



Workshop Summary Report

Corporate R&D investment for the support of EU's long-term competitiveness in a context of green and digital transition

22 May 2024, Brussels

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Executive summary

On 22 May 2024, the Joint Research Centre (JRC) and the European Commission's Directorate-General for Research and Innovation (DG RTD) organised the workshop 'Corporate R&D investment for the support of the EU's long-term competitiveness in a context of green and digital transition'. The workshop took place at the University Foundation in Brussels, by invitation only. It brought together 72 in-person participants from industry (top R&D investors, startups, and business associations), think tanks and the research community (academics and researchers, universities, research and technology organisations, technology transfer offices), government officials, and people from the Commission.

Private sector innovation is crucial for economic prosperity and the EU's long-term competitiveness, given the major global changes and as part of the twin transition of EU economies. Up to now, Europe has often been an innovation leader, but it fell behind when it came to bringing these innovations to the market, while its main global competitors have developed more innovation capacity in key sectors. This makes it all the more necessary to develop and adapt EU and national policies for more ambitious industrial policies and innovation strategies.

The participants at the workshop in Brussels discussed three main topics in moderated panel and breakout sessions. The EU Industrial R&D Investment Scoreboard, a key Commission tool for monitoring private research & development (R&D) and an EU flagship initiative since 2004, has found that ICT-related sectors have been the main game changers over the past two decades. The Scoreboard was acknowledged as an important tool used by a wide variety of stakeholders, especially EU policymakers, industry and academia. The consistent application of a rigorous methodology over the past few decades has resulted in a rich and widely used dataset that is in the public domain. This is especially useful for the longer-term analyses that are currently necessary to understand how to improve EU competitiveness. Scoreboard aspects that should be further developed can be summarised as follows.

- Better characterising firms through data mining in financial accounts and corporate publications, for example for differentiating between research and development activities and for gaining better understanding of corporate structures through subsidiaries or the location of laboratories.
- Linking to other data sources to establish technology profiles, the companies' contributions to societal challenges, and their involvement in mergers and acquisitions, corporate venture capital, as well as participation public funding. Additional data sources can be used not only to identify new candidate firms for the Scoreboard, but also to shed light on midcaps and high-growth firms' innovation trajectories.
- Continuing to explore the important relationship between R&D, innovation, profitability, and growth and reshoring/economic security strategies of firms. All this would help to better capture the dynamics of the EU's companies' positioning in relation to its global competitors.

On policy side, the workshop discussions reached the following conclusions.

- Regulation might hinder the work of startups or the innovation uptake of smaller European firms. However, the high global trust in the EU's legal framework also means that it is an attractive destination for software services and cybersecurity activities. Regulation also plays a significant role in upholding EU values and providing a stable environment that firms of all sizes appreciate, and on balance is therefore preferable to full de-regulation.
- Defining competitiveness is challenging. Having a nuanced understanding of it is crucial for formulating effective policies that can bolster the EU's industrial strength. There is ample evidence of the importance of large companies on competitiveness, but considerably less is known about small and medium-sized enterprises (SMEs). With regard to SMEs, participants specifically called for more evidence to be collected on the migration of startups to the US and China and their implications for the EU's competitiveness.
- On sustainability and competitiveness, it was noted that at firm level, sustainability costs such as those associated with carbon emissions or waste management are a small proportion of overall costs. Environmental policies are also drivers of innovation and revenue generation. A critical point in the discussion was how this revenue is reinvested in the economy to sustain long-term competitiveness.
- As demand is shaping research and development paths, demand for innovation that is in step with societal goals should be stimulated without dictating the specific technological approaches, but rather facilitating the bottom-up, market-driven development of solutions. It is imperative to understand the synergies, trade-offs and feedback loops between directional/strategic, breakthrough

and incremental modes of innovation to maximise overall benefits and make continuous improvements.

- Compared to other policy areas, European instruments for supporting innovation are relatively young and require specific knowhow to be properly implemented in the respective public administrations. This calls for concerted efforts to attract, develop and retain talented professionals in the civil service.
- While there are significant differences between Member States, technology transfer from universities and public research institutions should be fostered. In this context, lessons can be learnt from the 1980 US Bayh-Doyle Act, which is of particular relevance for the development of smaller innovative businesses. SMEs are also increasingly outsourcing R&D activities, enabling them to leverage capabilities found in university labs or targeted government support schemes. The roles of the European Innovation Council (EIC) and European Institute of Innovation & Technology (EIT) in these situations were also highlighted.
- On the question of whether EU policy should pick winners, technologies or sectors, speakers discussed the importance of certain key sectors such as aerospace and defence for technological development. They also emphasized the crucial roles of cybersecurity and artificial intelligence (AI) in future ICT infrastructures. Here, addressing skill gaps is essential, and policy should focus not only on R&D investments, but also on the diffusion and adoption of technologies. This approach could involve aligning skills with production and knowledge spaces to create a cohesive strategy for enhancing competitiveness. Such an approach would need to identify gaps and opportunities in the EU's industrial landscape, thereby informing policy decisions and investment strategies.

The lively discussions emphasised the need for evidence for innovation policymaking, in particular in face of the challenges of Europe's industrial transformation and the twin transition.

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The GLORIA project 2022-2024 is coordinated by Evgeni Evgeniev (Policy Officer, DG RTD.E1 ‘Industrial Research, Innovation and Investment Agendas’) and Alexander Tübke (Team leader, JRC.B6 ‘Industrial Strategy, Skills & Technology Transfer’), under the leadership of Doris Schröcker and Dominik Sobczak (respectively the Head and Deputy Head of Unit E1 ‘Industrial Research, Innovation & Investment Agendas’, Directorate E, DG RTD), and Asunción Fernández-Carretero and Fernando Hervás (Head and Deputy Head of Unit B6 ‘Industrial Strategy, Skills & Technology Transfer’).

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This summary report was produced by Alexander Tübke (Team leader, JRC.B6 ‘Industrial Strategy, Skills & Technology Transfer’), Evgeni Evgeniev (Policy Officer, DG RTD.E1 ‘Industrial Research, Innovation and Investment Agendas’), Elisabeth Nindl, Hugo Confraria and Francesco Rentocchini (JRC.B6 ‘Industrial Strategy, Skills & Technology Transfer’).

The JRC B and DG RTD E would like to thank the workshop participants for their lively contributions, as well as the speakers and panellists for all their hard work.

Authors

The main authors of this report are Alexander Tübke, Evgeni Evgeniev, Elisabeth Nindl, Hugo Confraria and Francesco Rentocchini.

1 Introduction

1.1 Policy context

Innovation is crucial for economic prosperity and the EU's long-term competitiveness. Achieving the 3% of GDP R&D investment target¹ is linked to boosting private R&D, which is 1.5% of EU GDP and lower than competitors' investments (1.7% in China and 2.3% in the US)². In the past, Europe has often been an innovation leader, but it fell behind when it came to bringing these innovations to market. The EU still constitutes around 18% of global private R&D, but its main competitors in the Industrial R&D Investment Scoreboard (the Scoreboard) have developed more innovation capacities in key sectors (the US is in the lead, with around 40% of global private R&D). This increases the EU's need for strong industrial policies tackling innovation, finance and technological capabilities³. The EU maintains its global leadership in automotive R&D with the top investors in the private sector, and the US in information & communication technology (ICT) services and health. China, with many large firms in ICT and health, has been a runner-up, overtaking the EU in ICT services. Regarding investments in smaller firms, which is at the core of the New European Innovation Agenda⁴, the corporate venture capital investments of EU-headquartered Scoreboard companies are 2.4% of own-funded internal R&D, compared to 4% of their US-headquartered peers. On this general level, potential measures to close the gap between the EU and the more developed US venture capital market could include better exit opportunities (facilitating easier floating on the stock market for example). Other policy measures may include promoting venture capital networks and the visibility of European startups, especially outside the country where the mother company's headquarters are located, to increase the deal flow across national borders and in activity sectors. On a sectoral level, ICT producers & services and health have shown a particularly strong positive correlation and high complementarity between R&D and corporate venture capital investments in the Scoreboard⁵.

Private R&D investments in the EU are crucial for industrial development, which in turn is central for achieving open strategic autonomy, with its emphasis on building EU-wide capacities and leadership in critical sectors and technologies, responsible openness and continued strengthening of the EU's single market⁶. The new economic security agenda⁷ and the Strategic Technologies for Europe Platform (STEP) initiative on strategic technologies⁸ highlight the importance of structural vulnerabilities and sectoral trends. The renewed EU Industrial Strategy, centred on innovation-driven competitiveness, is also a way of achieving the overall objectives of competitive sustainability (see the 2024 Annual Sustainable Growth Survey)⁹ and the Green Deal. The EU also needs to become a more attractive place to invest in, manufacture and deploy critical technologies. For clean energy, it is estimated that in the EU, the private sector contributes the majority (78%) of total R&I investments in energy technologies (EUR 31 billion)¹⁰. In 2022, venture capital investments in clean energy in the EU increased by 42% compared to 2021, reaching EUR 7.4 billion¹¹. The green and digital (twin) transition topic has received momentum from the 2022 Communication on the European Growth Model¹⁰, and the 2023 CONCORDi conference¹² highlighted the importance of the twin transition in reconciling open strategic autonomy/technological sovereignty with wider EU well-being goals (competitiveness, social inclusion, territorial cohesion).

