industrial and innovation leader, ranks 7th in the world for GDP, manufacturing power, and R&D expenditures. Despite recognition in transport, food, energy, and technology sectors, only 24% of SME managers invested in "green" initiatives by 2022, and digital intensity lags behind the EU average. France initially prioritized strategically digital transition, but green initiatives gradually gained prominence. While numerous pilot measures and strategies exist at different levels (European, National, regional, territorial, sectoral), their proliferation led to challenging coherence and bringing redundancy, especially for SMEs. France requires better multi-level governance for a more coherent and impactful green industrial transition.

France

Industrial context



Key figures

- 7th world power in terms of GDP in 2021 (3th in Europe) (Source: World Bank)
- 7th world manufacturing power (Source: World Bank)
- Industry accounted for 16,7% of GDP (Source: World Bank)
- Mainly composed by SMIs : 99,3% of French companies have fewer than 250 employees



Sectors

- An industry concentrated around 2 main sectors, representing 39% of the manufacturing of France
 - Food products, beverages and tobacco (20%)
 - Transport equipment (19%)
- Flagship sectors :
 - Transport : Aeronautic accounts for 12% of French exports, with industrial leader such as Airbus. Also industrial leaders in automobile and maritime and shipyard
 - Energy / nuclear : the nuclear sector is still responsible for 75% of electricity production in France
 - Materials : polymers, metallics products, etc.
 - High-reconingition of "Made in France" on agri-food (wine, cheese, etc.) and luxe (textile, cosmetics...)



Trends

- **Long trend of de-industrialization.** Over the last 50 years, the extremely low cost of labour in certain countries, particularly in Asia, has attracted French manufacturers who have chosen to relocate in order to remain competitive in the face of foreign competition.
- **Recent stabilizing.** Since 2010, there is a rehabilitation of the industrial image, and French state has undertaken national policies to support industry (18 priority sectors). Industry stabilized since 2017, excluding the conjunctural COVID crisis impact.
- **Sovereignty issue.** very high level of dependence on industrial imports: 35% for all imported intermediate goods and 24% for the industrial sector, mainly in the aerospace, chemicals and automotive sectors
- **Lack of mid-caps companies.** The imbalance in the industry, with a large number of SMEs and a few large groups, but very few mid-caps companies, even though keys in the economy (jobs, innovation).

Innovation context



Key figures

- R&D expenditures represents 2,21% of GDP in 2021 (€63 billion), ranking France 7th in the world in amount of expenditures. (Source: OECD)
- Industry accounts for 78% of expenditures on research and development (R&D), which represents the bulk of spending on innovation. This is equivalent to expenditure of €23.4 billion, compared with €6.6 billion in the rest of the economy.
- 2nd most innovative country in Europe in terms of patents
- 1 millions startups in 2021 (source: DGE)
- 28 unicorns in France in January 2023, compared with just 5 in 2018 and 3 in 2017. The aim is to have 100 French unicorns by 2030.
- In 2022, French start-ups raised almost €14 billion, compared with €11.5 billion in 2021.
- 22% of French companies will have developed or introduced new products, processes or services as part of their investment activities by 2022. 56% in industry (source: EIB Investment Survey 2022)



Technologies

- Microelectronics: with a cluster in Grenoble with international recognition (ST-Microelectronics, Soitec, CEA...)
- AI : the number of start-ups specialising in AI is increasing., and recruitment in AI is increasing by 40% a year.
- Space, biotech, energy



Ecosystem

- 55 competitiveness clusters, representing more than 10,000 SMEs. They play a major role in the integration of SMEs into national and European innovation processes
- 21 public research incubators, 400 public and private nurseries and accelerators
- Bpifrance's massive actions on innovation and industry, with €50 billion deployed in 2021 to support the economy
- Research Tax Credit (CIR) is the main source of public funding for R&D in France
- Private funding : Eurazeo, Kima Ventruies, ISAI gestion, Partech, Alven, BNP Paribas, ...

France

Industrial context

Innovation context

Position toward green industrial transition

The World Economic Forum ranked France among the "leading" countries, 18th in the world on the "Structure of production" criterion and 14th in the world on the "Driver of production" criterion (source: 2018 report on the level of preparedness of each country for the industry of the future).



