ERT

Innovation made in Europe

Setting the foundation for future competitiveness

“If I had asked the public what they wanted, they would have said a faster horse.“

Henry Ford, Founder of Ford Motor Company

“Innovation distinguishes between a leader and a follower”

Steve Jobs, Entrepreneur

“Innovate, or be history!”

Dr Sara Mazur, Scientist

“If I have a thousand ideas and only one turns out to be good, I am satisfied.”

Alfred Nobel, Chemist, Engineer & Inventor

“If at first the idea is not absurd, then there is no hope for it.”

Albert Einstein, Mathematician

“Never tell people how to do things. Tell them what to do and they will surprise you with their ingenuity.”

General George Patton

“The present is theirs; the future, for which I really worked, is mine.”

Nikola Tesla, Inventor

“The value of an idea lies in the using of it.”

Thomas Edison, Inventor

“Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less.”

Marie Curie, Physicist, Chemist & Radioactive Science pioneer

Introduction

Dr Martin Brudermüller

CEO of BASF SE of Chair of ERT's Committee on Competitiveness & Innovation

Dr Lars Frolund

Deep Tech expert at MIT and Member of the Board of Directors of the European Innovation Council

Ludwigshafen in January, on the BASF Werksgelände, a mid-sized town of its own with a 158-year history of innovation in the chemicals sector.

We met to record an episode of ERT's podcast *21st Century Industrialists*. The guests are Dr Lars Frolund and Dr Martin Brudermüller. The topic is 'Innovation made in Europe'.

It is a fascinating conversation, and there is no better opener to this ERT Flagship Paper.

We start with a basic question: **How has their career shaped their view on innovation?** With Lars, it was an early fascination on how we as human beings and as organisations can accept the "crazy" things that push the boundaries and that "we have to appreciate to really move the world forward". Martin was nurtured in scientific curiosity from childhood and studied chemistry, but when he joined BASF (in 1988), he realised that "it is good to have an idea and to be academic, but at the very end, it is about making money and bringing prosperity to people".

How do they feel about innovation – and especially European innovation today? Both are very candid, even emotional. Martin points to his own experience in China (2006–2015) and recalls the dynamism with which China has built its innovation and scale-up capabilities. Looking at Europe, his "heart is bleeding to see that we have given up that leading position" and he is driven by the question of how we can bring back this "innovation spirit and hunger to try new things". Lars was struck by the "different type of mental bandwidth" he experienced at MIT – and "the courage to have ambition" – which for him was an eye-opener.

Circling in on the European situation, what stands out? Both Martin and Lars agree – Europe is still strong in general basic research and scientific leadership – as Martin puts it, "here the European community has probably done its best job". But we are "coming down to mediocrity when it comes to getting innovations to the market". And Lars adds that "there are still too many companies that have the right potential to get into the market, but when they actually want to grow, they suddenly move to the US and become a Delaware company".

So why is that? Lars sees a main issue in Europe's lack of the right vehicles to enable start-ups to grow – Europe has a lot of wealth, but "we don't have the right [risk] capital". For Martin, the main factors holding back companies are the European way of "regulating everything" and that we do not use our Single Market in a way that allows faster scale-up and "generates the revenues to stay in the game".

What can Europe do to ramp up innovation?

One answer is to facilitate collaboration. Lars puts forward the idea of an "internal market for research infrastructure" to provide start-ups with access to advanced laboratories of both research institutions and corporations. Martin agrees and emphasises that even a company like BASF would "not survive with its own research only – it is all about collaboration … and cooperation is the art of innovation looking forward." He is concerned, though, that Europeans are still "too egoistic" to leverage the power of collaboration. Lars points to another challenge: "getting from a start-up's idea to impact" – i.e. how to get start-ups "to work with some of Europe's large corporations that have infrastructure and production capacity".

Another proposal is to create markets for innovation. For Lars it is important to set strong demand signals where you "stop buying the cheapest thing and start buying the best thing" – with a procurement system that does not predefine the solution already, but defines the problem – so that start-ups can develop solutions that find a market.

But is there a pre-condition for Europe's re-bound on innovation? For Martin, it is obvious that Europe has to "innovate regulation". This is a huge challenge as "in Europe, we want to regulate everything in detail. We generate a regulatory framework to enforce the transformation" of our industry. But it does not have to be like this. The US – most recently with the Inflation Reduction Act – "generate a business case to facilitate transformation". Europe could also learn how to regulate markets in a way that new products can flourish. But for now we seem to be stuck with an approach to regulating everything in detail although it is "holding back the whole ecosystem" – start-ups, academia and even big companies like BASF.