To deepen the Green Deal and strengthen the Commission's work with industry and social partners, in 2023 President von der Leyen introduced a series of Clean Transition Dialogues¹³. A follow-up communication¹⁴ summed up the needs for greening EU industries, including the specific situation of energy-intensive

¹ COM(2023) 168 final.

² [2022 Science, Research & Innovation Performance \(SRIP\) Report](#).

³ [2023 EU Industrial R&D Investment Scoreboard](#).

⁴ COM(2022) 332 final.

⁵ [2022 EU Industrial R&D Investment Scoreboard](#).

⁶ [Domnik et al. 2023](#).

⁷ Joint Communication (EC + High Representative of the Union for Foreign Affairs and Security Policy) – JOIN (2023) 20 final.

⁸ COM(2023) 335 final and European Council conclusions of 1 February 2024.

⁹ COM(2023) 901 final.

¹⁰ [JRC SETIS in SET Plan Progress Report 2023](#).

¹¹ JRC in [CETO](#) and [COM\(2023\) 652 final](#).

¹² [Domnik et al. 2023](#).

¹³ Furthermore, an [Antwerp Declaration for a European Industrial Deal](#) was promoted in February 2024 with the participation of President von der Leyen, calling for a business case for investments in Europe to respond to global challenges (for example, US support in terms of the Inflation Reduction Act and ease of accessibility, as well as Chinese overcapacity and increasing exports to Europe).

¹⁴ COM(2024) 163 final.

industries¹⁵. The Commission (DG RTD) has worked closely with Member States, associated countries and key stakeholders on implementing European Research Area (ERA) Action 12¹⁶ and holding the Industrial Decarbonisation Mutual Learning Exercise with 10 Member States and 2 associated countries¹⁷. The follow-up R&I Deployment Agenda for energy-intensive industries' climate neutrality is to be presented to governments, industry and stakeholders in autumn 2024, focusing on three main themes¹⁸.

- Valorisation of knowledge for boosting industrial R&I demonstrators;
- Promoting a business case for industrial R&I investments;
- Mobilising engagement and investments of relevant R&I stakeholders (actions beyond public funding under European programmes).

Together with ERA industrial technology roadmaps¹⁹, recent editions of the Scoreboard have analysed low-carbon technologies, the circular economy and the mobility technologies of leading global R&D investors. They reached the conclusion that the EU is a global green leader in high-value patenting.

1.2 Objectives

During the preparation of this report in May and June 2024, a public debate was ongoing about the future orientation of the EU's industrial and innovation policies in view of its global competitiveness agenda. This debate ran in parallel to the European Parliament campaign and elections, and the appointment of a new College of Commissioners to take office autumn 2024. Two recent contributions to this debate have attracted a lot of attention. Firstly, Mario Draghi proposed the deepening of industrial policies to tackle market fragmentation (in security & defence for example), a common approach for the EU energy market, improving collaboration in public procurement, harnessing the potential of infrastructure, continuing to address supply chain bottlenecks, improving capital market regulation, on-boarding private innovation investments, and developing a skilled workforce²⁰. Secondly, Enrico Letta suggested further developing the single market in the light of the forthcoming 2024-29 Multiannual Financial Framework²¹. His recommendation is to add a fifth freedom – research and innovation – to the existing four founding principles of the single market, namely the free movement of people, goods, services and capital. This fifth freedom would put research and innovation at the core of the single market, reflecting the evolving dynamics of a market increasingly shaped by digitalisation, innovation, and climate change. It would also entail systematically addressing trade policy and striking a balance between competitiveness, strategic autonomy and equitable global conditions, while seeking strategic partnerships based on well-founded policies.

¹⁵ Energy-intensive industries comprise sectors such as steel, cement, lime, chemicals, aluminium, ceramics, glass, pulp and paper. They are embedded in many strategic value chains, represent around 17% of greenhouse gas (GHG) emissions in the EU and make up more than half of EU industry's energy consumption. These industries were also mentioned by Mario Draghi in his speech of 16 April calling for a radical change.

¹⁶ 'Accelerating the twin transition of Europe's key industrial ecosystems' in the ERA Policy Agenda 2022-2024.

¹⁷ See, [Mutual Learning Exercise on Industrial decarbonisation | Research and Innovation \(europa.eu\)](https://ec.europa.eu/era/industrial-decarbonisation).

¹⁸ The transformation of energy-intensive industries into towards climate-neutral ones brings new challenges that will need to be tackled, along with the implementation of the current legislative and policy framework (the Fit For 55 package, the Net-Zero Industries Act, the Critical Raw Materials Act, etc.). Such a transformation will also face milestones, such as the ETS Directive, under which free allowances for these industries will be gradually phased out.

¹⁹ DG RTD [ERA industrial technologies roadmaps - European Commission \(europa.eu\)](https://ec.europa.eu/era/industrial-technology-roadmaps).

²⁰ Draghi, M.: "Radical Change – Is what Is Needed", Speech at the High-level Conference on the European Pillar of Social Rights, Brussels, 16 April 2024 April 16, 2024, see: <https://geopolitique.eu/en/2024/04/16/radical-change-is-what-is-needed/>.

²¹ Letta, E.: 'Much More than a Market: Speed, Security, Solidarity – Empowering the Single Market to deliver a sustainable future and prosperity for all EU Citizens', conclusions from a High-Level report presented to the European Council, Brussels, April 2024: <https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>.

1.3 Workshop implementation and structure of this report

This one-day workshop addressed the role of corporate R&D investment to support the EU's long-term competitiveness in the context of the green and digital transitions (see Annex Agenda). The first part presented evidence and analyses. The Commission introduced the workshop motivation and policy context from the point of view of the project partners. There then followed a keynote address on the merits of the Scoreboard over the past 20 years. After that, there was a presentation of Scoreboard results from the previous edition and research and innovation policy challenges.

The second part addressed the three main topics of the workshop through moderated panel and breakout group sessions:

- Corporate R&D strategies and the EU's long-term competitiveness
- Corporate R&D investors in support of the twin green and digital transition
- Policy implications of existing evidence of corporate R&D and the additional evidence needed given new policy developments.

The panel sessions, open to the whole audience, were attended by 72 in-person participants from industry (top R&D investors, startups, business associations), government authorities, think tanks and the research community (academics and researchers, universities, research and technology organisations, technology transfer offices), as well as people from the Commission.

The panellists prepared short statements, supported by slides²². Each statement was based on the panellist's individual expertise and current main activities, with the aim of providing lessons learned, specific examples and areas for action on the panel topic. The panellists were selected to span the whole scope of expertise from EU and national policy making, the theoretical/scientific state of the art, relevant specific policy actors, business associations and individual companies. This way, the statements of the panellists gave the audience a complementary overview of the panel topic, after which the audience was invited to questions & answers (Q&A).

To go further in depth on the three main workshop topics listed above, the audience was split into three moderated breakout groups to discuss each topic. The moderators of the breakout sessions guided the discussions to ensure all workshop participants could give their input. The discussions of the breakout sessions were then summarised and presented to the audience before the last panel discussion.

The workshop ended with a summary statement by the organisers presenting the next steps.

The following sections summarise the presentations of the first part in chronological order (see Annex Agenda). The second part of the workshop, with the panel and breakout sessions, is summarised thematically.

²² See <https://iri.jrc.ec.europa.eu/events/corporate-rd-investment-support-eus-long-term-competitiveness-context-green-and-digital>.

2 Summary of the workshop introduction

2.1 Welcome

Maria Cristina Russo, Director for 'Prosperity', DG Research & Innovation, European Commission

Maria Cristina Russo welcomed the audience and thanked the participants for their commitment to spending a full day to deliberate with the European Commission on aspects of the current debate on competitiveness in the context of the green and digital transitions. She briefly presented the role of her Directorate in implementing Horizon Europe to support industrial innovation, involving the deepening of the European Research Area with the Member States and the analysis of industrial R&I agendas. She acknowledged the longstanding collaboration with the Joint Research Centre, which monitors industrial R&D and which is co-organising the workshop.



Maria Cristina Russo said that the world has changed dramatically in only a few years. The known model of globalisation has faced repeated challenges and crises. This has made it vital to address the European Economic Security Agenda and the risk assessment of critical technologies, as well as the issue of dependencies on critical raw materials in the global value chain. The issues require cooperation across Europe and beyond.

'She stressed the need, in the context of the EU's renewed Industrial Strategy, to develop and adapt European and national policies for a New Industrial Deal, which help to anticipate and manage changes and crises. She also underlined the need to mobilise all existing and untapped resources – involving the whole of society, industry and the Member States.

Maria Cristina Russo emphasised that topics such as resilience and open strategic autonomy have climbed the policy priority agenda, making R&I policies key in the open strategic autonomy policy toolbox to tackle vulnerabilities and strengthen the technological sovereignty of the EU in strategic sectors of the economy, such as digital, energy, mobility, health, food supply and space/defence. This calls for a review of EU strategies and of how the EU protects and promotes European interests globally, while at the same time keeping its open approach to international cooperation.

Maria Cristina Russo highlighted the topics of the three panels and the main objectives to reflect on.