Green transition

- 7th in the world in terms of Sustainable development (based on the 17 SDG challenges) (source: 2022 edition of the Sustainable Development Goals Index, United Nation). Nevertheless, the SDGs on environmental transition are far from being achieved.
 - **SDG7 - Affordable and clean energy:** the challenge remains, with a score moderately improving, but insufficient to attain goal. The only but strong pending sub-challenge for France is the improving of the renewable energy share in total energy supply.
 - **SDG 12 - Responsible consumption and production:** : this challenges is one of the 2 major French challenges, with a score stagnating. Electronic waste and export of plastic waste are pointed as major challenges, and nitrogen emissions embodied in imports is a significant challenge.
 - **SDG13 - Climate action:** second major French challenges, with a score moderately improving, but insufficient to attain goal. If the objective regarding CO2 emissions embodied in fossil fuel exports is achieved, CO2 emissions from fossil fuel combustion and cement production, and CO2 emissions embodied in imports remain major challenges.
- 12th in the world on the Transitions Performance Index 2021, 9th at EU level (source: European Commission). On the environment criteria, France is ranked 7th at EU level.
- **Integration of green technologies:** France is paying particular attention to the development of key green technologies. In 2021, 6 research acceleration strategies were launched regarding ecological transition and decarbonized energy : Decarbonized hydrogen, Recycling and re-incorporation of recycled materials, Bio-based products - Sustainable fuels, Decarbonisation of industry, Greening of digital technology, and Advanced technologies for energy systems - Sustainable fuel
 - In 2022, 24% of SME managers have made "green" investments over the past three years, mostly for sorting or recycling waste (61%) or changing the fleet (43%). (Source, BPI France)
 - 35% plan to do so in the next three years



Digital transition

- The European Commission ranked France 12th in the European Union in terms of digital performance, ahead of the European average, but not yet among the digital frontrunners (source: 2022 edition of the Digital Economy and Society Index (DESI)). This report highlights a sustained effort in support of digitalization which has over-performed in the past years, progressing more than expected.
 - **Connectivity:** Digital connectivity has improved in France, with many upgrades on its fixed networks and the continuation of the implementation of the national broadband plan with a remarkable take-up of 1 Gbps across the country and a very wide availability of mobile broadband (4G coverage of 99% of households).
 - **Human capital:** France has devoted significant investments to the development of advanced digital skills to ensure there is an adequate supply of the specialists that the economy currently lacks. France performs above the EU average for basic and above basic digital skills, respectively at 62% and 31% of the population.
 - **Integration of digital technologies:** France is paying particular attention to the development of key digital technologies. In 2021, research acceleration strategies were launched for AI, cloud, cybersecurity, quantum and 5G, etc. However, SMEs are finding it more difficult to harness the potential of digital solutions for their business, with 47% having at least basic digital intensity, compared to the EU average of 55%. This puts France at a considerable distance from reaching the Digital Decade target of 90%. In 2021:
 - 58% of french companies uses ERP (+7% since 2016), 29% will be using CRM (down -1% since 2016), and 21% will be issuing orders via IT networks (-3% since 2016)
 - 25% of French companies uses the cloud, compared with and EU average of 34%
 - representing growth of 212% in 5 years.
 - 22% of companies in 2021 uses big data compared with and EU average of 14%
 - 21% of french companies uses the IoT (source: Eurostat, 2021).
 - Only 7% of french companies uses AI, compared with an EU average of 8% (source: Eurostat, 2021).



Italy

Italy, in 2021, held the position of the world's 8th largest economy and the 9th largest manufacturing power, witnessing an industrial resurgence since 2015. Despite initial struggles, the Italian industry proved resilience during the COVID-19 crisis, owing to its diversified sectors. Key manufacturing areas include metal products, machinery, equipment, and food-related industries. Notably, Italy stands as the third-largest exporter of robotics and is globally renowned for "Made in Italy" quality in various sectors. While Italy lags in digital performance, it ranks third in green performance. Challenges exist, including energy dependency on gas and a need for innovation, with R&D expenditure capping at 1.5% of 2020's GDP. Coordination with European green transition measures is evident, but there's a call for streamlining and focus to optimize public spending. The complexity of existing support systems and a lack of innovation dynamism bring challenges to the Italian industries.

Italy

Industrial context



Key figures

- 8th world power in terms of GDP in 2021 (4th in Europe) (*Source: World Bank*)
- 9th world manufacturing power: industry accounted for 22.5% of GDP (*Source: World Bank*)
- Mainly composed by SMIs and ETIs : 99% of Italian companies have fewer than 250 employees



Sectors

- A diversified industry
- 3 main sectors:
 - manufacture of metal products (iron, steel, non-ferrous metals) (16%)
 - manufacture of machinery and equipment (15%),
 - manufacture of food products, beverages and tobacco (11%)
- Flagship sectors :
 - Manufacture of robots : Italy is the second largest manufacturer of robots in Europe and the third largest exporter of robotics in the world, behind Japan and Germany.
 - The quality of "Made in Italy" is recognised over the world in the food sector (e.g. Mutti tomatoes, Illy coffee, Ferrero chocolates, etc.), design (e.g. Alessi and Kartel), textiles and clothing, leather and footwear (e.g. Gucci, Prada, etc.), automotive (Fiat, Ferrari, Lamborghini, etc.) and chemical and pharmaceutical products.