Is Europe capable of that? Maybe – both are a bit more hesitant. Martin points out that during the COVID-19 pandemic when European companies developed vaccines at record speed, we managed to break that pattern – "everyone asked 'what is my contribution to make it happen?'. We need to make this the normal spirit in Europe".

Why is an innovation re-bound so important? Both agree that innovation underpins that, if Europe's economic competitiveness. And that if we lose competitiveness, we will enter a downward spiral. As Martin puts it: "if you are struggling to be competitive, you also start saving on innovation and research. So that comes all together". Or you shift innovation and production abroad because "Europe is not the best place anymore". And that is why, when we "talk here about R&D, we have to talk about the overall competitiveness of Europe."

For Lars, bringing deep tech innovation to the market also means building production – and therefore new employment. Nurturing and scaling up deep tech innovation is therefore "a way to also create a sounder welfare state and better societies". Martin agrees – we are increasingly living in a high-cost environment – and we are more and more in need of a high share of very productive high margin business. This is "crucial for the survival of Europe and our level of wealth" because if we "only stay with the old products, we don't have the space to finance all the social ambitions we have as a society". And as Lars brings it to the point, today "innovation matters in a totally different way for societies".

Is Europe experiencing a catharsis moment? We could have reached that point. Martin in any case hopes so – because since the Lisbon process, we are aiming but "failing to become the world's most innovative region". And it is "almost programmed that we will fail again in the future if we don't focus" and if we don't "question many things that may have been right in the past, but that will do not do the job going forward".

Lars feels cautiously optimistic as "people talk again" about the "levers which you need to keep the industrial base of Europe competitive". To be in "more economically difficult times is a healthy part of a long-term societal development". We are at that point – and Lars does not "give the race lost … but a lot of painful things have to be done".

If we had to bring it down to one message – what would it be? For Martin, our choice is to "innovate or be history[1]". Lars brings it down to "stop competing not to lose but start competing to win. And if we can get that mentality going then we are there."

In our podcast Lars and Martin touch on many more aspects of innovation, spanning from pirate ships to innovation theatres to the nature of deep tech to pension funds.

We won't give away more, but we urge you to listen to the episode and hope you'll enjoy the ride.

ert.eu/podcast

1 Quoting Swedish physicist Sara Mazur

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Executive Summary

Rarely before has innovation been so important.

Europe's competitiveness has been on a downslide for quite a while. The reasons are largely home-made[1]. Now additional pressures arise from renewed geopolitical uncertainty, the energy market implications of Russia's war in Ukraine and the attraction of business to the US as a result of the US Inflation Reduction Act.

ERT has mapped Europe's global industrial competitiveness and made policy suggestions in our latest Benchmarking Report. This flagship paper sets out ERT Members' views on where Europe can and has to do better to remain an innovative powerhouse, a leading industrial base and a prosperous continent.

Our paper contributes five core observations and three priority policy messages. We have also collected 34 Innovation Stories as told by our Members – ten are included in this report, and all can be accessed on our website[2].

Five observations on Europe's status-quo in innovation

First, compared to our global peers and competitors, Europe's investment in R&D is relatively low. With a few exceptions, we are far behind in the tech race in the ICT area, and this endangers Europe's position in the next industrial revolution (i.e. Industry 4.0). An underlying cause is that in Europe's regulatory system, transformation is steered by regulation, rather than encouraged by incentives and business opportunities.

Second, with tools such as Horizon Europe and IPCEIs, Europe has a very elaborate innovation support system in place. It still has significant untapped potential which can be realised by scaling up scope and funding, and improving efficiency and impact. Simplification of bureaucracy and easier access to funding and common projects would be key.

Third, in the European R&D mix experimental development – which is 'high-risk, high-return' – plays a much smaller role than for other innovation leaders, such as Israel, South Korea, the US – and also China.

Fourth, our global peers and competitors take a strategic approach to creating synergies that stimulate innovation. This includes programmes enabling civilian and military research cooperation or specially designed ecosystems for product development.

Fifth, innovation increasingly builds on collaboration – whether cross-sectoral or between different types and sizes of companies. This makes triggering innovation even more complex. It also implies that current and future innovation support systems need to cater for a very diverse and interlinked ecosystem.

Three priority policy messages to help unleash Innovation made in Europe

1. **Rethink** regulation. Europe can only be a frontrunner in innovation if EU decision makers put the business case for innovating and investing in Europe at the core of EU regulation.