- To present the main findings and conclusions of the 20 years of analyses of the EU Industrial R&D Investment Scoreboard in support of the EU's long-term competitiveness and the economic security policy agenda. The key question is whether the policy dynamics and R&D investment challenges in the past two decades are well supported by the Scoreboard. During these years, there have been two major crises (the global financial crisis in 2009 and COVID in 2020), as well as Brexit, which had an impact on R&D Investments in the EU. Maria Cristina Russo emphasised that the Scoreboard is not only a monitoring tool, but also a tool to stimulate R&D investments.
- To discuss the challenges of R&D investments for the twin transitions. It is expected that the workshop participants discuss the issues R&D investors are faced with in order to advance with the green and digital transitions. These could include regulation, cooperation, data collection, identification of indicators and analysis, access to finance for SMEs, and R&I investment instruments.
- To discuss further policy needs and future supporting evidence on corporate R&D to develop fit-for-purpose policies. The Commission would be very interested in the participants' opinion on what type of evidence is still missing on corporate R&D investment to better understand what policies are needed in order to make progress on the competitiveness and sustainability agenda.

Maria Cristina Russo looked forward to a full day of exchange of knowledge and experiences.

Sabine Henzler, Director for 'Strategy & Impact', Joint Research Centre

Sabine Henzler introduced her role as Director for the JRC work programme. She described the role of the JRC as the Commission's in-house science-to-policy service, with nearly 8 000 peer-reviewed scientific publications in Scopus, of which 40-50% are published in the top 10% most cited journals and 5-7% in the top 1% most cited journals. She said that the longstanding collaboration with DG Research & Innovation had contributed to important recent policy initiatives²³. In the current challenges Europe is facing, the JRC has a strong motivation to monitor private sector innovation as it is crucial for economic prosperity and the EU's long-term competitiveness.

Sabine Henzler added seven key challenges the JRC found relevant for the current policy discussions:

- Achieving the 3% of GDP R&D investment target is linked to boosting private R&D, which is 1.5% of EU GDP and lower than the EU's competitors (1.7% in China and 2.3% in the US). In the past, Europe has often been an innovation leader, but it fell behind when it came to bringing these innovations to market. Meanwhile, its main competitors have developed more innovation muscle in key sectors, as presented below.
- From a global perspective, open strategic autonomy needs a more assertive policy framework. This will help defend Europe's strategic interests (through merger control, foreign subsidies, relevant regulatory exemptions, trade policy, single market policies, etc.).
- Industrial and innovation policy agendas need to come closer together. This will generate the critical mass needed to address strategic sectors (energy, space and defence, digital, the environment) and their enablers (finance, education and skills), so that structural change can happen. This could lead to an 'Industrial Deal', and it is why the JRC's next work programme (2025-2027), currently in preparation, will increase support for policy initiatives such as the Strategic Technologies for Europe Platform (STEP)²⁴ and Critical Raw Materials (CRM)²⁵, which run across EU policy portfolios.
- Europe's capacity to create and grow smaller companies needs to be strengthened. This will contribute to the robustness and resilience of key (strategic) industrial sectors and the creation of new ones. SMEs and startups in strategically important sectors need venture capital, particularly in the scale-up phase²⁶.
- Large companies such as those in the Scoreboard increasingly use mergers & acquisitions and corporate venture capital to secure promising technologies. This raises the question of how to effectively mobilise large and small firms' innovation strategies.
- Innovation ecosystems link the key stakeholders of the global and the local dimensions. Global leading companies play a key role in vitalising innovation ecosystems by leveraging e.g. the Regional Innovation Valleys of the New European Innovation Agenda²⁷ or other territorial policies, such as smart specialisation strategies²⁸.
- Harnessing stakeholder collaboration and technology transfer in innovation ecosystems will become more and more central for upgrading and transforming innovation ecosystems, especially given the aim to leave no region behind. Of particular importance in this respect are access to innovation infrastructure (universities, laboratories, demonstrators, testbeds, incubators and accelerators) and more successful technology transfer and public-private collaboration.

Sabine Henzler thanked the participants on behalf of the European Commission and looked forward to the interesting discussions.

²³ E.g. the EU long-term competitiveness agenda, the Net Zero Industrial Act, the mobility transition pathway, the Annual Single Market and Competitiveness Report.

²⁴ See <https://strategic-technologies.europa.eu/>.

²⁵ See https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en.

²⁶ Quas, A., Mason, C., Compano, R., Gavigan, J. and Testa, G., *Tackling the Scale-up Gap*, EUR 30948 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-46712-0, doi:10.2760/982079, JRC127232.

²⁷ See https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en

²⁸ See <https://s3platform.jrc.ec.europa.eu/home>.

2.2 Keynote address

'Merits and Challenges of the Industrial R&D Investment Scoreboard: Corporate R&D investment for the support of the EU's long-term competitiveness in a context of green and digital transition'

Lena Tsipouri, Professor Emeritus for Economic Development, European Economic Integration, the Economics of Technological Change and Theory of the Firm at the National and Kapodistrian University of Athens and co-founder of Opix AI



Lena Tsipouri delivered a comprehensive analysis of the evolution, utilisation and future directions of the EU Industrial R&D Investment Scoreboard. She began from a historical perspective, noting the Scoreboard's inception in 2004 as a pivotal resource for academics and consultants, and highlighted the initial focus on R&D as a key driver for economic growth and competitiveness, with an emphasis on the level rather than the direction of R&D investment.

Over time, Lena Tsipouri has observed a shift in the Scoreboard's relevance, expanding from competitiveness

to encompass broader societal goals such as welfare and sustainable development, with a growing concern for the directionality of R&D investments. She distinguished three main time periods. From 2004 until the global financial crisis, R&D was emerging as a driving force for growth and competitiveness. The Scoreboard was more conceived for the level of R&D than its directionality. The Scoreboard was then able to identify the influence of the global financial crisis on different industries, companies and countries, showing the impact of an asymmetric shock. After that, Europe became susceptible to big societal challenges (climate, health and demographics, food security, inclusivity and security), resulting in private R&D investment expanding its relevance from competitiveness and growth to welfare and development. In this changed perspective, the directionality of R&D investments became much more relevant.

Lena Tsipouri elucidated the Scoreboard's methodological contributions, particularly in collecting and harmonising data from the top 2 500 R&D investors, accounting for externally funded R&D, and handling subsidiaries. As a tool, the Scoreboard was at first used mostly by academics and consultants, and only gradually more and more by policymakers, eventually becoming a global benchmark and a report and database highly downloaded by all kinds of stakeholders and competitors of Europe. Lena Tsipouri acknowledged the usefulness of the methodology for monitoring private R&D and added that thanks to its consistent application over time and the extensive explanations in the methodological annex, which ensures transparency, the Scoreboard's reach now goes far beyond the data. Lena Tsipouri argued that the demand for the Scoreboard will increase as more evidence is produced combining R&D investments with patenting (in areas such as low-carbon technologies, circular economy technologies, mobility technologies, AI), with global value chains, or the impacts of different crises.

In terms of content, Lena Tsipouri outlined that throughout the past two decades, four sectors – ICT producers, ICT services, health and automotive – have been responsible for more than three quarters of Scoreboard R&D investment, with ICT-related sectors being the fastest growing sector. Lena Tsipouri identified several significant trends brought to light by the Scoreboard, such as the high concentration of R&D investment in a small number of companies, and the transformative impact of ICT-related sectors on R&D growth. At the same time, she raised some concerns about the slower growth of EU companies' R&D investments compared to their US and Chinese counterparts, and the EU's challenges in supporting new R&D-leading firms, especially in the ICT and AI sectors.

In the global context, the Scoreboard has found the main challenge for Europe to be the EU's relative difficulty in hosting new R&D-leading firms compared to China and the US. In ICT software and services, the

EU has a low share and is losing ground. Emerging smaller firms headquartered in the ICT sectors are rare in the EU. In the automotive sector, the EU's stronghold, the number of firms included in the 2023 Scoreboard decreased in the EU but increased in the US and China. In AI, China has the highest number of players (38%), followed by the US (20%) and the EU (11%). When only players with AI-related patents are considered, the EU falls further down the ranking.

Asserting the Scoreboard's role as a sentinel rather than a harbinger of doom for the EU, Professor Tsipouri suggested that insights from the Scoreboard could inform policy discussions and guide future research. Reflecting on the evidence from the Scoreboard, she developed nine key challenges for Europe.