Trends

- Industrial revival since 2015: industry's share of GDP has risen by 8% between 2015 and 2021 (*Source: World Bank*)
- One of the industries that has recovered best from the health crisis
- Italy's major dependence on natural gas for electricity and manufacturing production : the current global energy crisis is having a strong negative impact on Italy

Innovation context



Key figures

- Lack of dynamism in innovation
 - R&D expenditures represent 1.49% of GDP in 2021 (€24 billion), ranking Italy 26th in the world in amounts of expenditures (*Source: OECD*)
 - R&D expenditures in the industrial sector total almost €11 billion, or 66% of total business R&D expenditures.
 - Investment in innovative start-ups in Italy remains low compared to other European countries
- Progress made over the last ten years, but not enough to catch up
 - R&D spending has been rising steadily since 2015, with an average annual increase of 2.5%,
 - The threshold of one billion dollars invested in start-ups being passed in 2021 for the first time in the country's history



Technologies

- Italy is renowned for its technological expertise in robotics: it ranks sixth in the world for the number of scientific publications, and has some of the best robotics schools and universities in the world.
- Italy ranks third in the world for specialization in space technologies (proportion of patents related to space sectors compared to the total number of patents), following Russia and France, and ahead of Spain and Israel. Italy holds the fifth position in absolute values, with a share of 4.1%, trailing behind the USA, France, Japan, and China. (*Source: OECD*).



Ecosystem

- In 2012 and 2016 Italian M.U.R. created 12 National Technological Clusters
- Approximately 80 clusters organisations operate in the country
- Italy currently has 237 public/private incubators and accelerators, 44 of them are certified by C.o.C
- Tax credit for R&D issued through the *Piano Transizione 4.0* and supported by the National Recovery and Resilience Plan is the main source of public funding for R&D in Italy
- Invitalia is the main agency in charge of industry innovation funding management
- In 2018 Italy created 8 national high specialisation competence centers, which today manage part of NRRP public funding



Italy

Industrial context

Innovation context

Position toward green industrial transition

The World Economic Forum ranked Italy among the "leading" countries, 15th in the world on the "Structure of production" criterion and 30th in the world on the "Driver of production" criterion (*source: 2018 report on the level of preparedness of each country for the industry of the future*).



Green transition

- 25th in the world in terms of Sustainable development (based on the 17 SDG challenges) (*source: 2022 edition of the Sustainable Development Goals Index, United Nation*). The SDGs on environmental transition are in progress, but not achieved
 - **SDG7 - Affordable and clean energy:** the challenge remains, with a trajectory on track for SDG achievement. Two sub-challenges remaining: the improving of the renewable energy share in total energy supply, and the CO₂ emissions from fuel combustion per total electricity output.
 - **SDG 12 - Responsible consumption and production:** this challenge is still a significant challenge for Italy, with moderately but insufficient progress. 4 or 7 sub-challenges are achieved. Electronic waste and nitrogen emissions embodied in imports are respectively major and significant challenges for Italy. Export of plastic is a remain challenge.
 - **SDG13 - Climate action:** the challenge is one of a major challenge for Italy, with moderately but insufficient progress for SDG achievement. If the objective regarding CO₂ emissions embodied in fossil fuel exports is achieved, CO₂ emissions from fossil fuel combustion and cement production, and CO₂ emissions embodied in imports remain major challenges.
- 16th in the world on the Transitions Performance Index 2021, 13th at EU level (*source: European Commission*). On the environment criteria, Italy is ranked 3rd at EU level.
- From 2000 to 2016, the Italian green technological capacity focused on development of technologies in four key macro-sectors: greenhouse gas reduction in the energy sector (31%), climate change mitigation in transportation (19%), construction industry (15%), and the production of goods (15%). More specifically in renewable energy generation patents (18.8%), transportation (16.4%) and technologies for mitigating greenhouse gas emissions (7%), including batteries and energy storage systems.



Digital transition

- The European Commission ranked Italy 18th in the European Union in terms of digital performance, below the European average. (*source: 2022 edition of the Digital Economy and Society Index (DESI)*). This report notices the catching up of the Italy.
 - **Connectivity:** progress has been made in terms of broadband take-up and network deployment. Gaps remain in the coverage of very high-capacity networks (including fibre), which is still far from the EU average and from the Digital Decade target of universal coverage by 2030.
 - **Human capital:** Italy is narrowing the gap with the EU when it comes to basic digital skills, although more than half of Italians still lack these skills. The share of digital specialists in the Italian workforce remains below the EU average, and future prospects are compromised by low ICT enrolment and graduation rates.
 - **Integration of digital technologies:** most Italian SMEs (60%) have at least a basic level of digital intensity. There has been significant growth in the use of the cloud, but the adoption of other key technologies such as big data and artificial intelligence is still fairly limited. In 2021:
 - 43% of Italian companies uses ERP (down from 44% in 2016), 30% will be using CRM (down from 31% in 2016), and 15% will be issuing orders via IT networks (up from 9% in 2016).
 - 62% of Italian companies uses the cloud, compared with just 20% in 2016, representing growth of 212% in 5 years.
 - 32% of Italian companies uses the IoT.
 - Only 6% of Italian companies uses AI, compared with an EU average of 8%. Italy is lagging its European neighbors, particularly the leaders: Denmark (24%), Portugal (17%) and Finland (16%).
 - Italy will have seen 14,100 industrial robots installed, placing it 6th in the world (vs 4,000 in 2012). Italy has 217 robots installed for every 10,000 employees, putting it in 14th place worldwide and 7th place in Europe,
- The fragmentation of Italy's manufacturers around numerous SMIs is slowing down the process of digitalising industry: isolated investments by SMIs cannot benefit from economies of scale or a coordinated approach.



