European Commission

JRC Conference and Workshop Report

Leveraging the Deep-Tech Green Transition & Digital Solutions to Transform EU Industrial Ecosystems

Summary report of the 7th GLORIA hybrid workshop

Tübke, A., Evgeniev, E., Gavigan, J., Compañó, R., and Confraria, H

2023

Joint Research Centre

This publication is a Conference and Workshop report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication.

This Summary report of the 7th GLORIA workshop 'Leveraging the Deep-Tech Green Transition & Digital Solutions to Transform EU Industrial Ecosystems' is published in the context of the Global Industrial Research & Innovation Analyses (GLORIA) project that is jointly carried out by the European Commission's Joint Research Centre — Directorate B, Fair & Sustainable Economy — and the Directorate-General for Research and Innovation (RTD) — Directorate E, Prosperity.

GLORIA has received funding from the European Union's Horizon Europe research and innovation programme under a specific action for scientific and technical services by the Joint Research Centre. The main expected impact of GLORIA is the better understanding of corporate Research & Development (R&D) efforts in relation to the green deal and sustainability objectives, starting from the global competitiveness perspective of top R&D investors.

The workshop on which this publication is based was organised under the responsibility of Fernando Hervás (Acting Head and Deputy Head of Unit JRC B6 Industrial Strategy, Skills & Technology Transfer) and Doris Schröcker (Head of Unit DG RTD E1 Industrial Research, Innovation & Investment Agendas).

Contact information

European Commission - Joint Research Centre
Directorate B, Fair & Sustainable Economy - Unit B6 Industrial Strategy, Skills & Technology Transfer
Edificio Expo; c/ Inca Garcilaso, N° 3
E-41092 Seville, Spain

Name: Alexander Tübke
Email: Alexander.Tuebke@ec.europa.eu
Any comments can be sent to: jrc-b6-secretariat@ec.europa.eu
More information, including activities and publications, is available at https://iri.jrc.ec.europa.eu/home/
EU Science Hub https://joint-research-centre.ec.europa.eu

JRC133774

European Commission, Seville, 2023

How to cite this report: Tübke, A., Evgeniev, E., Gavigan, J., Compañó, R. & Confraria, H.: *Leveraging the Deep-Tech Green Transition & Digital Solutions to Transform EU Industrial Ecosystems*, European Commission, Seville, 2023, JRC133774.

Contents

Abstract

On 27 March 2023, the Joint Research Centre (JRC) and the European Commission's Directorate-General for Research and Innovation (DG RTD) organised the workshop 'Leveraging the deep-tech green transition and digital solutions to transform EU industrial ecosystems'. The workshop took place in a hybrid setting, co-organised with DEEP Ecosystems and hosted by the Technical University of Munich. The event gathered 35 in-person and 412 online participants.

The workshop participants discussed the importance of deep-tech for the green and digital transitions. They focussed on mobilising innovation strategies and cooperation between larger and smaller firms, the breakthrough potential of green deep-tech, stakeholder collaboration and technology transfer in innovation ecosystems, and policy instruments to facilitate especially the transfer of low TRL research results to industrial R&I.

The main elements coming out from the roundtable and four working groups were the importance of finance/investment for deep-tech, infrastructure, exit opportunities, and the role of the ecosystem for bringing together the stakeholders.

Additional elements raised were the persistence of founders, the need for European Business Angels and family offices, and the role of public actors in building trust. Further, speed regarding innovation investment decisions, simplified access to public funding with existing policy instruments, and efficient design of new ones were emphasised. Beyond that, the attitude to take risks and fail, Venture Capital-related training, skills development and increasing the pool of professionals are fundamental.

The Commission services will take the insights and opinions shared during the event into account for developing its tools, such as the EU Industrial R&D Investment Scoreboard, and in follow-up policy fora, such as that for ERA Action 12 'Accelerate the green/digital transition of Europe's key industrial ecosystems under the ERA Policy Agenda'.

Acknowledgements

The JRC B and DG RTD E would like to thank everyone who has contributed to the workshop, especially Prof Hanna Hottenrott & Felix Kurz, (Technical University of Munich), Thomas Kösters (DEEP Ecosystems), Prof Helmut Schönenberger & Lars Eiermann (UnternehmerTUM), Volker Ziegler (Nokia), Marie Wall (Ministry of Climate and Enterprise, Sweden), Pedro Ruão (Omniflow), Asier Rufino (Tecnalia Ventures), Roland Strauss (knowledge4innovation), Agnieszka Radziwon (University of California Berkeley and Aarhus University), Vlad Gliga (Rubik Hub & The Climate Vertical), Anne-Marie Sassen (EISMEA), Annick Meerschmann (CEFIC), Danijel Grabovac (Siemens AG Technology and Innovation Management), Christian May (FlexFunction2Sustain) and Bram Pauwels (European Business and Innovation Centre Network (EBN)).

Authors

The main authors of the report are Alexander Tübke, James Gavigan, Hugo Confraria, Ramón Compañó (all JRC B6 Industrial Strategy, Skills & Technology Transfer) and Evgeni Evgeniev (DG RTD E1 Industrial Research, Innovation & Investment Agendas).

1 Introduction

1.1 Policy context

The New European Innovation Agenda (NEIA), adopted by the Commission on 5 July 2022, strives to increase competitiveness, retain leading home-grown firms and technologies and facilitate growth in emerging sectors, particularly those enabled by deep-tech developments[1]. It aims to harness innovation ecosystems in Europe to support the industrial transformation necessary to meet the Green Deal policy targets.

The European Industrial Strategy is, at heart, an 'innovation' strategy. It builds on research and technological development by, for example, European partnerships with industry following European Research Area (ERA) industrial technology roadmaps, which form part of industrial transition pathways. Other policy instruments are industrial alliances to mobilise and build industrial capacities in key industrial and technological areas and Horizon Europe partnerships. On 5 May 2021, the Commission updated the EU Industrial Strategy, accounting for the post-Covid-19 crisis and supporting the transformation towards a more sustainable, digital, resilient and globally competitive economy[2]. This speeds up recovery and supports European leadership in green and digital technologies.

Among its objectives, the ERA policy agenda calls for 'accelerating the green / digital (twin) transition of Europe's key industrial ecosystems' (ERA Action 12). This action links ERA industrial technology roadmaps to national strategies aimed at meeting industry's need to access technology infrastructures and services. It focuses on breakthrough technologies and ensuring social adaptation to the green and digital transitions. The action gives rise to a pertinent question, relevant to this workshop, namely how to better support the transfer of fundamental / low Technology Readiness Level (TRL) research results to industrial R&I.

Europe's researchers and industry are leaders in green tech, related R&I investments and patenting. The Green Deal Industrial Plan of 1 February 2023 responds to the urgency to step up the production of the 'Net-zero technologies' which will support the decarbonisation of industrial processes and the circular economy in Europe[3]. The core green technologies are public goods, meaning that their direct benefits are non-excludable. The level of public policy interventions, regulations, and public financing in green sectors exceeds those typical of other industries, needing efficient public-private collaboration for the uptake of green technologies. In parallel, the global tech race in digital technologies, evidenced by growing differences in Research & Development (R&D) investment levels and growth rates between large EU companies and those from the US and China, are a cause for concern. This is a call for action by both the private and public sectors, addressed in this workshop from many points of view: main actors, investment, risk, collaboration and technology transfer.

From this follows the challenge how to develop a European industrial landscape of large and leading companies for the twin transitions. Large firms, such as those in the EU Industrial R&D Investment Scoreboard (Scoreboard), play a key role with large (direct and indirect) market and innovation power. Via their subsidiaries, suppliers and collaborators/networks, they are entry points for Small and Medium-sized Enterprises (SMEs) and startups to collaborate or regions to internationalise. Beyond direct innovation investment, they use Mergers & Acquisitions (M&A) and Corporate Venture Capital (CVC) to pursue their strategic interests and tap into risky ventures. Two-thirds of the Scoreboard companies use CVC, but by EU companies is only half of that by US companies. Moreover, 80% of funds from EU-based companies go to US-based startups, which triggers important spill overs. EU-based corporates invest largely in US startups, often via subsidiaries, and within the EU predominantly in the country of their headquarters. CVC complements and supports R&D especially in Information and Communication Technology (ICT) and health. What this means and how it might increase for green deep-tech collaboration between larger and smaller firms was also discussed at this workshop.

Finally, the public policies concerning technology infrastructures (universities, research institutes, demonstrators, open innovation testbeds, incubators and accelerators), Research and Technology Organisations (RTOs) and technology transfer are highly relevant for deep-tech. This topic found vivid discussions and new proposals from the workshop participants.

[1] The New European Innovation Agenda (europa.eu)

[2] The European Industrial Strategy (europa.eu)

[3] The Green Deal Industrial Plan (europa.eu)

1.2 Implementation and organisation

This one-day hybrid workshop addressed the potential of deep-tech and corporate open innovation to leverage the twin transformation of the EU's industrial ecosystems (see Annex Agenda). The morning session showed evidence and analysis. First, the University of Munich presented its incubator programme - one of the largest in Europe. Then, evidence of deep-tech activity in large and smaller firms followed. A keynote address bringing together the different aspects (open innovation, CVC and technology transfer) rounded-up the morning.

The afternoon started with a roundtable discussion where the moderator provided the canvas from the societal and environmental challenges and its implications for developing a pan-European innovation ecosystem. The roundtable members provided statements of main deep-tech challenges for public policies, ecosystem development, technology transfer, skills, industrial uptake, and policies from the European Innovation Council (EIC).

The participants then split into four dedicated working groups, each on one of the following questions:

1. How to effectively mobilise the innovation strategies of larger and smaller firms providing the green / digital solutions for our future? What is the potential for cooperation between large and small firms?
2. What is the breakthrough potential of green / digital deep-tech in Europe and where it is/should be focused?
3. How to harness deep-tech stakeholder collaboration and technology transfer in innovation ecosystems? What are the best practices for collaboration among actors?
4. What public policy instruments can facilitate increase of investments in green / digital deep-tech innovation and infrastructure (demonstrators, open innovation testbeds, incubators and accelerators)? How to better support transfer of fundamental / low TRL research results to industrial Research & Innovation (R&I)?

The workshop concluded with rapporteur statements from each working group and a summary statement by the Technical University of Munich.