- The proportion of EU companies in the top 2 500 R&D investors is small and is falling over time (because others grow faster), so there is more evidence needed on why this is the case (More US high-risk grants? Different fiscal regimes? Market size?).
- The EU is less well placed to host new companies capable of becoming global leaders in R&D. More evidence could help to identify and address the challenges in nurturing companies that could become global R&D leaders. On the availability of European venture capital and private equity, not only could the scale-up gap be tackled, but research could also be done to see if EIC companies are growing or if EU startups are acquired too soon.
- There is a constant rise in Chinese corporates, especially the catching-up in the automotive sector by Chinese companies specialised in electric vehicles and autonomous vehicles, combined with a Japanese decline. This raises the question of what kind of value chain strategies are needed for EU-based firms, and if the rise of Chinese corporate R&D has followed the same market principles.
- Four key sectors, such as ICT producers, ICT services, health and automotive, were responsible for more than three quarters of Scoreboard R&D investment. Questions arise as to whether economies of scale increase so much that 'winner takes all' dynamics need to be addressed by regulation, or how to combine EU cohesion objectives with the increasing concentration around top performers and excellence.
- An overarching global challenge is that ICT-related sectors have been central actors in the digitalisation witnessed in the past decades, but other world regions are leading. This poses the question if and how EU presence in these sectors could be increased, and if e.g. the 'Airbus' industrial policy model could provide useful for technologies and areas where substantial potential is seen. Lena Tsipouri stressed the role of the US Defence Advanced Research Project Agency (DARPA)²⁹ in creating the technology push on which the spectacular growth of the ICT and aerospace sectors is based, enabling the creation and growth of a large number of US-based firms that are Scoreboard leaders today. She mentioned that China also has a dedicated and long-term technology-push policy, leading to substantial spill-overs and firm creation. Lena Tsipouri further raised the question of whether EU State aid rules, which stem from a mainly intra-EU perspective dating back to 1952, should be reconfigured around the need to compete from an extra-EU perspective in a global technology race.
- Regarding the location of top R&D investors, the top 1 000 EU companies investing in R&D are located in 17 Member States. Half of the companies, accounting for 73% of the R&D investments, are in Germany, France and the Netherlands. This poses the 'million dollar' question for the EU: how to combine excellence with cohesion.
- In the automotive sector, the EU is still leading and improving, but China is catching up on electric vehicle (EV) and climate change technologies (CCT), which are major areas for future R&D investments. In the health sectors there are four EU companies in the top 10, but only one of them is also leading in terms of R&D growth. This raises questions as to how European private R&D can be best connected with the global market in those sectors, or if it would be sufficient to catch up with the US in sectors beyond the top four sectors..
- Regarding smaller firms, there are 180 SMEs in the EU 1000, with increasing R&D investments and growing numbers in some countries (e.g. Sweden, Ireland). This brings the role of European hubs around large players into the limelight, as well as the question of how to identify and grow emerging hubs around smaller players.

²⁹ See <https://www.darpa.mil/>.

- EU Scoreboard firms have exhibited a remarkable commitment to environmental responsibility. High-value inventions in climate change technologies are highest in the EU and patent applicants continued in their leadership position in green patenting (clean transport technologies). This shows that European companies are responding to EU policies, but changing consumer patterns are also needed to ensure that these investments pay off in the longer term.

These challenges illustrate the usefulness of the Scoreboard as a tool to compare the R&D investment of EU companies against their global competitors, and understand global industrial R&D dynamics in order to inform EU policies. Lena Tsipouri underlined that the Scoreboard's methodological rigour and the analysis of the time series provide a very valuable public asset that has been instrumental in identifying the highly relevant challenges described above.

Looking forward, Lena Tsipouri advocated for the Scoreboard to adapt to emerging technologies and challenges. She called for improved accounting techniques for R&D, strategies to manage startup acquisitions and mergers, differentiation between research and development, and better identification of public support for corporate R&D. She also recommended incorporating new data sources and analytical techniques³⁰, linking R&D to technology adoption (especially taking into account societal challenges), and exploring the relationship between R&D, innovation, profitability, and growth. Lastly, she emphasised the need to understand the changing landscape of public funding and additionality effects, the role of M&A in business dynamics, and the shifts toward de-globalisation and reshoring strategies.

During the Q&A session, the point was made that technology transfer from universities and public research institutions should be fostered. The 1980 US Bayh-Doyle Act³¹ allowed small businesses and non-profit institutions to elect to take title to federally funded inventions under certain terms and conditions. Lena Tsipouri underlined that this act can be seen as a game changer having contributed significantly to the wider uptake of innovation also in smaller firms.

2.3 Presentation on the evidence of the Scoreboard

'20 years of experience of the EU Industrial R&D Investment Scoreboard', Alexander Tübke (Team Leader) and Elisabeth Nindl (Economic Analyst), Unit B6. Industrial Strategy, Skills & Technology Transfer, Directorate. B. 'Fair & Sustainable Economy', Joint Research Centre, European Commission

Elisabeth Nindl presented the Scoreboard's main findings. These have been produced every year since 2004 by the JRC's Fair & Sustainable Economy Directorate, in close collaboration with DG RTD's Prosperity Directorate. The EU Industrial R&D Investment Scoreboard monitors and benchmarks the performance of the EU's leading industrial R&D investors against their peers globally. The 2023 Scoreboard lists and analyses both the world's top 2 500 companies and the top 1 000 EU-based companies with the highest R&D investment in 2022. The top 2 500 have headquarters in 42 countries and over 1 million subsidiaries worldwide, with each company investing over EUR 53 million in R&D in 2022. Notably, the top 50 companies accounted for 40% of the total 2 500 R&D investment (EUR 1249.4 billion), showcasing a consistent concentration of resources over the years. Despite economic uncertainties, EU companies demonstrated robust growth in R&D investments, outperforming the US for the first time since 2015.

³⁰ e.g. web scrapping, machine learning, LinkedIn data, Crunchbase data

³¹ When a company produces an invention based on the public support received, the Bayh-Doyle Act stipulates that it must grant the government a nonexclusive, irrevocable, paid-up licence to use the invention throughout the world. It is required that a substantial part of the manufacturing takes place in the US for any exclusive licensee, and the US government retains march-in rights. See <https://uscode.house.gov/view.xhtml?path=/prelim@title35/part2/chapter18&edition=prelim>.



Elisabeth Nindl stated that the 827 US Scoreboard firms remain in the lead in terms of global R&D share (42.1%). The R&D share of the 679 Chinese firms has quadrupled over the last decade, fuelled both by higher investments, a growing number of firms and increased compliance of Chinese accounting with international standards³². The global R&D shares of the EU firms and Chinese firms are now head to head (17.5% and 17.8% respectively) and seem to have stabilised over the past 2 years. US companies are the largest contributors to global R&D growth (exceeding all other countries combined in 2021), followed by China. The Scoreboard shows the intensification of the global technology race in the four sectors which account for more than three quarters of the total company R&D reported: ICT producers, ICT software & services, health and automotive. ICTs have dominated private R&D in the Scoreboard over the past decade, both in terms of share and disproportional growth (annual R&D growth rate of ICT services 18% and producers 14.6% respectively). Among these four sectors, EU-based firms are leading on automotive. The US leads on ICT services and health, with China partially overtaking the EU on ICT services and having a substantial number of firms in health.

Elisabeth Nindl explained the EU 1 000 sample, comprising firms headquartered in 18 Member States, with a lower R&D investment bound of EUR 3.1 million to enter the 2023 Scoreboard. Germany, France and the Netherlands host the majority of large EU R&D investors. Brexit reshaped the EU 1 000 sample, with places vacated by UK firms mostly filled by firms from Germany, Sweden and France. The data do not indicate Brexit-induced headquarters relocations in the Scoreboard sample.

Alexander Tübke then introduced some additional analyses that are determined for each annual cycle according to the policy priorities and which use the Scoreboard's core data, together with other information. The 20-year analysis is based on a panel dataset with observations for 6 218 firms over the period 2003-2022, including 801 firms with data over all 20 years. Since 2003, ICT services (and software) has been the game changer, showing remarkable dynamism, marked by an increase in R&D global share, R&D intensity and new entrants with higher R&D intensities than established firms. Further shifts in sectoral contributions were also observed. The EU has faced challenges in generating new R&D-leading firms compared to China and the US, despite hosting established R&D leaders. While EU strongholds such as industrials and automotive have witnessed declining R&D shares, ICT services and ICT producers, led by the US, have gained significant ground. China is in second place in the ICT and health sectors, with an increasing number of newcomers entering the top 2 500. The Scoreboard's resilience analysis during economic crises highlighted the importance of R&D investments, contributing to accelerated sales, productivity growth and environmental sustainability. Notably, recoveries following the financial and COVID-19 crises were quicker for US firms, led by strengths in the ICT software, hardware and health sectors.

Alexander Tübke showed the results from a patent analysis on green and clean transport technologies (CTT), which uses matched patent data at firm level. Germany and France always rank among the top five inventing countries in each patent category, and Sweden ranks among the top five EU patent applicants in all categories except aeronautics and air transport. Germany is the leader in all categories except aeronautics and air transport, which are led by France. France comes after Germany in most of the CTTs, except for alternative fuels and maritime and waterways transport. Finland comes second in alternative fuels, while the Netherlands comes second in maritime and waterways transport. Italy appears among the top five patenting EU Member States in all CTTs, except for alternative fuels, hydrogen for transport and maritime and waterways transport. Austria is among the top five in all categories except aeronautics and air transport, other CTTs for road

³² Chinese firms' adoption of international accounting standards (which allow for the inclusion of these companies in the Scoreboard) has grown and stabilised over the past 3 years.

transport and maritime and waterways transport, while Spain and Belgium are in the top five for aeronautics and air transport.

Examining the patent flows between locations of headquarters and subsidiaries and targeted patent jurisdiction, EU Scoreboard firms from the automobile and aerospace and defence sectors accounted for 93% of high-value CTT inventions. Companies active in CTT patenting from the automobiles and parts sector and the electronic and electrical equipment sector are mostly headquartered in Germany. French and Dutch Scoreboard companies active in CTTs are mostly from the aerospace and defence sector. Swedish Scoreboard companies patenting in CTTs are mostly from the industrial engineering sector. Almost all the high-value CTT inventions are filed by subsidiaries located in the EU. 61% of patent applications target a jurisdiction in Europe, followed by the US with 21% and China with 9%.