Spain

Spain has strategically positioned itself as an innovative leader in Europe, emphasizing the crucial role of SMEs in driving a green industrial shift. The nation's commitment is evident through a growing ecosystem that fosters innovation and sustainability through global collaborations. Spain's approach involves shared responsibilities at national and regional levels, facilitating comprehensive international collaborations. Despite challenges in aligning traditional industries with green policies, Spain's current landscape offers abundant opportunities for innovation and global partnerships. Although clusters, essential for innovation, lack official recognition in recent laws, they have demonstrated resilience, supporting Spain's recovery plan. Looking ahead, the Spanish Federation of Clusters calls for increased support, formal acknowledgment, and enhanced representation to boost business innovation, particularly in digital and green transformations.

Spain

Industrial context



Key figures

- 14th world power in terms of GDP in 2021 (5th in Europe) (Source: World Bank)
- 15th world manufacturing power (Source: World Bank)
- Industry accounted for 20,4% of GDP (Source: World Bank)
- Mainly composed by SMIs and ETIs : 99% of Spanish companies have fewer than 250 employees



Sectors

- The main sectoral structure in Spain (2021) is
 - Services (74,28%)
 - Industry (17,00%)
 - Construction (5,76%)
 - Agriculture and fishery (2,96%)
- Tourism services accounts for 8% of the national GDP.
- 3 main sectors represent 52% of the manufacturing of Spain (2020) :
 - Manufacture of food products, beverages and tobacco (21%)
 - Automotive and transport equipment (13,1%)
 - Basic metals and fabricated metal products, except machinery and equipment (10,1%)
- Flagship sectors :
 - Spain has a very strong reputation in Tourism, being the third country for number of tourists at global level.
 - Automotive (16,5%), Food (13,4%) and Chemicals (11,1%) are the sector with highest participation on the Spanish exports (MINCOTUR 2022).



Trends

- The Spanish Digital and Industrial strategies, aligned with the national Recovery and Resilience plan are supporting a real evolution of the Spanish businesses in terms of implementation of Digital Transformation plans and Sustainable and Green Technologies.
- Service-oriented Economy: Spain has been shifting towards a more service-oriented economy, with services contributing significantly to the country's GDP. This includes sectors such as tourism, hospitality, finance, telecommunications, and professional services.

Innovation context



Key figures

- 22,6% of the Spanish enterprises are qualified as « innovative », 19,9% in business processes and 12,6% in products (INE 2020).
- R&D expenditures represent 1,43% of GDP in 2021 (€ 17,249 million), ranking Spain 16th in the world in amount of expenditures (Source: OECD)
- Pharmacy (71,7%), ICT (60,5%) and Chemicals (55,5%) are the manufacturing sectors with highest percentages of innovative enterprises (MINCOTUR 2022).
- On innovation intensity (% over turnover) ICT (8,27%), other transport materials (6,55%) and pharmacy (5,56%) lead the statistics, with a 2,05% as industrial average.
- A similar ranking represents the investments on R&D, with ICT dedicating a 7,1%, other transport materials 5,9% and pharmacy 4,7%, being the industrial average 1,4%.



Technologies

- Spain has become a global leader in renewable energy technologies, particularly in the field of solar power.
- Spain has a thriving ICT industry, with strengths in areas such as software development, telecommunications, and digital services.
- We can highlight also
 - Transportation and Smart Mobility
 - Biotechnology and Life Sciences
 - Tourism and Hospitality Technologies



Ecosystem

- Spain counts with 130 Clusters and Agrupaciones Empresariales Innovadoras (AEIs), joining more than 12000 enterprises, that globally represent more than 42% of the Spanish GDP. Some regions, as Basque country and Catalonia, have very strong clusters programs.
- The Spanish Ministry of Industry, together with CDTI, Ministry of Science and Red.es, Ministry of Economy and Digital Transformation, are the main national agencies funding industrial innovation.
- During the last 3 years the Spanish Recovery and Resilience plan has injected big quantities of public funds on industrial innovation.



Spain

Industrial context

Innovation context

Position toward green industrial transition

The World Economic Forum ranked Spain among the "leading" countries, 29th in the world on the "Structure of production" criterion and 24th in the world on the "Driver of production" criterion (source: 2018 report on the level of preparedness of each country for the industry of the future).