The workshop was organised by the European Commission in collaboration with DEEP Ecosystems and hosted by the Technical University of Munich, located in one of the strongest deep-tech ecosystems in Europe. It was organised as part of the Global Research & Innovation Analyses[4] (GLORIA) project carried out by the JRC and DG RTD. GLORIA workshops[5] aim to discuss policy-relevant issues addressed in the analytical work of this project[6] and gather feedback from academics, policymakers and industrialists on the relevance and policy implications of the results.

DEEP Ecosystems is a global community of ecosystem builders empowering local startup support organisations to professionalise and improve their services to create globally-impactful initiatives that tackle society's most pressing challenges, such as climate change, education, gender equality and regional economic disparities.

The Technical University of Munich (TUM), School of Management, Professorship Economics of Innovation, addresses research and teaching not only in economics of innovation, but also in the organisation of science & innovation, as well as other topics related to science and technology policy.

[4] http://iri.jrc.ec.europa.eu/home/. The activity is carried out jointly by DG RTD, Directorate E (https://ec.europa.eu/info/research-and-innovation_en) and the JRC, Directorate B (https://op.europa.eu/en/web/who-is-who/organization/-/organization/JRC/COM_CRF_3582).

[5] To date, 14 Gloria workshops have taken place (https://iri.jrc.ec.europa.eu/events).

[6] https://iri.jrc.ec.europa.eu/rd_monitoring

2 Summary Report of the Workshop

2.1 Welcome

9:30-10:00 Arrival of the participants

An unexpected two-day strike by German transport workers announced 72 hours before the start of the event resulted in numerous flight and public transport cancellations on 26-27 March. This reduced the planned on-site participation by half. Nevertheless, most speakers made it to the venue, and virtual participation allowed the full programme to proceed as planned. The event gathered 35 in-person and 412 online participants.

The dialogue between policymakers, industry representatives, entrepreneurs, university researchers and technology transfer professionals was very positive, encompassing the importance of deep-tech for the green and digital transitions, the relationship between large industry (notably large R&D investors as represented in the EU Industrial R&D Investment Scoreboard) and startups, and their respective innovation strategies.

10:00-10:30 Welcome panel

Peter Dröll, Director for 'Prosperity', European Commission DG Research & Innovation

Mr Dröll welcomed the participants on behalf of the Commission. He highlighted that Europe is currently in a dynamic phase of an industrial revolution in which deep-tech has a significant role to play. Europe's deep-tech companies have a market value of EUR 77 billion, with Munich being one of the leading deep-tech ecosystems. Such deep-tech is vital in transitioning towards a new form of society based on the circular economy model and living in harmony with nature.

He emphasised that the New European Innovation Agenda focuses on deep-tech, startups, scaleups, firm creation, and knowledge spill overs. He also discussed the connection of this agenda with the Net-Zero Industry Act and the European Green Deal. Mr Dröll reminded participants that Europe is heavily reliant on critical raw materials for the energy transition, making it crucial to identify the right investments in materials - not just more mining but more substitution based on a new generation of materials.

He concluded by saying that while the strong EU policy steer identifies the final goals, the European Commission does not have all the answers as to how best to achieve them. He suggested exploring questions, such as how to boost VC, what innovation strategies would be most effective for both large and small companies, how to incentivise collaboration between the private sector, academia, and government for deep-tech, and how to deal with the concentration of capital in a few Member States, given that deep-tech is capital intensive. Finally, Mr Dröll urged participants to think about what works best for the transformation we are facing.

Mikel Landabaso, Director for a 'Fair & Sustainable Economy', Joint Research Centre

Mr Landabaso outlined the three main lines of work at the JRC related to deep-tech. First, support in developing innovation ecosystems through public-private partnerships for regional innovation. Second, setting up the European Centre for Algorithmic Transparency (ECAT) to help create algorithms with European values and penalise those not in line with European standards. Third, the work on industrial innovation, dynamics and productivity including the Industrial R&D Investment Scoreboard, which monitors current trends and provides evidence-based insights for EU policies on industry and industrial innovation.

Given the rise of China, as outlined in JRC's recent flagship report[7], Mr Landabaso stressed the need to address dependencies on primary and intermediate goods by promoting Open Strategic Autonomy (OSA) and technological sovereignty, linking them to Europe's global agenda, where a different type of globalisation among world regions is emerging. He also emphasised the importance of multilateralism and industrial policy for continued competitiveness.

[7] European Commission, Joint Research Centre, Kusch, S., Preziosi, N., Goenaga, X.et al., *China 2.0 – Status and foresight of EU-China trade, investment, and technological race: executive summary*, Kusch, S.(editor), Preziosi, N.(editor), Goenaga, X.(editor), Fako, P.(editor), Hervas, F.(editor), Dries, E.(editor), Publications Office of the European Union, 2022.

He continued by highlighting the need for more R&D investment to further Europe's 'Fit for 55' climate commitments by 2030. He stressed the importance of meeting the 3% GERD/GDP objective, not just for competitiveness, but also to adapt to climate change and strengthen Europe's prosperity. Although Europe is leading in green tech, the US is set to increase its competitiveness in this sector with the Inflation Reduction Act – and in parallel continues to increase its technological advantage in critical sectors such as digital and health. Therefore, a strong EU response and EU-US collaboration are necessary to create win-win situations, along with increased efforts to promote the scaleup and VC financing of new innovative firms.

Lastly, Mr Landabaso announced two upcoming events related to regional and deep-tech innovation. First, 'Partnerships for Regional Innovation: From playbook to implementation' on 28 March 2023[8]; and second, the 'Conference on deep-tech entrepreneurship for an innovative, resilient, and competitive internal market' on 1-2 June 2023[9]. Finally, he stressed the role of ecosystems in bringing together stakeholders. This concerns not only strong ecosystems, but especially lagging regions. To bring about change, a more efficient interplay between innovation funding mechanisms is necessary.

[8] https://joint-research-centre.ec.europa.eu/events/partnerships-regional-innovation-playbook-implementation-2023-03-28_en

[9] https://swedish-presidency.consilium.europa.eu/en/events/conference-on-deep-tech-entrepreneurship-for-an-innovative-resilient-and-competitive-internal-market-1-26/

2.2 Keynote addresses

10:30-10:45 'The potential of green / digital deep-tech and startups for leveraging innovation and industrial ecosystems, Helmut Schönenberger, UnternehmerTUM

Prof Schönenberger discussed the potential of deep-tech and startups for leveraging innovation ecosystems. He presented the Technical University of Munich's entrepreneurship center, UnternehmerTUM, founded in 2002 by the entrepreneur Susanne Klatten as a non-profit organisation to support entrepreneurship in Germany and a generally more entrepreneurial culture. Mr Schönenberger explained that the success of the Munich deep-tech ecosystem is due to UnternehmerTUM being itself a 'startup machine'. UnternehmerTUM teaches and enables people to do projects, including master's theses, resulting in high value creation. Their startups attract EUR 2 billion per year and aim to scale ten-fold by 2030 compared to 2020. With over 350 startup projects and 50 high-growth technology startups operating in 2022, it is one of Europe's leading centres for innovation and entrepreneurship. Entrepreneurship and technology are key elements of competitiveness – they create value, lead to new jobs and accelerate growth. But even more they are critical to generate innovations to solve the enormous challenges in climate change, renewable energies, diminishing resources and circularity. UnternehmerTUM's mission is to help founders implement their ideas, and for experienced teams to help startups with the development of products. More than 400 employees help to build and finance potential projects and develop them into startups. The accelerator, TechFounders, connects existing industry and businesses with startups, which helps to expand their innovative strength and corporate culture. Its MakerSpace offers 2 700 square meters to companies, startups and creative people to produce prototypes and pilot series. The programme's activities have substantially driven the Munich startup ecosystem in the past 20 years, which alone is currently responsible for developing around 20% of all high-growth, high-tech companies in Germany. The TUM Venture Labs, a joint initiative of TUM and UnternehmerTUM, support the entrepreneurial journey of scientists and students in numerous technology-based domains within the ecosystems. The more than 300 startups aim reach out globally for sustainable impact, and set strong foundation for climate action, responsible resource management, the circular economy and resilience.

Private-public collaborations and partnerships are essential. UnternehmerTUM's ecosystem benefits from 100 family businesses and a considerable number of key private partners contributing to the annual budget of EUR 50 million with a long-term investment perspective. Especially comparing to the Anglo-Saxon world, venturing is a bottleneck towards leveraging outstanding research for economic growth. Mr Schönenberger presented his vision to develop an integrated collaborative approach starting with at least ten ecosystems and supported by the national government. Attaining 50 such ecosystems would, in his opinion, ensure Europe's global technology leadership. On the European venture capital financing gap, Mr Schönenberger reminded participants that government VC is relatively small compared to private. However, government VC could unlock additional private money by building a funnel for early-stage financing deals of EUR 0.5-2 million. But to tackle the growth phase, increased scaleup funds would be necessary to enable investment rounds of up EUR 1 billion. Regarding green tech, he mentioned the grass-root attractiveness for students to build tech businesses for a more sustainable planet as an essential motivation of their approach. Mr Schönenberger gave some examples of successful deep-tech firms and unicorns, including Flixbus, Lilium, and Isar Aerospace.

Questions raised by the audience included, for example, whether it is possible to open this ecosystem to outsiders. Mr Schönenberger replied that 40% of their participants are not residents and that companies in the scaleup phase often need to go to the US. He raised the need for a European capital market and a European stock exchange with a tech segment to enable firms to get the liquidity they need. At present, most of the exit opportunities at large levels are concentrated at the NASDAQ.

10:45-11:00 'Green and digital deep-tech innovation and industrial ecosystems: What's at stake?' Volker Ziegler, Senior Technology Adviser, Chief Architect, Nokia

Mr Ziegler started his presentation by sharing his experience at Nokia Bell Labs, Nokia's industrial research lab, where innovation happens with a purpose, pursuing responsible, sustainable technologies that will have a demonstrable impact on society and industries. He briefly shared Nokia's 5G vison about connecting the digital and the physical worlds and augmenting human possibilities. Nokia Bell Labs has various research centres across the world, in Munich, Stuttgart and other European locations such as Finland (Nokia headquarters) and France.