Alexander Tübke then showed an analysis of Scoreboard firms from an ecosystem perspective, where the JRC used the artificial intelligence (AI) domain as mapped by the Digital Techno-Economic ecoSystem (DGTES)³³ methodological approach. In DGTES, the activities that form the AI domain include research, development and innovation (R&D&I) processes and general economic processes related to producing AI-related goods or other services. Thanks to the level of detail of the DGTES database, it is possible to look at individual players' features, such as organisational type, and so identify firms, universities, research institutes and governmental institutions actively engaging in AI-relevant activities, and their geographical location. By comparing different geographical areas and the same area over time, DGTES can offer an original overview of the evolving international industrial and research landscape for AI³⁴. The DGTES approach makes it possible to identify 105 374 firms worldwide involved in the AI ecosystem. Out of these, 2 170 are covered by the Scoreboard. China hosts the highest number of AI players (38% of all AI players), followed by the US (20%) and the EU (11%). The EU (11%) displays a higher share of research institutions than China (9.5%) and the US (4%). Patent activities are highly concentrated in China; the US and South Korea follow at a distance. The US has the largest number of companies in AI-related economic activities (34%), followed by the EU (19%). In terms of relative strength, Europe's revealed comparative advantage is slightly below 1, meaning that Europe's AI specialisation is below the world average. Looking at the Scoreboard companies active in AI, these are mostly found in the manufacturing (42%) and ICT (28%) sectors. Among the top 20 Scoreboard companies active in AI there are two European firms, namely Ericsson and Nokia.

Regarding the outlook for the 2024 Scoreboard cycle, Alexander Tübke mentioned that, in collaboration with Dirk Czarnitzki, a policy brief entitled 'Decomposing the R&D productivity puzzle: are ideas harder to find or does Europe suffer from a commercialisation gap?' is planned for October. There are also plans to: (i) examine the analysis of players in key sectors, e.g. the twin transition; (ii) invest in data collection and matching to capture e.g. public support from Horizon Europe; (iii) and further understand the role of competitiveness-enhancing technologies and M&A in innovation dynamics.

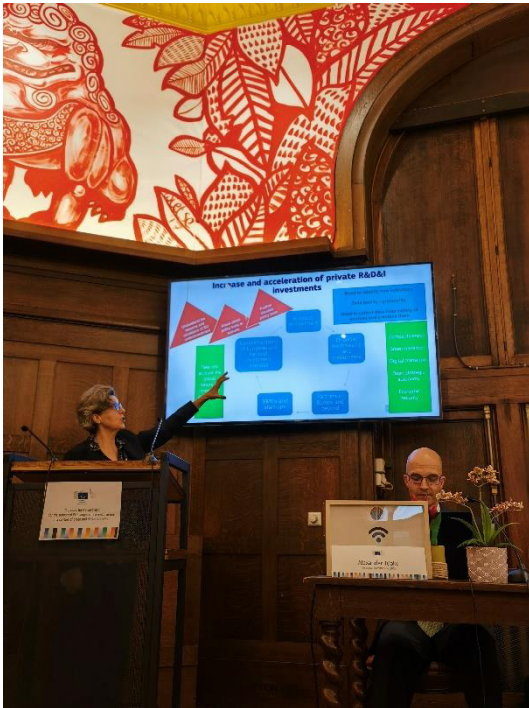
³³ See Calza, E., Dalla Bernetta, A., Kostic, U., Mitton, I., Moraschini, M., Vazquez-Prada Baillet, M., Cardona, M., Papazoglu, Michail, Righi, R., Torrecillas Jodar, J., Lopez Cobo, M., Cira, P., & De Prato, G. (2023), *Analytical insights into the global digital ecosystem (DGTES)* (JRC Technical Report No. JRC132991), Publications Office of the European Union, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC132991/JRC132991_01.pdf and Calza, E., Dalla Bernetta, A., Kostic, U., Mitton, I., Vazquez-Prada Baillet, M., Carenini, M., Cira, P., De Prato, G., Righi, R., Papazoglu, Michail, Lopez Cobo, M., & Cardona, M. (2022), *A policy oriented analytical approach to map the digital ecosystem (DGTES)* (JRC Technical Report No. JRC130799), Publications Office of the European Union, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC130799/JRC130799_01.pdf

³⁴ The DGTES methodology can also be employed to study and analyse the web of collaborations across players. In this way, by looking at the global and European networks of collaboration in R&D&I activities, it can help shed light on the interlinkages occurring across AI players – both at individual and aggregate level – as well as on their relative strategic positioning.

2.4 Presentation of the evidence needs from the EU policymaker

'The challenge of evidence on industrial transformation to underpin R&I policies', Doris Schröcker, Head of Unit, Industrial Research, Innovation and Investment Agendas, Prosperity Directorate, DG Research & Innovation, European Commission

Doris Schröcker explained as background information the work her unit was doing to strengthen industrial R&I and help industry in transferring R&I results to the society, and to achieve EU policy goals for the twin transition, resilience and recovery, and open strategic autonomy. In this context, she thanked the JRC for the partnership with its main deliverable the EU Industrial R&D Investment Scoreboard. As its objectives she referred to: (i) serving as a policy monitoring tool with a focus on the global tech race and R&D resilience; (ii) providing an understanding of the EU's position in relation to its global competitors, (iii) having firm-level evidence on how companies contribute to the digital and green transitions; (iv) providing an R&D investment database that companies, researchers and policymakers can use. Doris Schröcker emphasised how vital it is to have adequate evidence of industrial transformation to underpin R&I and other EU policies, and to help in crises when a rapid response is required. As examples of policies which rely on innovation, she referred to the European Green Deal agenda as an overarching framework dealing with climate, energy and the environment and to the Digital Decade policy programme. Both have clear goals, such as reducing emissions (2030, 2040) and achieving climate neutrality (2050), and digitisation objectives.



She referred to the single market and its role in putting framework conditions in place for businesses, and to the need for responding rapidly to crises (e.g. COVID-19, Russia's war of aggression against Ukraine and related supply chain disruptions and dependencies on critical raw materials, basic chemicals and medicines). She highlighted that for these policies, and for the European Research Area, the New European Innovation Agenda, and the risk assessment of critical technologies, the monitoring of private sector R&D investments provides important indicators for strategies with an impact on long-term competitiveness and the twin transition. This also applies to regional policies that take into account the territorial aspect of R&D investments.

Given the need to increase and accelerate private R&D&I investments, more evidence is needed to clarify the reasons for EU underinvestment, and to make it possible to know which policy tools to activate and how to further develop policy tools.

Taking into account the 'glocal' nature of innovation ecosystems, attention must be paid to policies' impact on the business environment, financial mechanisms and instruments, partners in and outside Europe, SMEs and startups, and the complementarity of European and national investment agendas, and how all these relate to each other. To support policy monitoring and development, she pointed to the need to identify new indicators, collect data from a variety of sources and combine them, to ensure data quality (and granularity). A comprehensive evidence-based approach is needed for policymaking to help the competitiveness, green and digital transition, as well as to achieve the EU's competitiveness, green and digital transition, open strategic autonomy and economic security objectives.

3 Summaries of the panel and breakout group sessions

3.1 Panel 1: 'Corporate R&D strategies and EU's long-term competitiveness'

Alexander Tübke of the European Commission's Joint Research Centre welcomed the panellists and introduced the panel topic. Román Arjona, Chief Economist at the Commission's DG GROW emphasised the robustness of the EU Industrial R&D Investment Scoreboard and how it had evolved during its 20 years of existence, emphasising that it has progressively become much more policy relevant. He went on to organise his discussion around three main themes related to open strategic autonomy: dependencies, distress and diffusion.

In terms of *dependencies*, Román Arjona highlighted the need for constant monitoring of goods produced and for determining those that are challenging to manufacture within the EU's strategic dependencies and vulnerabilities. This is carried out under the label of "SCAN Dependencies" as part of DG GROW's "Supply Chain Analytics Hub". Notably, using the methodology developed for the Industrial Policy package of 2021, his team identified 204 strategic dependencies in sensitive industrial ecosystems. These include intermediate products and raw materials with multiple high-tech applications in fields such as health, safety and security and in support of the EU's green and digital industrial transformation. China appears as the main producer of many those goods, followed by the US and Russia. Román Arjona stressed the need to better identify these dependencies, including single points of failure (SPOFs) or choke points, which emerge when production of a good is highly concentrated in a single country which is in turn very central in a global trade network. Out of the 204 dependent goods, 20% face a high risk of "SPOF", and this could threaten trade in the event of a crisis. On the topic of *distress*, he emphasised the importance of monitoring anomalous daily variations in prices and trade volumes of raw materials and intermediate inputs. That is the goal of the "SCAN distress" system is also part of DG GROW's Hub which permits to examine the evolution of prices and quantities of the raw materials needed for the most widely commercialised technological designs in the EU for net-zero technologies (solar, e-V example, heat pumps, fuel cells and wind turbines). On *diffusion*, Román Arjona underlined how the concentration of productivity gains in top-performing firms is driven by the new DNA of innovation, which involves great celerity and complexity of innovations (which now emerge at the cross-roads of various technologies and scientific disciplines, and have a "deep tech" angle). This, together with the network effects brought about by the digitalisation of the economy and society, lead to such high concentration of productivity gains. He advocated for smart policies to address the needs of the "big fat tail" of the productivity distribution and thus to foster knowledge diffusion and reduce the productivity gap between leading and laggard firms.

Elena Cefis, Professor of Economic Policy at the University of Bergamo and Sant'Anna School of Advanced Studies, discussed the costs and risks associated with R&D, noting that even unsuccessful attempts at innovation can bring new skills, competencies and absorptive capacity, which can support innovation in the future. She underscored the long-term impact of R&D, noting that there are differences in innovators' survival probabilities, relating to the firm's age and the sector. Firms that innovate are more resilient; this is especially the case for firms that are small and young. The adoption of digital technologies also leads to higher R&D productivity. She also pointed out to indications of an R&D productivity decline. More R&D tends to generate more patents, but patent citations are decreasing on average, meaning that the patents are becoming less influential and having smaller impact. Strategic patenting might be causing this phenomenon.