Green transition

- 16th in the world in terms of Sustainable development (based on the 17 SDG challenges) (source: 2022 edition of the Sustainable Development Goals Index, United Nation). The SDGs on environmental transition are mitigated, but not achieved
 - SDG7 - Affordable and clean energy: the challenge remains, with a score moderately improving, insufficient to attain goal. Only one of the four sub-challenges remaining : the share of the renewable energy in total energy supply.
 - SDG 12 - Responsible consumption and production: this challenges is still a significant challenge for Spain, with score stagnating. 3 or 7 sub-challenges are achieved. Electronic waste is pointed as a major challenge. Nitrogen emissions, export of plastic and non-recycled municipal solid waste remain significant challenges.
 - SDG13 - Climate action: the challenge is one of a major challenge for Spain, with moderately but insufficient progress for SDG achievement. CO2 emissions embodied in imports and CO2 emissions from fossil fuel combustion and cement production remain major challenges.
- 19th in the world on the Transitions Performance Index 2021, 15th at EU level (source: European Commission). On the environment criteria, Spain is ranked 11th at EU level.
- Spain has set ambitious renewable energy targets and implemented supportive policies to accelerate the transition towards a sustainable energy system. The country aims to reach 74% renewable electricity generation by 2030 and 100% by 2050. Various initiatives, including auctions and regulatory frameworks, have been implemented to attract investment and promote renewable energy deployment.
- On hydrogen, Spain has been making notable progress in recent years and has been taking steps to develop its hydrogen capabilities, launching its National Hydrogen Strategy in February 2021.



Digital transition

- The European Commission ranked Spain 7th in the European Union in terms of digital performance, ahead of the European average (source: 2022 edition of the Digital Economy and Society Index (DESI)). This report highlights the relative progress and overperforming versus previous years of Spain.
 - Connectivity: Spain is an EU leader in connectivity and ranks 3rd for the second consecutive year. It continues its steady progress in the roll-out of very high-capacity networks (VHCN) and is pursuing strategic reforms and investments under the Recovery and Resilience Facility (RRF).
 - Human capital: progress of Spain ranking 5th in 2022 compared to the 7th place in 2021. Spain is a relatively good performer on basic digital skills (64% compared to 54% at EU level) whereas it is below the EU average as regards the proportion of ICT specialists (4.1% compared to the EU average of 4.5%). and of ICT graduates. The shortage of advanced digital experts hampers the country's growth prospects and constrains productivity, especially for SMEs and micro-enterprises. Several measures outlined in Spain's Recovery and Resilience Plan (RRP) support the acquisition of digital skills, especially for employees of SMEs.
 - Integration of digital technologies: progress of Spain ranking 11th in 2022, 5 positions above 2021. 60% of SMEs has at least basic digital intensity, compared to the EU average of 55%. In 2021:
 - 58% of Spanish companies uses ERP (+7% since 2016), 29% will be using CRM (down -1% since 2016), and 21% will be issuing orders via IT networks (-3% since 2016)
 - 39% of Spanish companies uses the cloud, compared with and EU average of 34% and a ratio of 29 in 2021
 - representing growth of 212% in 5 years.
 - 9% of companies uses big data compared with and EU average of 14%
 - 21% of Spanish companies uses the IoT (source: Eurostat, 2021).
 - Only 8% of Spanish companies uses AI, aligned with an EU average of 8%



Poland

In 2021, Poland held the 21st position globally and 7th in Europe in terms of GDP, marking it as the fifth-largest economy in Europe. The country attracted significant investments in STEM fields (Science, Technology, Engineering and Mathematics), ranking among the top 10 globally in 2020. SMEs constitute 99.8% of all businesses in Poland, as highlighted in a report by the Polish Agency for Enterprise Development. Despite a leadership position in sectors like wholesale, retail, transportation, and food industry, Poland faces challenges in digital transformation, with below-average digitization levels compared to the EU. The shortage of specialists hinders technological integration. In the Transitions Performance Index 2021, Poland ranked 25th globally and 20th in the EU, particularly addressing environmental criteria, where it stood 19th at the EU level. The country's progress toward SDGs on environmental transition remains a work in progress.

Poland

Industrial context



Key figures

- 21th world power in terms of GDP in 2021 (7th in Europe) (Source: World Bank)
- 20th world manufacturing power
- Industry accounted for 27,9% of GDP (Source: World Bank)
- Mainly composed by SMIs and ETIs : 99% of Polish companies have fewer than 250 employees (97.0% - microenterprises, 2.2% - small enterprises, 0.6% - medium-sized enterprises).



Sectors

- The leader, in terms of sectors of the national economy, is wholesale and retail trade, transport, accommodation and food industry, according to data from the Statistical Office of the European Union.
- In second place is industry (24.7%), and in third place is public administration, defense, education, health care and social activities (14.6%). Next on the list of industries in Poland are professional, scientific and technical activities (8.6%), construction (7.2%) and real estate (5.5%).
- Flagship sectors :
 - Currently, the coal, fuel and energy industries are considered the most rapidly growing industries in our country. This is due to the modern equipment of enterprises in these industries.
 - In addition, their domestic use of mined raw materials is no small advantage.
 - Another strong branch of Polish industry is the transportation equipment industry. On the basis of capital raised from abroad, automotive companies are thriving in our country.
 - An important branch operating on the same basis is the electrotechnical and electronic industry - the production of household appliances dominates.