Nokia is focused on B2B business, and he sees the ICT industry on the way to unleashing the potential of digital in all industries via 5G. But in the global context, fragmentation of global standards is increasingly a

risk. Nokia strives to develop future networks in a sustainable and trustworthy way, digital inclusion needs to be assured to connect the unconnected - and Europe's aging population needs solutions for digital inclusion as well. To address objectives of innovation and digital transformation, collaboration is as important as access to finance, underlining the importance of EC programmes for public private partnership such as 5G Public Private Partnership (PPP) / Horizon 2020 and now Smart Network Services Joint Undertaking (SNS) under the umbrella of Horizon Europe.

For Nokia's world leading business in communication, he sees a shift going beyond telecommunications towards accelerating digital transformation as well as delivering the next generation of cloud. He highlighted that at Nokia sustainability and energy efficiency have become a key criterion of system design. Much of the future evolution is driven by the take-off of AI and machine learning, a pervasive technology enabler that will transform many business models. Mr Ziegler sketched the long innovation tradition and high ambition of Nokia Bell Labs, with a high culture of collaboration across teams at many locations across the world and in conjunction with many partners from academia, research institutions, SMEs and industry. He outlined the essential need to defend the principles of a fair, reasonable and non-discriminatory disclosure of innovation and a working patent regime, regretting that the current global situation has arrived at a point where global collaboration may be at risk. Mr Ziegler underlined the connection between digital and green innovation. As a matter of example, miniaturisation of chips, microsystems and other IT components not only increases their technical performance, but also contributes to energy efficiency gains. Other examples of combined 'green-digital' gains include predictive maintenance by connecting wind turbines, and vertical farming, where drones and interconnected sensing allow for both spatial and energy efficient management.

Questions from the audience concerned the role of standards, where Mr Ziegler hinted at the importance of global standards for interoperability and economy of scale while striking the necessary balance between the degree of standardisation vs. delaying market uptake. In the case of energy efficiency, he saw the potential for standards to play an important future role providing agreement on energy efficiency indicators and reference frameworks (device, cloud and network) and how to optimize overall consumption.

11:00-11:15 'EU innovation, corporate venturing and deep-tech potential of large firms: the 2022 EU Industrial R&D Investment Scoreboard', Alexander Tübke, JRC

Mr Tübke presented the 2022 EU Industrial R&D Investment Scoreboard and related deep-tech analyses. Since 2004, this Scoreboard has been produced every year by the JRC's Fair & Sustainable Economy Directorate working in close collaboration with DG RTD's Prosperity Directorate. Its main objective is to benchmark the performance of EU innovation-driven industries against major global counterparts, and to provide an R&D investment database that companies, investors and policymakers can use to compare company performance against leading global competitors. The 2022 edition of the Scoreboard covers the 2 500 companies that invested the largest sums in R&D worldwide in 2021. These companies – with headquarters in 41 countries and more than 900 000 subsidiaries all over the world – invested over EUR 48.5 million each in R&D.

According to Mr Tübke, the Scoreboard shows that European R&D is on the rise again, though the 8.9% increase is slower than in some other regions of the world. For the very first time since 2004, total investment across all 2 500 companies passed EUR 1 trillion, reaching EUR 1 093.9 billion – an amount equivalent to 86% of the world's business-funded R&D. The EU remains the global leader in R&D investment in the automotive sector. However, an important change in the 2022 Scoreboard is that the Chinese firms have now overtaken EU companies in terms of share of the global total (17.9% vs 17.6%). US firms, already in the lead, increased their share to 40.2% of the global total. The Scoreboard highlights that the global tech race is intensifying in the four key sectors that account for more than three quarters of the total company R&D reported: ICT producers (22.6%), health industries (21.5%), ICT services (19.8%) and automotive (13.9%). The R&D growth rates of US and Chinese companies – 16.5% and 24.9%, respectively – continued to outpace that of EU counterparts. The main reason for this is that US Scoreboard companies are leading R&D investors in the ICT (both as producers and service providers) and health sectors, while Chinese Scoreboard firms are ahead of the EU not only as ICT producers, but also in ICT services. The number of Chinese Scoreboard companies more than tripled over the past decade (from 176 in 2011 to 678 in 2021), displacing EU and Japanese firms from more traditional manufacturing sectors.

Mr Tübke informed the audience that VC investment in European companies in the EU is about one sixth of that of companies in the US. He expressed particular worry for the funding situation for scale ups in their growth phase or later phases. There is general agreement that rapidly scaling operations is harder for EU-based startups than for their counterparts located In the US or China. One cause of the European scale up gap

is the difficulty for European ventures to obtain external equity funding for the amount of EUR 100-200 million.

Regarding CVC activity in the Scoreboard, two thirds of these companies use CVC investment. These investments are increasing over the past 20 years (1 557 firms, mostly via dedicated subsidiaries). Compared to R&D, CVC is still rather modest size and but complementary to R&D, especially in ICT and health. EU-based corporates largely invest in US startups, often via subsidiaries within the EU, predominantly in the country of their headquarters, less frequent in other EU Member States. Total Scoreboard CVC investment grew steadily from USD 3.6 billion in 2013 to USD 14.5 billion in 2019, followed by a small decline in 2020 coinciding with the outbreak of the COVID-19 pandemic. An analysis of CVC flows in the Scoreboard shows that CVC by EU Scoreboard companies is just around half of that by US ones, and 80% of funds from EU-based companies go to US-based startups. Despite its increasing relevance, CVC remains small compared to other open innovation strategies available to large corporations (e.g. M&A and R&D alliances) and to internal R&D investment in terms of the amount of resources it mobilises (CVC/R&D ratio is 2.4% EU, 2.6% China and 4% US). Regression coefficients from a sectoral breakdown of the CVC-R&D relation for Scoreboard companies show an overall positive correlation and complementarity between CVC and R&D in the health and ICT sectors. The financial and automotive sectors display significantly negative elasticities, suggesting CVC used to tap into new business sectors. This would be in the strategic interest of top R&D investors looking to complement internal innovation capabilities, enlarge their product portfolio, explore new lines of business and/or counteract weaknesses in internal innovation capabilities via CVC.

The EU invests in industrial research and innovation (R&I) under Horizon Europe, including through the European Innovation Council and EU partnerships with industry. InvestEU facilitates startups and R&I financing for Small and Medium-sized Enterprises (SMEs) already on the market. National recovery and resilience plans under the NextGenEU programme also allocate significant funding to industrial R&I. The NEIA places great importance on deep-tech, which are expected to 'drive innovation across the economy and society addressing the most pressing societal challenges, including by achieving the SDGs'. Mr Tübke provided evidence from the 2019 report '[Dawn of the Deep-tech Ecosystem]' by Boston Consulting Group and Hello Tomorrow on the global deep-tech trends. He also presented the deep-tech 'conundrum' combining highest product and market risk[10].

He then showed evidence from the Scoreboard on the link between the technological and scientific outputs that fall under the deep-tech category. This involved two steps. First, linking Scoreboard companies to technological and scientific outputs relevant to SDGs; and second, selecting deep-tech outputs from among the SDG-relevant outputs of the Scoreboard companies above. With this information, a string search with all the keywords in the abstracts and project descriptions linked to SDGs 7 (affordable and clean energy) and 13 (climate control) was performed. It was possible to associate 70 Horizon 2020 (H2020) projects, 734 scientific articles and 206 patents with one or more deep-technologies. These associations are found in 234 Scoreboard companies, revealing a base of real corporate activities in deep-tech, and that technologies are not equally relevant in the exploratory dataset. For instance, cryogenics and most of the digital deep-technologies are either marginal or missing, irrespective of the type of output considered. Moreover, the relevance of deep-tech varies with the type of output. For instance, the deep-techs that are associated to numerous documents are rather evenly distributed across patents. The same is not true for H2020 projects, in which environmental monitoring technologies and local digital twins are the most represented. For scientific articles, keywords associated to deep techs water-energy nexus, sustainable buildings, and sustainable electronics are the most common.

Questions from the audience concerned how to identify deep-tech companies in large datasets, which is very challenging as datasets don't include market and technology risks as such, and how can deep-tech improve the circularity of the economy, e.g. via new materials, improving recyclability or durability. The very high number of green patents at the Chinese national patent office was raised. This situation could make green deep-tech inventions redundant if they succeed in gaining international protection. This case can however also be seen as a success for national policy incentives for green patenting.

[10] European Startups: '2021: the year of Deep Tech' report by Dealroom and Sifted, https://europeanstartups.co/reports/2021-the-year-of-deep-tech

11:30-11:45 'Trends and challenges for European deep-tech startups: the heatmap', Thomas Kösters, CEO, DEEP Ecosystems

Mr Kösters presented DEEP Ecosystems, an accelerator for the growth of regional ecosystems in the world. He presented the Start-up Heatmap Europe[11], the leading study of European startup cities published annually by DEEP Ecosystems. Mr Kösters showed how data can help understand how to improve ecosystems. DEEP has accelerated 35 ecosystem projects in its own ecosystem accelerator using the firm's hands-on know-how, international network and data. The Startup Heatmap Europe has been produced since 2016, and is one of the most established surveys among founders in Europe.

DEEP Ecosystems analysed the profiles of 24 000 founders in Europe, 5 000 or which were addressed in last year's survey and about 700 responded. In the survey, 75% of founders said they were very or extremely positive about the development of their local startup hub. The highest levels of satisfaction were found in the UK and Ireland and the least in Central Eastern Europe. Local startups have so far raised an overall amount of more than EUR 1 billion in 1 year in 12 European cities, compared with only two cities in 2014. The ranking is changeable and fluctuates year over year, but some cities, such as Barcelona, Lisbon and Tallinn, are rising in the ranking. Over the past years, the landscape in the EU has changed quite dramatically for the better, Munich being one of the hubs that has shown the highest growth across metrics.

Overall, the most successful in terms of funding raised among European ecosystems is London. When focusing specifically on the deep-tech aspect, London remains number one, but interestingly, smaller ecosystems like Zurich and Copenhagen have jumped several steps up the ranking. From a strategic point of view, the investment attitude to deep-tech seems to have improved lately. Riskier hardware investments are increasingly receiving funding whereas previously they did not. Attractive locations for deep-tech, like Düsseldorf, Cologne, Munich, Stuttgart, Lausanne, and Zurich often also host multiple corporate headquarters which serve as 'anchor' companies for deep-tech startups.