Alex Nussem, the Secretary General of the European Industrial Research Management Association (EIRMA), emphasised the importance of an innovation culture, using Israel's successful startup environment as an example. Israel attracts headquarters of major innovation leaders potentially because it has a better environment for innovation. He also highlighted the need for a simpler, more streamlined message from the



Scoreboard, given the varying reaction times within industry, policy and academia. He pointed out that aerospace and defence are important sectors for technology push, and he strongly argued that public policies and incentives can have a strong role for industry. Alex Nussem also mentioned that an analysis of case studies such as Israel's technology policies over the past decades could provide important insight regarding the strategic development of sectors such as aerospace and defence, biotech and advanced agriculture.

Martina Piazza, Digital Technology and Innovation Manager at DIGITALEUROPE, endorsed the allocation of 25% of the EU budget towards digital initiatives, stating that this would benefit not just the ICT sector but all sectors due to the pervasive impact of the digital transition. She called for improvements to address the complexity of EU funding conditions to allow firms to thrive. Specifically, there are long lags between applications and the allocation of the money, and the need for continuity in funding topics. Piazza emphasised the importance of industry input in designing funding calls to ensure better mutual understanding. She highlighted that a twin transition fund implemented together with the European Investment Bank could play a key role in this new approach. Martina Piazza also argued that coordinating tax incentives and leveraging the EIB's role as a financier could be crucial to improving capital markets and coordinate tax incentives.

Lionel Anciaux, Founding Partner of IOT factory, spoke of the challenges of heavy R&D investment requirements and the complexity of EU funding, which deter firms from applying. He explained that for companies selling software as a service, many licenses (each with low individual subscription value) must be sold to fund substantial R&D investments. This business model entails high expenditure on salaries and resources while generating small amounts per license, limiting the ability to pursue long-term R&D projects without quick outcomes. Anciaux pointed out regional differences in starting points regarding funding, regulation and language, noting that venture capital in Europe is less generous compared to other parts of the world, and expanding internationally within the EU is complex. He observed that the larger markets in the US and China aid startups in their development. Finally, Lionel Anciaux mentioned that ICT patents are not a good indicator of innovation in his area. To appropriate the gains of innovation, his company needs to stay ahead of the curve. He argued that many factors that contribute to achieving innovation are unrelated to patents.

Xavier Baillard, Innovation Director at EIT Manufacturing, identified five main challenges for European industry: a skills gap, lack of diversity, linear production models, emissions targets and resilience. He stressed that the need for new skills in Europe is tremendous and requires urgent action. Diversity is a source of innovation and firms in Europe lack diversity. There is still a pattern of linear production models and a move towards circularity is needed. It is also important to understand how crises can kill companies. He also highlighted the importance of AI and data, the industrial "metaverse", circular economy, net-zero industry and renewable energy in the future of industry.

Questions to panellists explored the reasons for weaker venture capital in Europe and why subsidiaries are not relocating here. A potential contributing factor identified was the skills gap. One example given was the lack of European experts in cybersecurity, a field deemed crucial for future ICT infrastructures. The panel acknowledged the need for more research and policy actions to address these issues, also addressing the trend of the steadily increasing attractiveness of many Asian countries for all different types of R&D&I activities. While red tape and over-regulation might hinder startups or the innovation uptake of smaller European firms, it was also pointed out that the high global trust in the EU's legal framework also means that the EU is good at attracting software as a service and cybersecurity activities.

The corresponding breakout session was moderated by Asunción Fernández of the JRC. The breakout group stated that to engage in this discussion it is essential to define the types of innovation dynamics the EU wishes to incentivise, as this will dictate the strategies and actors involved. Asunción Fernández pointed out three main types of innovation dynamics.

- **Directionality:** Steering research and innovation towards societal challenges or missions requires a clear understanding of the desired outcomes. The EU should create conditions that foster demand for solutions to these challenges, as industry tends to follow demand-pull dynamics. It was suggested that it is important to maintain technological neutrality, allowing industries to develop appropriate technologies in response to market needs, rather than prescribing specific technological solutions.
- **Breakthrough innovations:** These are disruptive innovations that can change paradigms and are relatively rare. Supporting breakthrough innovations requires a different set of strategies, including fostering environments where high-risk research is encouraged and where failure is seen as a learning opportunity.
- **Incremental innovations:** These refer to advancements that augment productivity and are often the result of continuous improvement processes within companies. Supporting incremental innovation involves ensuring that firms of all sizes have access to the necessary resources and knowledge to make ongoing improvements.

The allocation of resources to one mode of innovation inherently affects the availability of resources for the others. It is imperative to understand the synergies, trade-offs and feedback loops between these modes of innovation. Policies should aim to balance these modes to maximise overall benefits.

An industry participant underscored the importance of demand in shaping research and development paths. The EU should work to stimulate demand for innovations aligned with societal goals without dictating the specific technological approaches, allowing for a bottom-up, market-driven development of solutions.

It was also noted that European instruments for supporting innovation are relatively new, and their impacts will take time to fully materialise. The lack of specific criticisms of these instruments during the different sessions indicates a need for further evaluation to determine their effectiveness.



On institutional factors and the frequently voiced criticisms of potential excessive bureaucracy within EU institutions and the efficacy of funding mechanisms, a participant emphasised the significance of upholding EU democratic values. The discourse on this topic should not be overly negative. To illustrate her point, Asunción Fernández referenced China, noting that despite the prevalence of policy waste in its initiatives, the success stories that come to light create the perception that their system is highly effective. This highlights the importance of maintaining a balanced narrative that acknowledges not only Europe's challenges but also its successes, ensuring that EU institutions strive for both efficiency and adherence to democratic principles.

As for the capabilities of civil servants involved in industrial policy, it was underscored that they are tasked with a range of complex responsibilities, including business development, policy formulation, and the creation and analysis of indicators. The sophistication of these tasks necessitates a workforce of highly qualified individuals. This calls for concerted efforts to attract, develop and retain talented professionals within the civil service, ensuring that they are

equipped to navigate the complexities of the industrial landscape and contribute to the strategic advancement of the EU's competitiveness.

On the topic of funding incentives, the importance of partnerships between universities and firms was highlighted, as such collaborations are instrumental in diffusing knowledge and spurring innovation.

A pressing concern identified by the group was the challenges faced by SMEs in scaling up to become market champions. While support for SMEs is in place, there is a growing trend for promising startups to be acquired by multinationals, which can stifle business dynamism. The EU was encouraged to act creatively to address the impacts of these 'killing acquisitions' and to foster an environment where home-grown companies can thrive and contribute to the EU's long-term competitiveness.

3.2 Panel 2: 'Corporate R&D investors in support of the twin green and digital transition'

Roland Strauss, co-founder and Managing Director of Knowledge4Innovation, welcomed the panellists and introduced the topic. Massimiliano Mazzanti, Professor in Economic Policy at the University of Ferrara, discussed the 'twin transition' and its relation to techno-organisational settings, presenting empirical evidence from Italian regions. At the micro level, he highlighted the importance of organisational innovation, or 'soft' innovation, stating that the joint adoption of digital innovation and innovative organisational or work practices, along with training, has positive effects on the adoption of the twin transition strategy. At the macro level, he emphasised the role of policies in addressing the structural mass of knowledge already present in an economy, with R&D investment increasing the medium-term effectiveness of policies through better absorptive capacities. However, Massimiliano Mazzanti also pointed out that policies could have negative effects if an economy lacks sufficient absorptive capacity.

Aliki Georgakaki of the Joint Research Centre presented insights from JRC research on energy and competitiveness, covering corporate investment, patents and the EU's position in clean energy technologies compared to other regions. She noted that private investment accounted for over 75% of the R&I investment

in clean technology fields and discussed how patents are used to estimate in which technologies/ technological fields companies perform or invest in R&D. In the EU, companies allocate a lower share of R&D investment to clean energy technologies compared to other regions, but EU companies perform very well relative to other major economies when looking at high-value patents in these technologies. The strong increase in patenting in China suggests that even if most of the patents are not high-value, the numbers are a strong indicator of internal activity there. Finally, she discussed the ICT sector's high number of patents in green technologies and pointed to the need for a focus on the intersection of green and digital patenting, where the EU currently seems to be falling behind.



Markku Markkula, Vice-President of the European Committee of the Regions, presented seven key messages in support of the twin green and digital transitions, emphasising the importance of EU climate policy in the next 5-10 years. The role of climate policy for welfare, the economy, competitiveness and security highlights the interconnected nature of these policy areas. He urged the new Commission to recognise these interdependencies and to collaborate across Directorates to address these complex issues. According to Markku Markkula, the need for knowledge in achieving the twin transition goals and the Net-Zero Industry Act indicates that a gap remains, requiring a heightened focus on skills and the identification of experts. Additionally, the transition from basic research to application must be strengthened. Markku Markkula also stressed the importance of increased private sector investment and the role of pioneering cities and regions in demonstrating systemic transformation. Cooperation with EU mission cities, roadmaps, climate city contracts, and action paths should prioritise breakthrough innovation. Lastly, the EU should elevate the role of

innovation, including the integration of 'social knowledge' in innovation, such as through living labs.