   This requires a regulatory framework that is coherent with political goals and that is kept up to date to accommodate innovation timely enough for quick commercialisation. A coherent framework also includes fast approval processes and the facilitation of testing under real-life conditions. Moreover, we need a more pragmatic approach to IPCEIs – and have to foster private sector funding for R&D, which would be supported by an overhaul of the taxonomy rules and the fast completion of the Capital Markets Union.

2. **Re-focus** on robust Intellectual Property rights and international standardisation. Solid globally competitive intellectual property (IP) rights are key for the business case of innovation.

   Stepping up on international standardisation is important to avoid delays in innovation and commercialisation. It is also the only way in which Europe can preserve its role and values in global standards. This will be key for the digital and green transition and to avoid

1 See ERT Benchmarking Report 2022 https://ert.eu/2022BMR/

2 ERT Innovation microsite https://ert.eu/innovation/

delays and disadvantages in innovation and commercialisation.

3. **Realise** the scale-up of investment-intensive innovation. To move forward with the green and digital transition, we have to de-risk technology development. We can do so through public-private partnerships and innovation oriented public funding.

Europe's response to the US Inflation Reduction Act

As this paper is being finalised, the European Commission has just published its Green Deal Industrial Plan. This could be a huge opportunity to improve the EU's innovation support system and competitiveness – provided it is crisp, pragmatic and effective to facilitate economic investments in the EU.

Specifically on the innovation process, the Commission delivers a promise to support innovation through faster permitting and better testing conditions for selected sectors. We urge the EU to broaden this promise to all sectors and industries and make sure that the promise becomes reality by immediately tackling the issues addressed by this Flagship paper.

Additional policy messages targeted at specific challenges can be accessed on the ERT Website.

Scan to explore all ERT Innovation stories

I. Innovation made in Europe: still going strong?

For a long time, innovation made in Europe has been the driver for our economic success – domestically and in terms of exports and direct investment abroad. And yet, our innovation leadership and industrial competitiveness cannot be taken for granted.

Global competition is increasingly fierce across industrial sectors – and also increasingly complex. The bigger picture includes factors such as Industry 4.0, the green transition, geopolitical trends, supply of raw materials and energy prices.

Technological change is fast paced, and on a global market, breakthrough innovation, wherever it takes place, has a global impact. Technological leadership is always challenged, and any failure to keep up is punished fast by customers and markets.

1) Global innovation leaders: where does Europe stand?

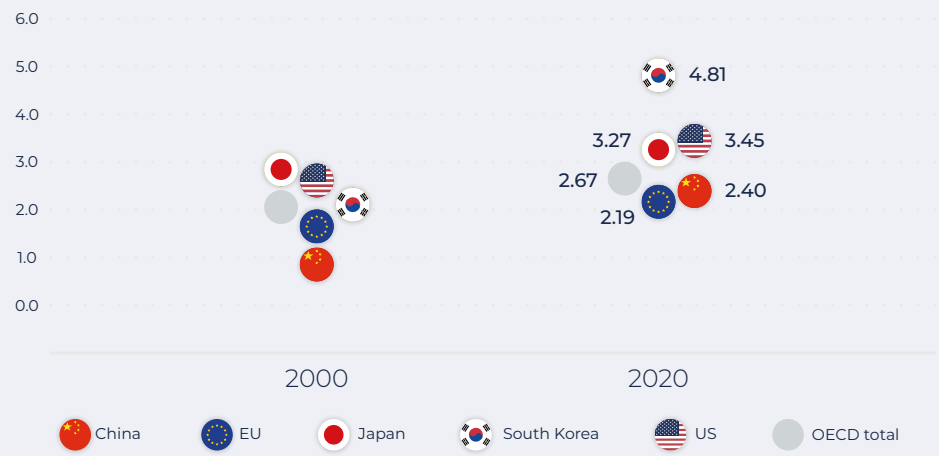
R&D intensity

In 2021 the EU's average R&D intensity was estimated at 2.27% GDP[3], far below its long-held ambition to invest an annual 3% of GDP into R&D (a target originally set in 2000 for 2010).

As OECD data on R&D intensity show, the EU is clearly lagging behind global peers (see Fig 1 for 2020 data).

Within Europe, R&D intensity varies strongly across Member States. Sweden is leading with 3.35%, followed by Austria (3.22%) and Belgium (3.19%) – which also rank highly in global comparison. On the other extreme are Slovakia, Cyprus, Bulgaria, Latvia, Malta and Romania – all with ratios below 1% of GDP.

Figure 1 - R&D spending as a share of GDP, %



Source OECD. For a full evolution, see the ERT Benchmarking Report 2022

The EU is challenged not only in terms of average R&D intensity, but also structurally as innovative regions and inactive regions are likely to drift further apart in terms of competitiveness and sustainable economic development.