Regarding sustainability, an analysis based on data mining of social media conversations, startup event descriptions and tech blogs, has helped to identify the cities with the most ecosystem activities on innovation trends. According to this analysis, Stockholm is one of the leaders in sustainability, just behind London. Regarding female founders, only 16% of startups in Europe are led by women, the share being even lower in traditional economic centres. This gender gap may partly be due to the generally low number of female PhD graduates in STEM. Interestingly the female share is much higher in Eastern Europe than in the West, particularly in Poland and Romania, indicating a higher long-term potential in those countries. DEEP Ecosystems also observes a higher-than-expected migration from North America to Europe, indicating the very high mobility of founders.

Mr Kösters proposed making better use of opportunities to attract founders (e.g. from the Middle East, Latin America, or Africa) to Europe. Locations that attractdestination founders are not necessarily the most dynamic or fastest growing hubs, but ones that offer positive conditions such as easy access to visas and work permits, lower costs to set up a business - including affordable housing, access to accelerator know-how and universities, or access to finance. A key question is whether founders of deep-tech businesses tend to move less than their peers who have less physical infrastructure needs. There is little empirical evidence to confirm this, but it seems reasonable to believe that the decision to choose or move location is taken at the early stages of venture building. Overall, Mr Kösters reported an increase in mobility both at intranational and transnational levels, with the rate of founders moving to participate in accelerators increasing from 49% to 62% over the past years. Around 37% of all founders in Europe grew up in a different country.

The audience asked about the impact of Brexit on the ranking of hubs, which seems to have contributed to Berlin taking over from London as most popular hub in Europe. This in turn raised the question of whether infrastructure may play a more important role in the future if there is more hardware investment in startups. The discussion suggested that founders are very mobile in the early phase and that once they found the right set-up, they are likely to expand to new locations rather than moving the company away from an existing location.

[11] See www.startupheatmap.eu

11:45-12:30 'Building a green industrial ecosystem: practitioner view', Asier Rufino, CEO Tecnalia Ventures

Including 15-minute Q&A from the audience

Mr Rufino shared insights on building a green industrial ecosystem from the VC perspective. Europe's substantial scientific knowledge provides a solid base for future innovations, spurring him to successfully build technology ventures. Using Tecnalia's portfolio as an example, he explained the importance of complementary components of entrepreneurial ecosystems: minds, management, and money. While these three components are necessary, it is often challenging for them to communicate effectively.

Mr Rufino argued that the concept of technology transfer is flawed, as companies are not interested in technology as an end goal, but rather on how it generates revenue. Additionally, the idea of transfer is linear and the process is often complex. He mentioned a particular challenge for corporates: as big companies, they may have efficient scouting teams and be good as venture clients, but unfortunately, they have difficulties dealing with seed-level deep-tech.

He emphasised that deep-tech is resource-intensive and requires prioritising resources for specific projects. He noted that there is a 'valley of death' in deep-tech, with resources for research and for applied research, but little in between. Thus, there is significant potential in connecting edge research and organisations that apply that research to industrial problems. Mr Rufino provided insight from a deep-tech project, H2Site[12], that is using advanced membrane generators / separators installed into existing pipelines. It allows transporting hydrogen through natural gas pipelines, thus making existing infrastructures greener.

Questions from the audience concerned the way such deep-tech projects climb up the ladder from concept to commercialisation. He mentioned the need for vision and focus during realisation, where entrepreneurial spirit and collaboration of the right people in the right ecosystem need to come together. Mr Rufino highlighted the need for sandboxes and pilot installations in Europe as critical policy measures to ensure that projects do not get stuck or leave Europe.

12:30-12:45 'Venturing into green / digital deep-tech from within: hands-on experience from a startup', Pedro Ruão, CEO and Founder, Omniflow

Mr Ruão presented his company's sustainable smart cities solutions, focusing on their solution for street lighting. Currently, street lights have a significant carbon footprint, occupy a lot of infrastructure, and generate high costs. To address these issues, his company proposes infrastructure with multiple services in the same light posts for a modern smart city. Their mission is to reduce CO_2 emissions by incorporating solar panels and wind turbines into each infrastructure component to generate energy and light. Replacing conventional lighting by LED could already cut energy consumption by 50% to 60% but, if LEDs are combined with wind turbines, the installation would become fully autonomous with no need to be connected to the power grid, reducing energy consumption by more than 90%. So this represents a reduction in the huge energy bill of cities and big corporates, accounting for something like 35% of the electricity bill. They aim to reduce energy consumption in cities and use each post to provide alternative services, such as observing open parking slots, charging points for drones, and platforms for 5G or the internet of things. The company has over 20 patents, solid funding, and partnerships with large firms like Amazon or Orange. Mr Ruão raised the point that fundraising for hardware firms seems still much more difficult compared to software businesses, thus there is high need for deep-tech scale up capital.

Questions from the audience addressed the energy savings from off-grid systems that generates all the energy for their on-site services. Major challenges are that the company might not grow quickly enough if scale up capital is not available, and that, in litigation patent enforcement is generally much more resource-intensive for SMEs than for large firms, leaving the former in a potentially more vulnerable position.

[12] https://www.h2site.eu/en/

2.3 Roundtable discussion

14:00–15:00 Roundtable: 'Leveraging green and digital deep-tech innovation ecosystems for Europe: challenges and opportunities', Moderator: Roland Strauss, Co-founder and Managing Director, Knowledge4Innovation

The moderator, Mr Strauss, opened the roundtable discussion stressing the need for a new green industrial revolution and a new way of thinking for the green transition. He emphasised the importance of Artificial Intelligence (AI) for sustainability, but especially the need to bring together climate action, circularity, renewable energy and natural resources for a full green transition. Key for this is the development of a Pan-European innovation ecosystem that would allow any innovation actor in Europe to connect with others on subjects of common interest.

The first speaker, Ms Marie Wall (Deputy Director of the Ministry of Climate and Enterprise of Sweden), presented a government perspective on the topic. She underlined the policy challenge to ensure that deep-tech companies can successfully grow in Sweden and the EU, while readily availing of both R&D and management skills. A critical element is access to customers that can participate in co-creation through pilots and demonstrations. Ms Wall emphasised the crucial role of finance and the demand for deep-tech in Europe. She highlighted the need for changes in the European financial system, not only in VC but also in new ways of customer finance and regulations. She expressed worry that 40% of VC in Europe comes from the US, indicating that Europe needs to be more attractive for exit strategies and offer the full range of secondary markets.

Pointing out that most government measures focus on the supply side, Ms Wall insisted on the customer / demand side. Young innovative companies are born global, and Europe will lose companies that do not find customers. For deep-tech technology creation, a co-creation process is needed for system solutions that drive European deep-tech. Therefore, Ms Wall said that measures by policymakers and other actors should directly address the demand side by facilitating access for deep-tech startups to lead private sector customers, as well as deploy the full potential of public procurement. She outlined the need for a functioning finance ecosystem, with timely grants and customer financing, venture capital and financing guarantees for customer orders.

The second speaker was Mr Vlad Gliga (CEO & Founder, Rubik Hub & The Climate Vertical) who highlighted the difference in entrepreneurial mentality and culture between Europe and the US. He underlined that Europe needs a cultural shift combined with a vision to make a substantial contribution to society, to make deep-tech ventures succeed despite the many challenges. Mr Gliga also emphasised that he became more conscious of sustainability when he had children.

Prof Radziwon (University of California Berkeley and Aarhus University), highlighted the importance of stakeholder collaboration, open innovation and science. She spoke about the challenges of technology transfer between academia and industry, where patents can prevent researchers from publishing their results in journals, which are crucial for academic career evaluation. Additionally, there are few career incentives for collaboration between academics and industry, as it can take away time from research.

Ms Radziwon noted that the lack of people with deep understanding of technology in startups is an issue in industry. She suggested that making more PhD internships available in companies, like in the US system, could help lead to a change in mentality. She also pointed out that, with salaries getting lower in academia, smart people are increasingly tempted to leave academia and go to industry. Even though the research-funding infrastructure in Europe is very good, there is a need for more collaboration with industry at different career stages not only for students but also for researchers and University professors. Ms Radziwon suggested changes in evaluation parameters to place more weight on collaboration with industry and less on publications, which often have little societal impact. By doing so, researchers would become more familiar with industrial problems and improve their understanding of how research can address these problems.

Mr Ziegler (Senior Technology Adviser and Chief Architect at Nokia), reiterated the need for visionary drivers on sustainability challenges. He mentioned trustworthiness, security, digital inclusion and co-creation. He highlighted the role of Horizon Europe for research collaboration, and the fact that many large companies now actively collaborate with smaller ones to advance innovation. He stressed that the digital and green transitions will require new skills to ensure that Europe stays at the forefront of technological innovation.

Ms Meerschman (Director of Innovation at the European Chemical Industry Council), highlighted the historical importance of the chemical industry for Europe and how the digital / green transition will be the biggest transformation the industry has to go through, given its high energy intensiveness. She underlined that this cannot work without innovation and collaboration across the whole value chain, with academia, startups, and companies of different sizes. She also mentioned that while innovation is getting more open in the chemical

sector, proprietary intellectual property remains important. In terms of future challenges, she emphasised high energy costs, a lack of (digital) skills, and the need for a harmonised policy framework also in the broader field of climate neutrality, circularity, digital and data sharing.

Lastly, Ms Sassen (Head of Unit at the Programme Managers Office at the European Innovation Council and SMEs Executive Agency (EISMEA)) emphasised the importance of the European Innovation Council (EIC) to help solve the European paradox, where Europe is doing very good research but not bringing it to the market sufficiently. She highlighted that the EIC is one of the only institutions that funds R&D from TRLs 1 to 9 and that it is probably Europe's biggest deep-tech investor. The lower TRL projects are supported by grants, whereas the higher TRLs are supported by equity investments. Ms Sassen presented the Investor Days, which facilitate matchmaking, including for corporates striving to increase their corporate venturing activities, and instruments for innovation procurement. She mentioned that the researchers involved in early- stage pathfinder projects tend to prefer staying in research, even if the company aims to scale up via the accelerator instrument. She also stressed the importance of teaching researchers about licensing and that there is a lot of tech talent in the periphery of Europe with a lot of potential.

2.4 Working groups in parallel breakout sessions

15:30 – 16:30 Building possible solutions: distribution of participants (physical and remote) in four separate sessions, each addressing a key question

Session 1. How to effectively mobilise the innovation strategies of larger and smaller firms providing the green / digital solutions for our future? What is the potential for cooperation between large and small firms?