Trends

- Major trends in industrial manufacturing are moving toward autonomous technology, B2C and carbon neutrality. In addition, accountability, AI, cybersecurity and a focus on employee retention and maintaining diversity will be important.

Innovation context



Key figures

- R&D expenditures represent 1,44% of GDP in 2021 (above €8 billion), ranking Poland 20th in the world in amount of expenditure (Source: OECD) .
- The highest internal R&D expenditures among the executive sectors executive sector was characterized by the business sector, which allocated to the implementation of scientific research and development of PLN 23.8 billion (16.7% more than in 2020). The outlays of this sector in 2021 accounted for 63.1% of gross domestic expenditures on R&D (vs. 62.8% in 2020).
- The shares of other executive sectors in these outlays were: higher education - 34.7%, government - 2.0%, and private nonprofit institutions - 0,2%.



Technologies

- Poland is the fifth economy in Europe and one of the 10 in the world that attracted the most investments in science, technology, engineering and mathematics (STEM) in 2020, according to the report "Invest in digital Poland".



Ecosystem

- There are over 80 clusters in Poland. 41 clusters from Poland participated in the cluster benchmarking of the Polish Agency for Enterprise Development in 2022. The most numerous industries represented by clusters are those related to the quality of life, tourism and recreation (11 clusters), industrial processing and transport (13 clusters representing metalworking, automotive, aviation and transport), as well as ICT clusters (8 clusters).
- 20 Clusters in Poland have the status of National Key Clusters, understood as clusters of significant importance for the country's economy and high international competitiveness (the competition is organized by the Ministry of Development and Technology)
- Private funding - In 2022, over EUR 0.8 billion flowed through the Polish VC market. This is the total value of capital that Polish and foreign funds invested in 460 transactions in 435 domestic innovative enterprises.



Poland

Industrial context

Innovation context

Position toward green industrial transition

The World Economic Forum ranked France among the "leading" countries, 19th in the world on the "Structure of production" criterion and 31th in the world on the "Driver of production" criterion (source: 2018 report on the level of preparedness of each country for the industry of the future).



Green transition

- 12th in the world in terms of Sustainable development (based on the 17 SDG challenges) (source: 2022 edition of the Sustainable Development Goals Index, United Nation). Nevertheless, the SDGs on environmental transition are far from being achieved.
 - SDG7 - Affordable and clean energy: this challenge is a major Polish challenge, with a score stagnating. Two sub-challenges are majors : the improving of the renewable energy share in total energy supply, and the CO₂ emissions from fuel combustion per total electricity output.
 - SDG 12 - Responsible consumption and production: this challenges remains significant in Poland, but the trajectory is on track to achieve long-term objective. Electronic waste is pointed as major challenges, and export of plastic waste are s is a significant challenge. The 5 additional sub-challenges are achieved.
 - SDG13 - Climate action : this challenge is also a major Polish challenge, with a score stagnating. All the sub challenges are not achieved (CO₂ emissions embodied in fossil fuel exports is remaining, CO₂ emissions from fossil fuel combustion and cement production is major challenge as CO₂ emissions embodied in imports, and Carbon pricing score EUR60/tCO₂ is significant cahllenge)
- 25th in the world on the Transitions Performance Index 2021, 20th at EU level (soucre: European Commission). On the environment criteria, Poland is ranked 19th at EU level,.
- The National Plan for Energy and Climate for 2021-2030 covers some issues in its assumptions, while part of it has been included in the Polish Water Strategy, prepared by the Ministry of the Environment. This strategy is based on the development of hydrogen technologies as a counterbalance to the current hydrocarbon technologies. Low-emission issues are also addressed in the Productivity Strategy 2030.
- Greenhouse gas emission reductions
- As part of the National Plan for Energy and Climate for 2021-2030, we will find issues related to reducing emissions.