Marc Vancoppenolle, VP Policy and Government Affairs at Nokia, discussed boosting the EU's competitiveness through innovation. He highlighted the EU's falling behind the US and China in innovation and technology, mentioning that China leads in 13 out of 17 ICT, AI and quantum technologies. Marc Vancoppenolle also pointed out the EU's lag in telecom network investments and discussed the importance of 5G as an enabler for industrial transformation and the twin transition. According to the EU digital decade targets, by 2030, all EU residents should have gigabit internet access, but there is still a long way to go to reach this target – the delay in 5G rollout also leads to innovation delays in sectors which rely on digitalisation. EU telecom operators are significantly smaller than those in China, India or the US, resulting in more difficult investment conditions. His recommendations to strengthen network investments included fostering scale (operator consolidation where that makes sense), increasing the use of AI to reduce the energy consumption and thereby costs of telecom systems, the financing of telecom networks, and better alignment of EU R&D programmes. Moreover, as the EU taxonomy for environmentally sustainable activities does not include telecom, it is more difficult for the sector to attract the (green) finance needed to speed up network deployments. . Finally, regarding Europe's lead in telecom R&D, Marc Vancoppenolle called for the revision of the 'standard essential patents' framework proposal, which in its current form is considered as unbalanced and puts EU ICT at a disadvantage.

Anna Domenech, Innovation Director of CELSA, presented the current challenges and opportunities in the European steel producing and recycling industry. She highlighted the contrast between big steelmakers' investment in new technologies in the EU and their investment in China in 'dirty' technologies with larger capacities, undermining the European emission-saving activities. She emphasised the transformative challenges for energy-intensive industries, pointing to the larger scale of operations, energy consumption, and emissions. She also mentioned the role of a 'welcoming' market for innovative products and processes; in this context, she pointed to the EU emission trading system that is now moving to a carbon border adjustment mechanism (CBAM). However, this generates another advantage for Chinese steel producers, as these companies only need to pay the carbon taxes for the tonnes they export to the EU, meaning that in total they are less taxed than their EU peers, resulting in another cost advantage. Finally, on research and innovation, Anna Domenech advocated for a human-centric approach based on motivation, happiness and a sense of

fulfilment and purpose for employees. She also encouraged companies to overcome collaboration fears and emphasised the importance of cooperation.

In the discussion, it was suggested that value added tax could be linked to the carbon content of a product. This new tax could be extended to materials, as materials play an increasingly important role in the economy. This would also make resources a common good. In the discussion about leadership in green patents, the EU is still leading in some areas, while in others it is doing quite well. The developments in green patenting also relate to the incentives the EU put in place for green innovation. A final comment drew attention to the role of changing consumer preferences in the success of European companies. If consumers exhibit a preference for green products and are willing to pay slightly more for sustainable goods and services, EU companies will be at the forefront.

The breakout session on this topic was moderated by Aliko Georgakaki of the JRC. Among the key takeaways, the group agreed that the green transformation cannot occur without the digital component, and that the EU's primary challenge lies in the digital aspect. Strategic technology and knowhow must be secured within the EU to ensure a successful transition.

On the R&D investment strategies of firms, it was emphasised that companies must anticipate the next 5 years or more. To do so, they require a clear and stable regulatory environment, which will support innovation to be directed without the need for monetary incentives to individual firms. It was also mentioned that innovation becomes easier when the entire value chain is present in a single country, from those who develop the technology to those who use it. Another point raised was that companies often prefer to stay within the mainstream to ensure a steady cash flow. Consequently, a transformation requires support, as evidenced in the US and China.

The breakout group acknowledged the significant disparities across Member States and firms. In response, it is essential to support research infrastructure and research organisations for SMEs, as these companies increasingly outsource R&D. In this regard, positive mention was given to the support provided by the EIC and the EIT for small firms in the Nordic countries. Another example referred to the Netherlands' Industry 4.0 policy, where a network of universities, government institutions and small companies effectively facilitated technology diffusion.

The groups' opinions diverged on whether EU policy should pick winners, technologies or sectors, or should instead focus on supporting R&D without specifying the target technologies or innovations. Related to this discussion, the crucial role of technology diffusion across firms was mentioned, and it was noted that policy should not concentrate solely on R&D investments, but also on the diffusion and adoption of technologies.



3.3 Panel 3: ‘Policy implications of existing evidence on corporate R&D and additional evidence needed in view of new policy developments’

The moderator, Evgeni Evgeniev, Policy Officer at the Prosperity Directorate, DG Research & Innovation, European Commission, welcomed the panellists and introduced the topic. Alexandr Hobza, Chief Economist at DG Research & Innovation, began by highlighting technological and industrial gaps in the EU, noting that the EU faces a significant middle technology trap, given its focus on sectors such as automotive and manufacturing. This trap is exacerbated by path dependency in the structural composition of EU industries, where dominant companies have remained entrenched in specific sectors for decades. This stands in stark contrast to the US, which has undergone a more comprehensive transformation in its industrial and technological landscape, fostering innovation across a wider array of sectors.

Alexandr Hobza showed that comparative technological strengths reveal the EU’s focus on less sophisticated technologies, while the US and China dominate more complex fields, particularly digital technologies. This technological disparity has led to a decline in business dynamics within the EU, driven by challenges in accessing finance and a restrictive business environment. Although there has been an increase in venture capital availability, scaling up remains a significant hurdle. Additionally, the overall business environment poses substantial barriers to growth and innovation. Recent proposals from the European Commission aim to address these challenges through targeted industrial policies. However, Alexandr Hobza emphasised that the effectiveness of these policies is constrained by scarce resources and a low starting point, making significant progress difficult.



Taina Tukiainen, Research Director at the University of Vaasa and Professor (adj.) in Sustainable Leadership and Innovation at the University of Turku, transitioned the topic to climate adaptation in the context of the EU missions and climate change policies. She emphasised the importance of understanding micro-level dynamics, as successful case studies can offer valuable insights. However, the region faces a deficit in the necessary capabilities and skills to fully

exploit these insights. In Finland, the approach to competitiveness is intrinsically linked to addressing societal challenges, showcased by the country’s ‘moonshots’ for green growth, which combine green and digital initiatives. These initiatives include innovative materials and technologies, such as bio-based product materials, decarbonisation technologies and services, circular batteries, green metals and green hydrogen production. Taina Tukiainen underscored that Finland promotes the concept of net positive living, ensuring that decarbonisation efforts align with and support economic growth. Another critical component mentioned was the importance of fostering multilevel governance through innovation camps. These camps emphasise the need for collective knowledge and expertise to address societal challenges, both generic and local. The innovation camp methodology serves as a tool to leverage regional strengths and create impactful collaborations across sectors. Central to this approach are capacity building for social innovation, the importance of diverse perspectives, and active engagement from young people, policymakers and stakeholders. The process involves meticulous planning, documenting shared knowledge and ensuring follow-through with prototyping and commitment. The workshop underscored that achieving real impact requires time and sustained effort, with practical outcomes aimed at breaking down barriers and fostering synergies for effective problem solving.

Déborah Goll, Senior Project Manager at the European Digital SME Alliance, brought the panel’s attention to digital SMEs and their role in developing innovative solutions to advance Europe’s twin transition across sectors. The Alliance represents more than 45 000 digital SMEs focused on enhancing their role in the digital economy. She highlighted the importance of measuring SMEs’ R&D investments as indicated by various editions of Scoreboard. According to OECD findings, SMEs often rely on networks to bolster their innovation capabilities. These include supply chain management, knowledge sharing, access to R&D facilities, and strategic partnerships, clustering within the value chain, Digital Innovation Hubs, clusters, etc. However,

Déborah Goll noted significant technical challenges regarding the representativeness of the Scoreboard, particularly as the data from smaller companies is not always reflected in research, while companies with fewer than 10 employees constitute 93% of EU SMEs. Moreover, SMEs face many barriers in R&D, creating scalability and innovation bottlenecks. The DIGITAL SME Manifesto 2030 (European Digital New Deal), provides recommendations to address some of these challenges, notably by supporting SMEs in mastering digital innovation, facilitating business operations within the single market, and fostering alliances within the ecosystem, thus enhancing the competitiveness and innovation capacity of digital SMEs across the EU.

Marta Walker of Directorate General III (Innovation & Technology) at the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, discussed the country's focus on transformative research and innovation, aimed at fostering a greener industry. Key aspects of this transformative R&I approach include impact orientation, system understanding and change, foresight and strategic intelligence, and agility and learning. Marta Walker introduced the national ministry's climate and transformation initiative, noting that the 2023 call for this initiative seeks innovative projects to decarbonise Austrian industry, encouraging collaborative approaches to achieve these goals. This initiative underscores Austria's commitment to leading the charge towards a more sustainable industrial future.

Luisa Henriques, Advisor to the Board of Directors at Portugal's Foundation for Science and Technology (Fundação para a Ciência e a Tecnologia), explored how policy tools and scoreboards can serve as effective policy instruments for EU Member States. She compared the two primary scoreboards: the EU Innovation Scoreboard (EIS), established in 2000, and the EU Industrial R&D Investment Scoreboard, established in 2003. Despite its potential, she noted that the EU Industrial R&D Investment Scoreboard could be more fully utilised or mobilised in EU documents as evidence for policymaking. National policymakers also tend to overlook this tool, and the media interest focuses more on the results of global companies rather than on the EU and Member States levels policymaking issues. With Portugal as a case study, she illustrated that the EU Industrial R&D Investment Scoreboard has the potential to highlight structural changes and weaknesses of European R&I systems. Suggestions for improvement consider targeting midcaps and startups, and enhancing the policy impact and visibility to policymakers with a better coverage of the Union providing alerts for new policy developments. It was proposed to explore comparing the EIS with the EU Industrial R&D Investment Scoreboard.