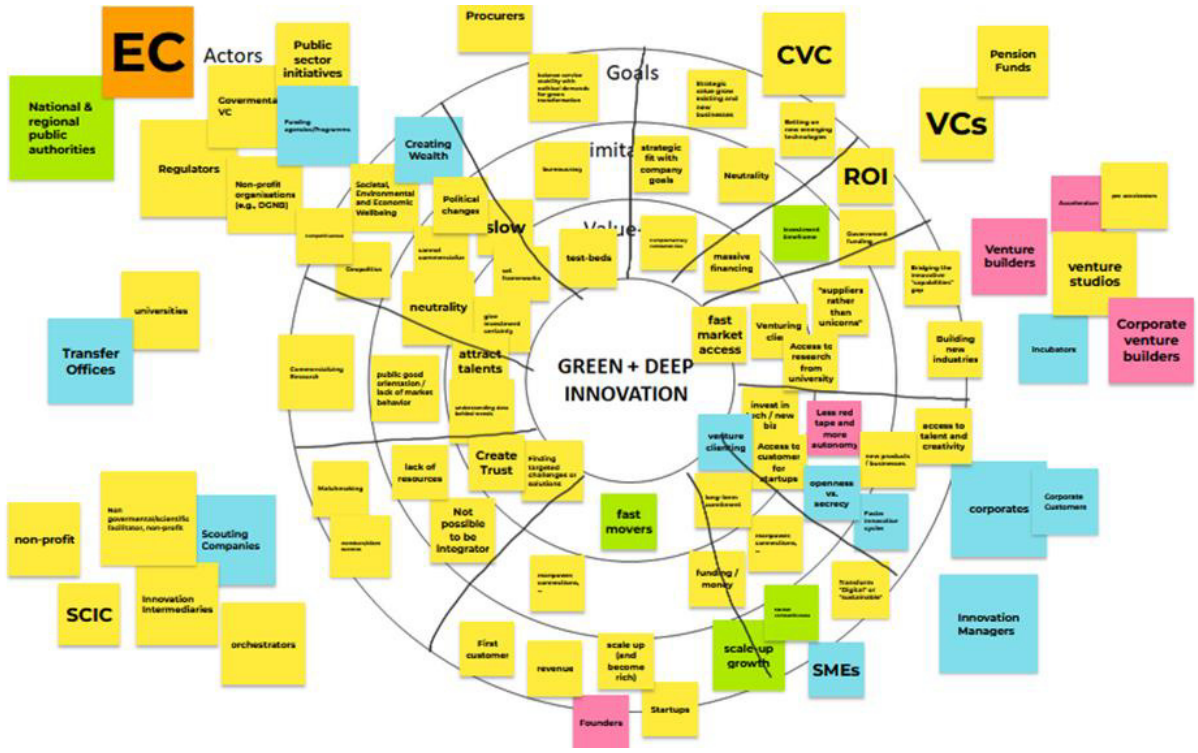
Moderator: Thomas Kösters, CEO & Co-founder DEEP Ecosystems, Facilitator: Danijel Grabovac, Siemens

This session was kicked off with a presentation by Mr Grabovac (Siemens AG Technology and Innovation Management). Mr Grabovac started by showing Siemen's investment figures for 2021 indicating EUR 4.9 billion spent on R&D, 42 500 R&D employees, and 2 520 patent applications, positioning Siemens as one of Europe's most innovative corporates. Despite these figures, he still thought startups had more budget for transformation than corporates. Given that startups also hold much of the talent he considered collaborating with them necessary to accelerate innovation for their customers. Siemens is not alone in this view. According to Capgemini, 10% of corporations sourced innovation from startups in 2020 and this figure is expected to increase to 44% by 2025. The reason for this is that working with the best technology startups enables access to innovation solutions, expands existing ones, reduces risks and achieves quick and tangible results.

Siemens has set up a three-pillar approach to Open Innovation. The first is their Research and Innovation Ecosystems (RIS). Siemens operates 16 RISs located in: Germany (5); the USA (4); the UK (2); China (2); Switzerland (1); Austria (1); and India (1). Via these, Siemens has received over 1 200 proposals for ideas, collaborations and co-creation projects. Its second pillar, set up with the Technical University (UnternehmerTUM) and the municipality of Munich – the 'Munich Urban Colab' – is a place designed for cross industry and inter-disciplinary collaboration. Its third pillar is a venture clienting scheme for technology partnerships with startups.

After Mr Grabovac's presentation, Mr Kösters moderated a two-step visual brainstorming exercise together with the working group. The objective was to create an ecosystem map depicting the actors deemed central to the mobilisation of green and deep-tech innovation from large and small firms. In the first step, participants listed all possible actors in an ecosystem, and arranged them into 10 groups ranging from government, university and tech transfer offices to non-profit intermediaries, demonstrating the complexity of the field. Figure 1 shows some actors beyond the outer edge of a spider graph. In a second step, the group explored goals, limitations and value added for each group of actors with the aim of understanding their strategic space, and potential strategic overlaps and synergies.

Figure 1: 'Post-it' sketch of ecosystem actors, roles, limitations and contribution to the ecosystem



Source: DEEP Ecosystems

In the brainstorming discussion, participants thought that corporate innovation units might make better use of the existing talent within their own workforce or that they have untapped potential for accessing pilot customers. On the flipside, corporates had a limited capacity for making growth capital available for spin-outs or for motivating their talent to become entrepreneurs. In this respect, VC firms are complementary – capable of making large financial investments in new startups without the limitations a corporate innovation team might have.

Among startups, founders are fast movers, but they lack access and financial capabilities to work directly with corporates or obtain early investment by venture capital firms. In these cases, intermediaries play an important role as 'honest brokers', creating trust between new innovators and the established business sector. In addition, 'innovation support' actors can be useful in translating new tech developments into understandable language and providing support for testing new solutions by corporates and, increasingly, SMEs. An example is plant-based proteins and meat alternatives. The first experimentation with the new technology took place in university labs and among communities of enthusiastic innovators. Trust in the technology allowed VC to invest in firms like 'Beyond Meat' and encouraged a range of corporates to enable large-scale commercialisation and market adaptation.

A final message is that actors should not try to integrate the entire innovation cycle nor 'replace' other actors for the sake of gaining control or making the process easier to handle. Rather, they ought to look for matches of value added and limitations to allow for collaboration with other actors. Not to do so would be a step backwards to a linear corporate or university-based R&D model driven and limited by the principal actor's own objectives and possibilities. Instead of rebuilding the linear R&D model using different terms like 'intrapreneurship', a true ecosystem approach allowing for collaboration in an open-ended process is advised.

Session 2. What is the breakthrough potential of green / digital deep-tech in Europe and where it is / should be focused?

Moderator: Bram Pauwels, Chief Strategy Officer, European Business and Innovation Centre Network (EBN).

The aim of this session was to tap into the collective intelligence of the group, using an anticipatory approach to assess the need for both supply and demand-side market stimulation through policy instruments. In order to assess the breakthrough potential of green / digital deep-tech in Europe from the market supply side, participants were asked to concentrate on two aspects – feasibility and impact. Feasibility is categorised by market-readiness indicators such as the availability of financial policy instruments, technological maturity, innovation ecosystem and global innovation hub characteristics and matureness, availability of talent and so forth. Impact is categorised by indicators assessing the potential for growth, the potential impact on Green Deal intermediate and long-term goals: key solutions (green hydrogen, carbon capture and storage, circular economy, electrification, energy renewables), EU market competitiveness, et cetera.

The participants assessed and forecasted the breakthrough potential of green / digital deep tech in Europe from a demand-side market perspective. Feedback was provided on feasibility and impact, with a strong focus on the potential for breakthrough commercial success.

- ⇨ User aspects were categorised by indicators such as Total Addressable Market (TAM), industry size, current R&D investment multinational corporations (industry EUR 14 000 million; energy EUR 5 500 million, mobility EUR 62 000 million), technological maturity, amount of private investments et cetera.
- ⇨ Value aspects were categorised according to the size of the problem, potential for growth/ number of users of the solution, corporate competitiveness, innovativeness (patents), impact on EU GDP, et cetera.

The moderator asking the roundtable participants to introduce themselves. Then, the participants discussed the questions raised, which can be summarised as follows:

- ⇨ The green deal is crucial for the long-term goal of having net-zero CO_2 emissions. There is a need for new technologies (e.g. carbon capture) and materials that help decarbonise the economy. Europe has the edge in some of these areas and it is important to materialise that edge for competitiveness.
- ⇨ Green and digital deep-tech can also play a crucial role in improving energy efficiency. In terms of recycling batteries, participants commented that it is important to recycle not just some of the materials inside the batteries, but the entire battery, to have a more efficient process and cut down on new materials.
- ⇨ Since green hydrogen as an energy source requires a lot of investment in infrastructure (e.g. new pipes), it is important to find ways to adapt the current infrastructure.
- ⇨ New solutions are needed to enable sharing of data between different stages of production (value chain) in different sectors.
- ⇨ It is sometimes difficult to demonstrate the value of deep-tech companies for venture capital. Green / digital deep-tech takes more time to develop and, although venture capital is interested in climate-related issues, they also want short-term revenue. Therefore, there is a need for new types of capital for this sector (blended finance solutions – public-private).
- ⇨ Another barrier is that startups in this technological area are often also more costly than other startups. It is hard to have big industry testing some pilots or as first user, and therefore there is a need for more support to scale ups.
- ⇨ In some emerging technological areas Europe is a long way from having the most patents, nor is it gaining ground. Therefore, there is a need for more R&D investment (intensity), and more R&D directed to green / digital deep-tech. We also need a better understanding of which technologies we have the edge in and where these technological capabilities.
- ⇨ Political stability is essential for the type of long-term investment that is needed. Since there are different demands, cultures and political systems in the EU, it is challenging to develop long-term core investments.
- ⇨ Red tape surrounding public investment should be taken into account – or improved.

Session 3. How to harness deep-tech stakeholder collaboration and technology transfer in innovation ecosystems? What are the best practices for collaboration among actors?

Moderator: Giancarlo Caratti, Joint Research Centre, European Commission; Facilitator: Asier Rufino, Tecnalia Ventures

Mr Caratti opened the working group session with a few observations to frame the discussion. He stressed that technology transfer in deep-tech presents several challenges due to the complex and often cutting-edge nature of the technologies involved, which can be summarised as follows.