Digital transition

- The European Commission ranked Poland 24th on 27 in the European Union in terms of digital performance, below of the European average (source: 2022 edition of the Digital Economy and Society Index (DESI)).
 - **Connectivity:** Poland ranks 25th in the EU in the connectivity ranking. In 2021, Poland observed a steady increase in the percentage of households covered by Fixed Very High Capacity Networks – 70% compared to 65% in 2020. As part of this, Poland's total Fibre-to-the-Premises (FTTP) coverage also saw a slight increase – 51.9% in 2021 compared to 44.6% in 2020. The FTTP coverage in rural areas remains at a lower level, even if is progressing compared to 2020.
 - **Human capital:** still persistent gaps, Poland ranks 24th, scoring below average in all the indicators. Only 43% of people between 16 and 74 years have at least basic digital skills (54% in the EU) and 57% have at least basic digital content creation skills (66% in the EU). ICT specialists account for a slightly lower percentage of the workforce in Poland than the EU average. With the low share of digital specialists in the Polish workforce and the future prospects being undermined by only average rates of ICT enrolment and graduates, a significant change of pace in the country digital skills' readiness is crucial
 - **Integration of digital technologies:** The shortage of specialists is significantly affecting businesses' integration of digital technology. Digital technologies kept on gaining popularity among Polish enterprises, with 19% using cloud solutions and 32% engaging in electronic information sharing (EU: 38%). Nevethless, with only 40% of Polish enterprises having at least basic digital intensity, compared to the EU average of 55%, Poland is at a considerable distance from reaching the Digital Decade target of 90%.
 - 19% of Polish companies uses the cloud, compared with and EU average of 34%
 - representing growth of 212% in 5 years.
 - 8% of companies uses big data compared with and EU average of 14%
 - Only 3% of Polish companies uses AI, compared with an EU average of 8%



Sweden

In 2021, Sweden ranked as the 22nd largest global economy and 8th in Europe, with a robust industrial sector contributing 22.6% to GDP and employing 17.7% of the workforce. The nation excels in manufacturing goods like vehicles, machinery, and forest products, along with industries such as life sciences, telecom, and ICT. Sweden's economic strength stems from innovation and a solid training system, with R&D spending surpassing the Lisbon objective at 3.3% of GDP. Digitally, Sweden stood 4th in Europe in 2022, rapidly adopting technologies such as AI and cloud computing. Environmentally, it ranked 7th in the Transition Performance index, displaying a keen interest in green industrial transition, though knowledge gaps and regulatory challenges persist.





Sweden

Industrial context



Key figures

- 22th world power in terms of GDP in 2021 (8th in Europe) (Source: World Bank)
- 24th world manufacturing power
- Industry accounted for 22,6% of GDP (Source: World Bank)
- Mainly composed by SMIs and ETIs : 99% of Swedish companies have fewer than 250 employees. They contribute to 56% of employment and 49% of value added (OECD average, 68% and 59%)



Sectors

- A concentrated industry, with the transport equipment sector representing 1/5 of the manufacturing sector (21%)
- 3 additional sectors representing more than 10% of the manufacturing of Sweden :
 - Basic metals and fabricated metal products, except machinery and equipment (15%)
 - Wood and paper products, and printing (13%)
 - Machinery and equipment n.e.c. (11%)
- Flagship sectors :
 - Automotive
 - Advanced machinery
 - Forest industry
 - Life science,
 - Telecom and ICT
 - Steel and Minerals



Trends

- The use of natural resources combined with advanced digital solutions and engineering to contribute to the green transition
- The availability of clean energy and valuable minerals is of great importance
- Development of battery manufacturing and green steel.
- The industry is shortening its global value chains and choosing to concentrate its production increasingly in regions, such as Europe. This is supported by investments in advanced digital technologies, with investments in, for example, AI and robotics that can make industry more efficient and make it still competitive.

Innovation context



Key figures

- R&D expenditures represent 3,35% of GDP in 2021 (\$18 billion), ranking Sweden 18th in the world in amount of expenditure (Source: OECD)
- Over 70% of the R&D is financed and run by the companies.
- Sweden ranks No. 2 in the Global Innovation Index (source: Global Innovation Index Database, WIPO 2022)
- 48% of Swedish SME companies say that they have developed and sold new or significantly improved goods and/or services in the last three years (source: Företagens villkor och Verklighet, the Swedish Agency for Economic and Regional Growth 2020)
- How well companies use emerging technologies and are innovative differs between industries and regions (source: Företagens villkor och Verklighet, the Swedish Agency for Economic and Regional Growth 2023)



Technologies

- Advanced digital techniques (AI, IoT etc) together with cutting edge technology for the telecom industry are key technologies.
- Life Science, which is one of the leading Swedish technology areas
- Cleantech, where energy, minerals and metals are particularly relevant.
- Technology linked to the automotive sector and process industry
- European Spallation Source: it provides outstanding opportunities for industry, both for basic research and more applied materials research



Ecosystem

- Clusters play an important role in the ecosystem, often in close cooperation with the regional S3 strategies. Clusters of Sweden brings together more than 20 of the leading large Swedish clusters.
- Within lhubs, regional innovation environments that have received support in the Winnväxt program come together.
- Incubators and Science Parks come together in the organization SISP, which has just over 60 members.
- The major financiers of the innovation system are Vinnova, Formas, the Swedish Energy Agency, the Agency for Growth and Sweden's 21 regions.





Sweden

Industrial context

Innovation context

Position toward green industrial transition

The World Economic Forum ranked Sweden among the "leading" countries, 8th in the world on the "Structure of production" criterion and 9th in the world on the "Driver of production" criterion (source: 2018 report on the level of preparedness of each country for the industry of the future).