Questions to the panel focused on monitoring policy dynamics and the coverage of existing tools like the European Innovation Scoreboard³⁵ compared to the EU Industrial R&D Investment Scoreboard. The EIS provides a comparative analysis of innovation performance in EU countries, other European countries and regional neighbours. It uses a composite indicator with 32 components, where the EU Industrial R&D Investment Scoreboard constitutes a measure of private R&D investments. The discussion underscored that each of the tools are fulfilling their objective but alone are insufficient to address all the current policy dynamics, particularly considering recent developments and pressures. The COVID-19 pandemic has highlighted the necessity for new tools and approaches. The efficacy of these tools depends heavily on available resources and careful selection. Emerging methods, such as complexity analysis, are proving useful. For SMEs, the focus should be on high-impact entities like gazelles and unicorns, which contribute significantly more than their smaller counterparts. Improving the EU Industrial R&D Investment Scoreboard for policymaking involves extending it to better capture the dynamics of SMEs, adopting a regional and local ecosystems perspective, using both qualitative and quantitative data for comprehensive policy evaluation and early technological assessment, and understanding the regional impact of multinational operations.

The breakout session on this topic was moderated by Constantin Belu, Policy Officer at the Prosperity Directorate of DG Research & Innovation. The group addressed various aspects of competitiveness, highlighting the complexities and the multifaceted nature of this concept. Six main lines of discussion were identified:

- Defining competitiveness: One of the key points of discussion was the definition of competitiveness, a term that encompasses various dimensions such as cost advantage, differentiation, territorial competitiveness, market power and technological competitiveness. Participants underscored that defining competitiveness is challenging and emphasised that the EU must approach this definition

³⁵ See https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en.

carefully to avoid undermining itself. A nuanced understanding of competitiveness is crucial for formulating effective policies that can bolster the EU's industrial strength.

- **Role of SMEs in competitiveness:** A significant portion of the discussion centred on the role of SMEs in the EU economy. There is ample evidence regarding the impact of large companies on competitiveness, but considerably less is known about SMEs, despite their disproportionate contribution to job creation. Concerns were raised about the migration of startups to the US and China, which might be driven by differing innovation cultures and risk-taking approaches in these regions. Participants called for evidence to be collected in order to better understand these migration patterns and their implications for the EU's competitiveness.
- **Sustainability and competitiveness:** It was noted that at firm level, sustainability costs such as those associated with carbon emissions or waste management comprise a small share of overall costs. Moreover, environmental policies were highlighted as drivers of innovation and revenue generation. A critical point of discussion was how this revenue is reinvested into the economy to sustain long-term competitiveness.
- **Strategic focus on technologies and sectors:** Participants emphasised the need for a focused decision on which technologies or sectors the EU should strive to be competitive in. Potential areas include automotive, sustainability, education, aerospace and defence. The suggested guiding principle was to identify sectors strategically and invest in them systematically. The discussion also touched on whether the EU should aim to bridge gaps in existing industries or build its competitive advantage in emerging technological developments.
- **Governance and R&D investment:** The governance structure of companies was identified as an important factor influencing R&D investment and the timing of these investments. Effective governance can facilitate better decision-making and more strategic investment in R&D, which is essential for enhancing competitiveness.
- **Mapping the competitiveness landscape:** The increasing need for comprehensive mapping of the competitiveness landscape was another focal point. This mapping involves aligning skills with production spaces and knowledge spaces to create a cohesive strategy for enhancing competitiveness. Such an approach would help identify gaps and opportunities in the EU's industrial landscape, informing policy decisions and investment strategies.

4 Closing remarks and next steps

The Joint Research Centre and DG Research & Innovation thanked the participants on behalf of the European Commission for the vivid and open contributions during the whole day, before going on to provide final remarks and observations. As a next step, the team has prepared this summary report and made it available together with the presentations³⁶. The Commission will also take into account the insights and opinion shared during the event when preparing the next editions of the EU Industrial R&D Investment Scoreboard.

³⁶ <https://iri.jrc.ec.europa.eu/events/corporate-rd-investment-support-eus-long-term-competitiveness-context-green-and-digital>

List of abbreviations and acronyms

Artificial intelligence (AI)
Climate change technologies (CCT)
Critical raw materials (CRM)
Corporate venture capital (CVC)
Digital Techno-Economic ecoSystem (DGTES)
Electric vehicle (EV)
Energy-intensive industries (EIIs)
European Industrial Research Management Association (EIRMA)
European Research Area (ERA)
EU Industrial R&D Investment Scoreboard (Scoreboard)
European Commission (EC)
European Commission, Directorate-General for Research and Innovation (DG RTD)
European Commission, Joint Research Centre (JRC)
European Investment Bank (EIB)
European Innovation Council (EIC)
European Innovation Council and SMEs Executive Agency (EISMEA)
European Institute of Innovation & Technology (EIT)
European Union (EU)
Horizon Europe (HE)
Information and communication technology (ICT)
Intellectual property (IP)
Mergers & acquisitions (M&A)
New European Innovation Agenda (NEIA)
Open strategic autonomy (OSA)
Questions & answers (Q&A)
Public-private partnership (PPP)
Research & development (R&D)
Research, development and innovation (R&D&I)
Research & innovation (R&I)
Small and medium-sized enterprises (SMEs)
Strategic Technologies for Europe (STEP)
Technology readiness level (TRL)
Technology transfer organisation (TTO)
United Kingdom (UK)
United States of America (US)
Venture capital (VC)

Annex agenda

Corporate R&D investment for the support of EU's long-term competitiveness in a context of green and digital transition

22 May 2024, University Foundation, Brussels, Belgium

9:00-9:30 **Arrival** of the participants at the venue

9:30-09:45 **Welcome**

Maria-Cristina Russo, Director 'Prosperity', European Commission DG Research & Innovation, European Commission

Sabine Henzler, Director 'Strategy and Impact', Joint Research Centre, European Commission

09:45-10:30 Keynote speech and Q&A:

Lena Tsipouri, Professor Emeritus for Economic Development, European Economic, Integration, Economics of Technological Change and Theory of the Firm at the National and Kapodistrian University of Athens and co-founder of Opix AI

10:30-10:50 **20 years of experience of the EU Industrial R&D Investment Scoreboard**, **Alexander Tübke** (Team Leader) and **Elisabeth Nindl** (Economic Analyst), Unit B6. Industrial Strategy, Skills & Technology Transfer, Directorate. B. 'Fair & Sustainable Economy', Joint Research Centre, European Commission

10:50-11:00 **The challenge of evidence on industrial transformation to underpin R&I policies**, **Doris Schröcker**, 'Prosperity Directorate', Head of Unit, Industrial Research, Innovation and Investment Agendas, DG Research & Innovation, European Commission

11:00-11:30 **Coffee Break**

11:30-12:30 **Panel 1: Corporate R&D strategies and EU's long-term competitiveness**

Moderator: Alexander Tübke, JRC, European Commission

Roman Arjona, Chief Economist, DG GROW, European Commission

Elena Cefis, Professor of Economic Policy, University of Bergamo and Sant'Anna School of Advanced Studies

Alex Nussem, Secretary General, EIRMA,

Martina Piazza, Manager Digital Technology and Innovation, DIGITALEUROPE

Lionel Anciaux, Founding Partner, IOT Factory

Xavier Baillard, Innovation Director, EIT Manufacturing

12:30-13:15 **Lunch break**

13:15-14:30 **Panel 2: Corporate R&D investors in support of the twin green and digital transition**

Moderator: Roland Strauss, Co-founder and Managing Director, Knowledge4Innovation

Massimiliano Mazzanti, Full professor in Economic Policy, UNIFE

Aliki Georgakaki, JRC, European Commission

Markku Markkula, Vice-President, European Committee of the Regions

Marc Vancoppenolle, VP Policy & Government Affairs, Nokia

Anna Domenech, Innovation Director, CELSA

14:30-15:15 **Break-out sessions**

The audience will be randomly distributed in three break-out sessions, which will cover the three topics of the panels. Each session will be moderated, whereas a rapporteur will put together the findings and conclusions.

15:15-15:45 Coffee Break

15:45-16:00 **Reporting from the break-out sessions**

16:00-17:15 **Panel 3: Policy implications of existing evidence on corporate R&D and additional evidence needed in view of new policy developments**

Moderator: Evgeni Evgeniev, Policy Officer, 'Prosperity Directorate', Industrial Research, Innovation and Investment Agendas, DG Research & Innovation, European Commission

Alexandr Hobza, Chief Economist, DG Research & Innovation, European Commission

Taina Tukiainen, Professor of Sustainable Leadership and Innovation, Turku University and Vaasa University

Déborah Goll, Senior Project Manager, European Digital SME Alliance

Marta Walker, Policy Officer, Directorate General III (Innovation and Technology), Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Austria

Luísa Henriques, Advisor to the Board of Directors, Foundation for Science and Technology (Fundação para a Ciência e a Tecnologia), Portugal

17:15-17:30 **Closing remarks and next steps**

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