- ⇨ Technical complexity. Deep tech often involves complex and sophisticated technologies that require a high level of technical expertise to develop, transfer and adopt. This can create barriers to technology transfer if the technical knowledge required to understand and use the technology is lacking.
- ⇨ Intellectual Property (IP) protection. IP protection is critical for deep-tech to be a commercial success, but it can also pose a challenge for technology transfer. For example, licensing agreements may be necessary to allow others to use the technology, but negotiating these agreements can be time-consuming and complex.
- ⇨ Market acceptance. Deep-tech can face challenges in gaining market acceptance due to lack of understanding or familiarity with the technology. This can be especially true for technologies that are still in the early stages of development and have not yet been widely adopted.
- ⇨ Funding. Deep-tech often requires significant funding for development and commercialisation, which can be a challenge for technology transfer. The high level of risk associated with deep-tech can make it difficult to secure investment, and funding sources may be limited.
- ⇨ Collaboration. Collaboration and partnerships are essential for successful technology transfer, but they can be challenging to set up in the deep-tech space. The specialised nature of the technology and the need for technical expertise can make it difficult to identify potential collaborators and partners.

The moderator then asked the 15 workshop participants present online and in the meeting room two questions to kick-start the interaction.

A. What are the biggest barriers to deep-tech in Europe?
B. What actions would you suggest undertaking at the EU level?

The debate that followed was very lively with several useful comments raised by participants. In summary, there was general agreement on the following observations.

- ⇨ Technology transfer in deep-tech is inherently different from mainstream technology transfer for innovation projects, and it requires a different approach. It usually takes 15 years for a deep-tech to reach the market as compared to an average 8-11 years, but the products last longer. In most cases, deep-tech starts in universities or in public research organisations. Since the incubation time is long, the universities should not spin them out too early. Deep-tech usually produces higher social benefits and requires higher public funding, as capital expenditure is much higher. Key Performance Indicators (KPIs) and Key Value Indicators (KVIs) should thus reflect their different nature with a different balance between grants, loan, equity and guarantee funds. Other challenges come from the complexity of State aid regulations and procurement rules. It was suggested that a group of potential investors could be created at EU level to look at the specific needs of deep-tech funding.
- ⇨ Collaboration and co-creation in deep-tech are essential, in particular because different specialised skills are required. Deep-tech should therefore be embedded in innovation ecosystems where these competencies are available. A suggestion for the EU was to support 'venture builders': these are new intermediary companies that take care of building a new company from scratch based on a technical innovation. A successful example is the Dutch company NLC in the field of health[13], which may be replicated in other areas such as green tech. It was also suggested that technology transfer organisations need at least three complementary figures to enable them to: i) understand science, ii) understand management and iii) understand markets. Discussions were proposed with the Erasmus+ programme to explore the possibility of offering exchange programmes between industry and universities to collaborate on deep-tech.

[13] https://nlc.health/

⇨ Deep-tech also requires technology infrastructure for testing and demonstration. Such infrastructure can also serve as a platform for collaboration, in particular between research intensive SMEs and large companies (if the mutual trust barrier can be overcome). The forthcoming EU initiative to support access and collaboration on technology infrastructure is considered very promising for deep-tech.

Session 4. What public policy instruments can incentivise and facilitate increased investment in green / digital deep-tech innovation and infrastructure (demonstrators, open innovation testbeds, incubators and accelerators)? How to better support transfer of fundamental / low TRL research results to industrial R&I?

Moderator: Evgeni Evgeniev, DG Research and Innovation, Prosperity Directorate, European Commission, Facilitator: Christian May, FlexFunction2Sustain (Open innovation test bed facility).

The moderator, Mr Evgeniev, introduced the question for this working group session referring to ERA Action 12 on accelerating the green / digital transition of Europe's key industrial ecosystems as well as increasing their resilience. Before opening the discussion, the facilitator, Mr May, described an on-going Open Innovation Test Bed (OITB) facility for thin film coatings – of relevance to established firms needing to make concrete changes to their business compatible with their green-transition aspirations.

The ensuing discussion was driven by points raised by the participants. It focused mainly on the challenges and difficulties of deep-tech startups in bringing their businesses to the level and maturity required to prove viability and further scaling thereafter. It gave rise to several suggestions on what public policy could do to facilitate things more for such high-potential deep-tech businesses.

Significant emphasis was placed on measures to help unleash the power and efficiency of private demand – especially for 'lead customers' or 'first customers' for First-Of-A-Kind (FOAK) systems that deep-tech startups aim to bring to the market. Regulatory requirements can provide potential startup customers (large and medium-sized companies and public utilities) with a strong stimulus to embrace deep-tech solutions, which aid the twin transition. Given the high levels of finance needed for deep-tech developments, fiscal / tax incentives or staged subsidies which apply to financing by lead customers for FOAK systems could be designed and made available. Government procurement can also play a similar role in cases where public authorities can be lead customers. A lot of potential exists for improving these and other types of incentives by making measures taken at different governance levels more consistent and compatible with each other, and better still, mutually reinforcing. The current unfavourable situation in the EU in this regard, has to be seen in a context where footloose startups may leave Europe to benefit from attractive conditions offered elsewhere such as by the Inflation Reduction Act in the US.

A number of participants from Germany-based deep-tech startups commented that, while they wished to stay located in the EU, they received a lot of professional advice recommending moves to either the UK or the US to take advantage of better financing conditions and deal sizes. It was also stated that, while deep-tech startups are born with global reach and ambition, they tend ultimately to locate close to their most friendly/ lead customers and where the relevant infrastructure and favourable framework conditions are found. EU-level grant and equity financing schemes were deemed to be very complicated and to have too long lead times for startups from initial application to actual receipt (anything over 6-9 months was deemed too long and incompatible with planning demands). Participants pointed out that the decade-long investment required for deep-tech developments gives rise to three challenges, which have an effect on investor confidence, required to raise and allocate large amounts of capital. Among the start-ups mentioned in the discussion was one working on Long-Duration Energy Storage (LDES) solutions to decarbonise the electricity grid and another working on fusion energy.

The working group pointed out the following challenges:

A. The first step to scaling. Finance for FOAK demonstrators is hard to find because they are expensive; early-stage customers are risk-averse and; startups lack working capital.
B. How to scale up? It is difficult to scale production and lower costs in initial deployments. Who pays for the first 100 MW of scaling?
C. How to embed in the market? The future market landscape is uncertain; future market reforms could impact LDES revenue streams.

The following sets out elements of potential policy responses to these challenges.

A. Regarding the first step to scaling:

- ⇨ Increasing tax benefits for customers of deep-tech startups. This would make it economically attractive for businesses to buy FOAK systems and compensate for technological risk. This way, when customer demand becomes apparent, startups would not face additional grant proposal and application hurdles. This could provide deep-tech startups with straightforward access to the working capital needed to build FOAKs. It could take the form of a tax exemption for the customer on twice the cost of the FOAK as a deductible from corporate taxable income. In addition, a 50-70% subsidy could be justified as FOAK systems are often twice as costly as the second or third systems that are built aferwards. An advantage of these measures is that they would help to attract innovators and early adopters to procure FOAK systems, by making them affordable while sending a positive signal to investors and permitting the startup to charge the full price.
- ⇨ European Investment Bank (EIB) loans to the startup to pre-finance FOAK systems. These would help to unlock scaling and widen deployment of twin-transition-promoting deep-tech such as LDES.
- ⇨ Mandating procurement of FOAK systems by public utilities, which can take on more risk than private customers.
- ⇨ Fostering direct customer relationships, similar to how the European Space Agency (ESA) procures from rocket startups. The EU could be a lead customer for FOAK systems or alternatively could guarantee a purchase option of FOAK systems from corporates after 3 years in order to de-risk their development.

B. Regarding how to scale up (case of LDES):

- ⇨ Staged subsidies. A tiered subsidy scheme for energy storage manufacturers based on the idea that the first 100 MW of each manufacturers' production would attract a 50% subsidy for the customers of the given manufacturer, 101 MW-1GW would attract a 30% subsidy, and anything over 1GW would attract a 25% subsidy permanently, to be competitive with the US Inflation Reduction Act[14]. This should boost European industry by incentivising storage manufacturers to scale their production to become more cost-effective. The scaling steps to 100 MW and to 1 GW would be 'by company' so that every new and innovative European industry player would be supported in ramping up production. Significant shares of production could then be required to be located in Europe, connecting this ramp up stage with the prior FOAK stage.
- ⇨ Provide easy access to significant funds to set up production lines in Europe through the EIB.
- ⇨ Provide low-effort / easy access grants to startups to set up production in Europe.
- ⇨ Mandate public utilities to increasingly use storage.

C. Regarding how to embed this in the market (case of LDES):

- ⇨ Mandate ambitious LDES targets at both European and national levels.
- ⇨ Provide subsidies for LDES rollout, as described above.
- ⇨ Implement EU-level strategy to send long-term signals to investors.
- ⇨ Energy storage as fourth pillar of the energy system – legally classify energy storage as a separate asset class rather than as generation/consumption.
- ⇨ Prohibit double taxation, non-cost-reflective grid fees and discriminatory permitting procedures.
- ⇨ Dedicated tenders and support schemes (storage-only auctions, Contracts for Difference (CfDs)).
- ⇨ Enable additional financing aid, as in Spain, by creating a capacity market.
- ⇨ Limit permission time in the different countries for grid connection of and in general energy storage projects to maximum six months.

Figure 2 summarises the challenges and recommendations shared by the working group.

[14] This would be similar to the electric vehicle credit in the US, where, for every 100 000 cars sold by a given manufacturer, the tax credit is reduced.

Figure 2: Factors and policy incentives for the discussion of fostering public policies

Source: own compilation

3 Conclusions

16:30 – 17:15 Seven-minute summary from each working group

Draft summary statement and moderator: Prof. Hanna Hottenrott, Professorship Economics of Innovation, TUM School of Management

Including 15-minute Q&A from the audience

Mr Kösters summarised working group 1 on the effective mobilisation of the innovation strategies of larger and smaller firms and the potential for cooperation between them. He described the spider graph (see Figure 1 above), which identifies the actors and motivations needed to leverage these large and small firms' innovations. Government actors were identified as key in deep-tech, especially regarding their role in bringing all the necessary stakeholders together, ensure knowledge transfer and provide stability. Due to the huge investment needs, collaboration between governments and private venture capital is crucial. Another aspect is that SMEs) might have different needs and motives to large multinationals, e.g. more limitations in terms of financing and workforce but also more agile decision-making.