Green transition

- 3rd in the world in terms of Sustainable development (based on the 17 SDG challenges) (source: 2022 edition of the Sustainable Development Goals Index, United Nation). Nevertheless, the SDGs on environmental transition are far from being achieved, except regarding energy.
 - SDG7 - Affordable and clean energy: the challenge is achieved, with a trajectory maintain to achieved the SDG challenge in the future. All the sub-challenges are achieved.
 - SDG 12 - Responsible consumption and production: : this challenges is one of the major Swedish challenges, with a score moderately improving, but insufficient to attain goal. Electronic waste and export of plastic waste are pointed as major challenges, and nitrogen and SO₂ emissions embodied in imports are a significant challenges.
 - SDG13 - Climate action: this challenges is one of the major Swedish challenges, with a score stagnating. If the objective regarding CO₂ emissions embodied in fossil fuel exports is achieved, CO₂ emissions embodied in imports and Carbon pricing score EUR60/tCO₂ remain major challenges.
- 7th in the world on the Transitions Performance Index 2021, 5th at EU level (source: European Commission). On the environment criteria, Sweden is ranked 23th at EU level.
- Sweden is ranked No. 1 in the Global Green Economy Index 2022, and maintains its top position. source; (GGEI 2022)
- Sweden has set an ambitious target of achieving carbon neutrality by 2045. Through the Recovery and Resilience Swende's Plan, €286 million will be allocated to climate investment in the industrial sector, projects that develop and implement new technology with zero, low or negative emissions of greenhouse gases in industries with high process emissions
- Northern Sweden is a pioneer regarding green transition, with massive investments and projects to fundamentally change the iron and steel Swedish industry



Digital transition

- The European Commission ranked Sweden 4th in the European Union in terms of digital performance, ahead of the European average, and among the digital frontrunners (source: 2022 edition of the Digital Economy and Society Index (DESI)).
 - Connectivity: Sweden has fallen back to 9th place and is below the EU average on 5G coverage. Concretely, Sweden scores far below the EU average (66 %) in 5G coverage of populated areas at 18 %
 - Human capital: Sweden ranks 4th, continues to be an area of strong performance compared to other countries in the EU. The general population has both a high degree of basic digital skills (67 %) and above basic digital skills (36 %). Despite having one of the highest percentages of ICT specialists in employment in the EU and an above-average proportion of ICT graduates, Sweden continues to struggle with the supply of ICT professionals in relation to demand, as 55.1 % of enterprises report that they find it difficult to fill vacancies.
 - Integration of digital technologies: Digital technologies, both existing and emerging, are increasingly being used by Swedish enterprises. Sweden ranks 3rd among the EU countries in this field. Sweden adopts new and advanced technologies at a rapid pace, led by significant joint work between academia and the business sector; this can be seen in areas such as Artificial Intelligence (AI), cloud, high performance and quantum computing. Sweden also aims to become a world-class electronics industry country, in electronic components and systems by 2025.
 - 86% of SMEs having at least basic digital intensity, compared to the EU average of 55%.
 - 69% of Swedish companies uses the cloud, compared with and EU average of 34%
 - representing growth of 212% in 5 years.
 - 19% of companies uses big data compared with and EU average of 14%
 - 40% of swedish companies uses the IoT (source: Eurostat, 2021).
 - 10% of Swedish companies uses AI, compared with an EU average of 8%



Conclusion

In the Innovation Ecosystems analysis covered by the CAFEIN project, France, Italy, Poland, Spain and Sweden, several common challenges and opportunities have surfaced. Amongst them, there seems to be clear opportunities to learn from best practices and enhance innovation policies developing a more comprehensive strategic vision that would facilitate smoother collaborations and shared best practices and accelerate innovation in the less innovative countries/regions. This overarching strategy would also help in clearly defining the roles and responsibilities of various entities involved in the innovation ecosystem, reducing confusion and duplication of efforts.

The project discussions and analyses have culminated in a series of six main policy recommendations, that will be developed in a coming Joint Action Plan, aiming at fostering growth and cooperation within the European Innovation Ecosystems:

- **Enhancing Interconnected Innovation Ecosystems** by developing peer learning programmes on a pan-European scale, as well as adapting existing programmes that facilitate collaborative exchanges.
- **Encouraging Cross-Border Collaboration and Networks** to support the activities spearheaded by cluster networks at various levels and to push towards regulatory harmonization in Europe.
- **Nurturing Collaborative Initiatives**, such as the promotion of sustainable development to lead the green industrial transition, aligning with Europe's broader objectives of sustainable growth.
- **Fostering Funding and Investment** by launching joint funding schemes for research and innovation projects and encouraging collaboration between various European regions and nations.
- **Facilitating Support and Mentorship** that offer guidance from experienced professionals across Europe to nurture SMEs, startups, young firms, and cluster organisations.
- **Scaling-Up Innovation Ecosystems Across Europe** through the integration of collaborative innovation elements into educational curricula and the facilitation of cross-border exchange programmes.

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