Mr Pauwels summarised working group 2 on the breakthrough potential of green / digital deep-tech in Europe and where it is / should be focused. The water sector was mentioned in terms of water loss, where more research is needed and there are major investment issues. The US act pushing green, digital and electric R&D investments was mentioned, and the need for EU policy governance to ensure projects here go forwards. The group raised the recycling of batteries, which might provide a solution to materials shortages if the conditions for the sale of the recycled materials provide the right incentive. Regarding the chemicals industry, the group addressed the sharing of data among suppliers in different phases of the innovation value chain. For example, the energy used by different chemical plants can already be shared with R&D departments. Regarding hydrogen, industry in Germany, for example, could provide both investment and more widespread first use. Regarding markets for breakthrough solutions, startups are partnering up with corporates to allow for more testing within the same environment and also using the testing facilities within corporates, not just financial support.

Mr Caratti summarised working group 3 on deep-tech stakeholder collaboration and technology transfer in innovation ecosystems and their best practices. He underlined the importance of the deep-tech long-term timeframe (usually over a decade) in combination with the huge investment needs (e.g. around EUR 100 million) and very strong potential to serve societal needs. This is in contrast to digital platform startups, for example, with a much shorter time horizon and high market growth expectations. Deep-tech startups thus require investors who understand science and have a long-term view, with the financial stability to take on the risks. Another important element is to foster the managerial competencies of deep-tech startups, where technology transfer offices can make a big difference. Then, the difference between Europe and the US regarding university-industry collaboration was outlined. Programmes like Erasmus+ could further foster such collaboration, but other instruments might be necessary to better connect universities with industry in Europe, across the Member States. A final point was the need to create suitable KPIs especially for the sustainability and societal impact of deep-tech startups. Finally, the key element of access to infrastructure was mentioned. The audience raised the example of Sweden, where studies are being conducted into how to have access to research infrastructure at marginal costs, to enable deep-tech startups and SMEs for example.

Mr Evgeniev summarised working group 4 on public policy instruments for facilitating increased investment in green / digital deep-tech innovation and how to support the transfer of fundamental / low TRL research results to industrial R&I. The group discussed the case study of an open innovation testbed illustrating how the ecosystem with startups and SMEs was built. First, the US (Inflation Reduction Act), the UK and the EU (Green Deal Industrial Plan) all offer financial benefits for potential green deep-tech startups that are relevant for the up to EUR 200 million needed per project in Europe. The EU Green Deal Industrial Plan, the Net-Zero Industry Act, and the Critical Raw Materials plan identify target technologies that are prioritised. This is complemented by EIC and Horizon Europe funding, but these do not target startups and need at least 6 months until funding decisions can be expected. The group discussed test beds in the EU as ways to bring academia, Research & Technology Organisations (RTOs) and companies to a single entry point offering easy access to users. This single entry point concept could be transferred to other areas where stakeholder collaboration is critical. Another point raised were tax incentives, which are rather standard instruments (tax credits and government targeted subsidies for deep-tech solutions) especially for deep and breakthrough technologies, which should be fostered. Also, there is the need for a European capital market for exit, and matchmaking funds to bring large and small companies together, possibly linked to EIB financing to bridge gaps. Finally, governments could more frequently be the first big customers of deep-tech companies to help them establish a customer base and revenues, which would in turn help them to get private venture capital on board.

Prof Hottenrott then gave a final summary statement, outlining the three main elements (finance / investment, infrastructure and exit opportunities), and the role of the ecosystems in bringing the stakeholders together.

The audience raised the topic of the persistence of founders, the need for European Business Angels and family offices, and the role of public actors in building trust. Also, speed was mentioned as a critical factor regarding innovation investment decisions, where investees from English-speaking countries are often leading, evidenced by them funding the majority of EU-based scale ups. Simplified access to public funding with existing instruments and efficient design of new instruments would also help to speed up access to funding. Finally, audience members mentioned willingness to take risks and fail as a necessary part of developing entrepreneurial spirit. This applies not just to entrepreneurs themselves but potentially all actors in the ecosystem. It also links to the point of VC-related training and setting up and running professionally from the beginning. Increasing the pool of professionals goes hand in hand with the need to change the cultural mind-set, starting from university students up to the highest levels of decision-making in industry and public authorities.

17:15-17:30 Closing remarks and next steps by the organiser

The organisers provided final remarks and observations and thanked the audience. As a next step, the Commission team has prepared this summary report[15]. The Commission will also take into account the insights and opinion shared during the event when preparing the 20th jubilee edition of the EU Industrial R&D Investment Scoreboard to be issued in December 2023. Finally, the input from the event will be further discussed in follow-up policy forums under ERA Action 12 that relate to activity 12.3 'Develop a robust policy framework to better support industrial R&I from fundamental / low TRLs research at national and European levels to generate breakthrough knowledge and innovation for greener future industries'.

[15] https://iri.jrc.ec.europa.eu/events/workshop-leveraging-deep-tech-green-transition-and-digital-solutions-transform-eu-industrial

List of abbreviations and acronyms

Artificial Intelligence (AI)
Chief Executive Officer (CEO)
Corporate Venture Capital (CVC)
EU Industrial R&D Investment Scoreboard (Scoreboard)
European Centre for Algorithmic Transparency (ECAT)
European Commission (EC)
European Commission, Directorate-General for Research and Innovation (DG RTD)
European Commission, Joint Research Centre (JRC)
European Innovation Council (EIC)
European Innovation Council (EIC)
European Innovation Council and SMEs Executive Agency (EISMEA)
European Investment Bank (EIB)
European Research Area (ERA)
European Space Agency (ESA)
European Union (EU)
First-Of-A-Kind (FOAK)
Gross Domestic Product (GDP)
Gross Expenditure on R&D (GERD)
Horizon 2020 (H2020), now Horizon Europe (HE)
Information and Communication Technology (ICT)
Intellectual Property (IP)
Key Performance Indicators (KPIs)
Key Value Indicators (KVIs)
Long-Duration Energy Storage (LDES)
Mergers & Acquisitions (M&A)
New European Innovation Agenda (NEIA)
Open Innovation Test Bed (OITB)
Open Strategic Autonomy (OSA)
Public Private Partnership (PPP)
Research & Development (R&D)
Research & Innovation (R&I)
Research and Innovation Ecosystems (RIS)
Research and Technology Organisation (RTO)
Research and Technology Organisations (RTOs)
Small and Medium-sized Enterprises (SMEs)
Smart Network Services Joint Undertaking (SNS)
Technology Readiness Level (TRL)
Technology Transfer Organisation (TTO)
Total Addressable Market (TAM)
United Kingdom (UK)
United States of America (US)

List of figures

Annexes

Annex 1. Workshop Agenda

LEVERAGING DEEP-TECH GREEN TRANSITION AND DIGITAL SOLUTIONS TO TRANSFORM EU INDUSTRIAL ECOSYSTEMS

- 27 March 2023 Technical University of Munich, Munich or online

9:30-10:00	**Arrival** of participants
10:00-10:30	**Welcome**, **Peter Dröll**, Director for 'Prosperity', European Commission DG Research & Innovation
	Aims of this workshop, **Mikel Landabaso**, Director for a 'Fair & Sustainable Economy', Joint Research Centre
10:30 – 10:45	**'The potential of green / digital deep-tech and startups for leveraging innovation and industrial ecosystems'**, **Prof Dr Helmut Schönenberger**, CEO UnternehmerTUM
10:45 – 11:00	**'Green and digital deep-tech innovation and industrial ecosystems: What's at stake?'**, **Dr Volker Ziegler**, Senior Technology Adviser, Chief Architect, Nokia
11:00 – 11:15	**'EU innovation, corporate venturing and deep-tech potential of large firms: the 2022 EU Industrial R&D Investment Scoreboard'**, **Alexander Tübke**, Joint Research Centre, European Commission
11:15-11:30	**Coffee break**
11:30-11:45	**'Trends and challenges for European deep-tech startups: the heatmap', Thomas Kösters**, CEO, DEEP Ecosystems
11:45-12:30	**'Building a green industrial ecosystem: practitioner view'**, **Asier Rufino**, CEO Tecnalia Ventures
	Including 15 mins Q&A from the audience
12:30-12:45	**'Venturing into green / digital deep-tech from within: hands-on experience from a startup'**, **Pedro Ruão**, CEO and Founder, Omniflow
12:45-14:00	**Lunch break**
14:00–15:00	**Roundtable discussion: 'Leveraging green and digital deep-tech innovation ecosystems for Europe: challenges and opportunities'**, **Moderator: Dr Roland Strauss**, Co-founder and Managing Director, Knowledge4Innovation
	Roundtable members:
	Marie Wall, Deputy Director, Ministry of Climate and Enterprise of Sweden Anne-Marie Sassen, Head of Unit, Programme Managers Office, EISMEA Vlad Gliga, CEO & Founder, Rubik Hub & The Climate Vertical Agnieszka Radziwon, Professor, University of California Berkeley and Aarhus University Volker Ziegler, Senior Technology Adviser, Chief Architect, Nokia Annick Meerschman, Director Innovation, CEFIC

Questions to be addressed

1. *How to effectively mobilise the innovation strategies of larger and smaller firms providing the green / digital solutions for our future? What is the potential for cooperation between large and small firms?*
2. *What is the breakthrough potential of green / digital deep-tech in Europe and where it is/should be focused?*
3. *How to harness deep-tech stakeholder collaboration and technology transfer in innovation ecosystems? What are the best practices for collaboration among actors?*
4. *What public policy instruments can facilitate increased investment in green / digital deep-tech innovation and infrastructure (demonstrators, open innovation testbeds, incubators and accelerators)? How to better support transfer of fundamental / low TRL research results to industrial R&I?*

15:00 – 15:30 **Coffee break**

15:30 – 16:30 **Building possible solutions**: Separation of participants (physical and virtual) into **four moderated groups**.

Groups by question to be addressed

1. How to effectively mobilise the innovation strategies of larger and smaller firms providing the green / digital solutions for our future? What is the potential for cooperation between large and small firms? **Moderator: Thomas Kösters**, CEO & Co-founder DEEP Ecosystems, **Facilitator: Danijel Grabovac**, Siemens

2. What is the breakthrough potential of green / digital deep-tech in Europe and where it is/should be focused? **Moderator: Bram Pauwels**, Chief Strategy Officer, European Business and Innovation Centre Network (EBN).

3. How to harness deep-tech stakeholder collaboration and technology transfer in innovation ecosystems? What are the best practices for collaboration among actors? **Moderator: Giancarlo Caratti**, Joint Research Centre, **Facilitator: Asier Rufino**, Tecnalia Ventures.

4. What public policy instruments can incentivise and facilitate increased investment in green / digital deep-tech innovation and infrastructure (demonstrators, open innovation testbeds, incubators and accelerators)? How to better support transfer of fundamental / low TRL research results to industrial R&I? **Moderator: Evgeni Evgeniev**, DG Research and Innovation, Prosperity Directorate, European Commission; **Facilitator: Christian May**, FlexFunction2Sustain – Open Innovation Test Bed facility.

Possible topics to address: the potential impact of R&D or startup investments for the Green Deal, thematic R&D gaps, new policy needs from deep-tech, ways to provide policy synergies and increase stakeholder interaction, or practical adjustments in innovation management.

16:30 – 17:15 **Seven-minute summary from each working group**

Draft summary statement and moderator: Prof. Hanna Hottenrott, Professorship Economics of Innovation, TUM School of Management

Including 15-minute Q&A from the audience

17:15-17:30 **Closing remarks and next steps by the organisers**

Annex 2: Broader Policy Context

EU industrial and innovation policies provide incentives to become more competitive, retain home-grown technologies and firms, and facilitate growth of emerging – particularly green and/or digital - sectors of activity. This includes policies for transforming 'traditional' manufacturing sectors, support startups and scale ups, and increasing industrial capacities where most added value in value chains is produced.

Examples

- The New European Innovation Agenda (NEIA), among others, addresses firm creation and growth in deep-technologies to trigger spill overs between sectors with support from the European Innovation Council (EIC). A flagship initiative of the NEIA aims to strengthen innovation ecosystems across the EU, while another targets improvement of policy tools and interactions between stakeholders.

- Action 12 of the European Research Area (ERA) policy agenda targets support for accelerating the green and digital transitions in Europe's key industrial ecosystems[16]. It has as a strategic focus on the role of industry and industrial R&I for the twin transitions and increased resilience. The implementation is structured in four 'activities': industrial technology roadmaps (12.1), technology infrastructure (12.2), policy framework for transfer of fundamental research results to industrial R&I (12.3), and social adaptation of the green/digital transitions (12.4). The action further calls for:

    a) a consultation process on the R&I related needs of industry, and
    b) the development of a policy approach to link industrial and R&I policies.

- ERA Action 12 links the industrial technology roadmaps to national strategies and industry's need for access to technology infrastructure and services. It can serve as a contribution to the Green Deal Industrial Plan[17]. Implementation of the action started in 2021 with the preparation of the two industrial technology roadmaps and with calls for Horizon actions to support a European strategy for technology infrastructure. In 2023, implementation is planned in the form of thematic workshops, conferences, meetings and reporting to the ERA Forum in March, September and October.

[16] 22 Member States, 3 Associated Countries and 7 key stakeholder organisations joined this action in mid-2022. Activity 12.3 of ERA Action 12 aims to address stocktaking, forecasting and roadmapping of key technologies of the future, with a specific focus on digital and green aspects, with input from stakeholders.

[17] The Green Deal Industrial Plan intends to enhance the competitiveness of Europe's net-zero industry via a fast transition to climate neutrality and the scaling up of the EU's manufacturing capacity for net-zero technologies. It is based on four pillars: a predictable and simplified regulatory environment, speeding up access to finance, enhancing skills, and open trade for resilient supply chains.

Annex 3: Additional Research Evidence

As part of the evidence base underpinning policy, the European Commission benchmarks EU companies against their global competitors and monitors trends via the annual EU Industrial R&D Investment Scoreboard[18]. It is based on the latest audited accounts of the world's top 2 500 R&D investors, including the EU-based top 1000[19]. The 2022 Scoreboard published in December shows that EU investment in research & development (R&D) rebounded after a COVID-induced dip. Europe's industry is back on track in terms of R&D investment, with an 8.9% increase in 2021 compared to the -2.2 % pandemic-related dip in 2020. The EU remains the global leader in R&D investment in the automotive sector, where the transition towards electric vehicles and digitalisation is fully underway in both established companies and younger firms. The Scoreboard also shows a broad sectoral diversification for the EU, especially compared to the US where R&D investment is highly concentrated in information and communication technologies (ICTs).

The Scoreboard highlights the intensification of the global tech race in the four key sectors which account for more than three quarters of total reported company R&D: ICT producers (22.6%), health industries (21.5%), ICT services (19.8%) and automotive (13.9%).

The R&D growth rates of 16.5% and 24.9%, respectively, US and Chinese companies continued to outpace their EU counterparts. US Scoreboard companies are leading R&D investors in ICTs (both as producers and service providers) and the health sector, while Chinese Scoreboard firms are ahead of the EU not only as ICT producers, but also in ICT services. The number of Chinese Scoreboard companies more than tripled over the past decade (from 176 in 2011 to 678 in 2021) and their R&D investment share surpassed that of the EU for the first time (17.9% vs 17.6%, respectively), displacing EU and Japanese firms from more traditional manufacturing sectors. The leading share of US firms increased to 40.2% of the global total.

DEEP ECOSYSTEMS aggregates information and insights from local sources with global trend data. The Startup Heatmap Europe is its most visible outlet, and the DEEP Ecosystem Conference brings together ecosystem leaders globally to unearth local insights and jointly identify strategies to adapt to global trends. The development of new ecosystem initiatives is supported in the accelerator programme. The DEEP Community spans more than20 countries and more than 250 ecosystem builder organisations. Currently, DEEP is involved in the build-up of over 30 innovation hubs across the world ranging from the HR Valley in Zurich to the City of Sapporo's international startup hub.

[18] The Global Industrial Research & Innovation Analyses (GLORIA) project is jointly carried out by the European Commission's Joint Research Centre —Directorate B, Innovation and Growth— and the Directorate General for Research and Innovation (R&I) — Directorate E, Prosperity.

[19] The world's top 2500 Scoreboard companies, with headquarters in 41 countries and more than one million subsidiaries all over the world, each invested over EUR 48.5 million in R&D in 2021, and the EU-1000 firms EUR 3.1 million, respectively.

Annex 4: Deriving Science to Policy Questions

Firstly, growing and retaining home-grown firms in line with EU policy objectives, and establishing spill overs, would have the effect of reducing the R&D investment and R&D intensity gaps between the EU and its main competitors, and increase Europe's technological sovereignty and strategic autonomy. Although top R&D investors and other large players have a key role in R&I investment worldwide due to their size and centrality, radical and game-changing green and digital innovations often come from young and innovative companies that have been able to grow and scale up quickly. As a relatively new aspect of corporate innovation strategies, corporate venture capital (CVC) has been analysed. It is used by two thirds of Scoreboard companies and has increased over the past 20 years, with a positive correlation and complementarity between R&D and CVC especially in ICTs and health. CVC by EU Scoreboard companies is just around half of that by US ones, and 80% of funds from EU-based companies go to US-based startups. The first question is how to effectively mobilise the innovation strategies of larger and smaller firms providing the green solutions for our future.

Secondly, Scoreboard companies are also central in developing breakthrough technological and scientific solutions to tackle the Societal Development Goals (SDGs). Patenting linked to climate action (SDG 13) is concentrated in technologies related to energy storage, decarbonisation, and materials for low-power electronics, also relevant to clean and affordable energy (SDG 7). In contrast, scientific research relevant to SDG 7 is concentrated in relatively few technologies, while scientific research linked to SDG 13 is spread across a much wider range of fields. This is another indicator of the potential for breakthrough technologies, to help achieve green and energy policy goals as well as SDG targets. The EU has an existing base of smaller firms in key industrial ecosystems across Member States and excellent technology capacities. The second question is about the breakthrough potential of green deep-tech in Europe and where it is/should be focused.

Thirdly, innovation ecosystems are where it's happening, linking key stakeholders at global and local level. Global lead companies, such as those in the Scoreboard, play a key role in vitalising innovation ecosystems given their large (direct and indirect) market and innovation power, and an as entry point towards regional and local upgrading via collaboration and internationalisation. The presence of such large companies or their subsidiaries in regional innovation ecosystems could leverage the New Innovation Agenda's connected regional innovation valleys or other territorial policies by the Commission[20]. By better understanding the distribution of technology development efforts across actors and places in the EU, efforts could be better coordinated and diffusion of solutions facilitated[21]. The third question is about harnessing deep-tech stakeholder collaboration and technology transfer in innovation ecosystems.

Fourthly, the policy mix across all governance levels together with access to deep-tech infrastructure comes into play. Easy access to state-of-the-art innovation actors and technology infrastructure (demonstrators, open innovation testbeds, incubators and accelerators) is a main enabler of innovation at local level, and even more so of new breakthrough technologies such as deep-tech[22]. Research and technology organisations (RTOs) can promote the links between actors and facilitate access to shared research capacities. In the context of implementing the above ERA action 12 policy agenda, this produces the fourth question about what public policy instruments can incentivise and facilitate increased investment in green / digital deep-tech innovation and infrastructure (demonstrators, open innovation testbeds, incubators and accelerators). It will also build on the critical question of how to better support transfer of fundamental / low TRL research results to industrial R&I.

[20] The Partnerships for Regional Innovation (PRIs) enhance the coordination and directionality of regional, national and EU innovation policies, bringing the above aspects into policy implementation.

[21] Diodato D., Moncada-Paternò-Castello P., Rentocchini F., Tübke A. (2022) 'Industrial innovation for sustainable competitiveness: Science-for-policy insights'. Science for Policy Brief – Industrial Innovation & Dynamics Series. No. JRC128430. European Commission, Joint Research Centre – Directorate for Growth and Innovation, Seville (Spain), February 2022

[22] Viscido, S., Taucer, F., Grande, S. and Jenet, A., Towards the Implementation of an EU Strategy for Technology Infrastructures, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-46490-7, doi:10.2760/4834, JRC128007

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

— by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

— at the following standard number: +32 22999696,

— via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

Open data from the EU

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society

EU Science Hub
joint-research-centre.ec.europa.eu

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

@eu_science