A shift in corporate R&D investment

The December 2022 EU Industrial R&D Investment Scoreboard[4] found that in 2021 the global top 2500 companies' R&D investment surpassed for the first time EUR 1 trillion. Of this investment 40.2% was made by 822 US companies and 17.9% by 678 Chinese companies who have for the first time overtaken the 361 remaining European corporations (17.6%).

The number of Chinese companies, many of which in the ICT sector, has tripled since 2012 – displacing more traditional manufacturers from Japan and the EU. On the other hand, the average European (or Japanese) company (still) spends significantly more on R&D than the average Chinese company (but less than the average US-based company).

The Scoreboard findings reflect a global tech race that is intensifying in four key sectors:

ICT products and services attract the highest R&D investment, and the race is largely between US and Chinese companies.

The health industry tech race is predominantly between US and EU companies, and marked by much higher R&D investment in the US.

3 Eurostat, November 2022, EU investment to R&D increased to EUR 328 billion in 2021 https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20221129-1

4 Accessible here: https://iri.jrc.ec.europa.eu/sites/default/files/contentype/scoreboard/2022-12/EU%20RD%20Scoreboard%202022%20FINAL%20online_0.pdf

In the automotive tech race, European companies are leading in R&D investment, but spending by competitors in the US and China is growing much faster. High R&D levels can be explained to some extent by the green transition.

That said, Europe has a very diversified industrial base. Many 'traditional' European industries are comparatively mature, and those sectors might not attract extremely high levels of R&D spending in any jurisdiction. However, also in those more traditional sectors European R&D investment does not always come out on top.

Human capital and patents

Europe is a hotbed for scientific research. EU, UK, Switzerland and Norway together are home to 2.3 million scientific researchers, the highest number globally. China, however, is catching up fast and has already surpassed the EU-27[5].

And yet, Europe struggles in turning this advantage into business opportunities, and notably patents. Patents are a key indicator of an innovation system's current competitiveness, but also allow some prediction on the future competitiveness of an economy versus its peers: patents indicate who will own tomorrow's key technologies.

The ERT Benchmarking Report 2022 shows that, compared to global competitors, Europe has fallen far behind in terms of patent applications in some key sectors such as ICT (with some exceptions, such as connectivity or biotechnology).

According to OECD data, climate change mitigation is the only area where Europe is a clear leader in terms of patents, but even here China is catching up fast. Also the US Inflation Reduction Act could well trigger a shift in favour of the US in the mid-to long term.

Observations

Europe's relatively low investment in R&D raises concerns for our industries' future competitiveness. These concerns are confirmed by trends in patenting applications.

In part the difference in R&D spending reflects the geographical concentration of the high growth ICT sectors in the US and increasingly China. But the reasons likely run deeper – the European policy/ regulatory environment is not best suited to create a business case for disruptive innovation. This is set out in more detail in our policy recommendations (Chapter III).

Looking ahead, Europe's lack of leadership in the ICT sector endangers our industrial base just as we are entering the age of Industry 4.0[6].

KEY INSIGHT: The relatively low level of Europe's R&D investment raises concerns for future competitiveness. We need to urgently restore the business case for innovation made in Europe.

5 ERT 2022 Benchmarking Report, based on OECD data

6 See ERT Benchmarking Report 2022 https://ert.eu/2022BMR/

2) Europe's support system for innovation: up to its potential?

European policymakers are keenly aware of the continuous innovation challenge, and over the last 40 years the European Institutions have put in place an extensive system to support research excellence and innovation made in Europe, and to enable synergies across the Union.

Europe's innovation potential clearly benefits from Horizon Europe (with its EUR 95.5 billion budget) including a new pillar (Pillar III) dedicated to supporting start-ups and scale-ups. The new approach to use Missions and moonshot projects to trigger innovation and innovation spill-overs across sectors is also promising. The New Innovation Agenda seeks to empower deep tech innovation and improve cohesion between regions.

The advancement of Important Projects of Common European Interest (IPCEIs) via EU support and State aid is a tool with high potential to scale up break-through innovations that under current regulatory and market conditions do not (yet) have a business case.

Since 2020 the European Innovation Fund has been created, supporting the development of low carbon technologies, and the European Defence Fund, set up to promote state-of-the-art and interoperable defence technology and equipment.

Separately, the European Investment Bank and national government agencies also take active part in R&I investment, with the provision of loan guarantees, direct funding or co-financing projects under EU initiatives.

In short, EU institutions are doing a lot to strengthen innovation made in Europe. Without these initiatives our competitive position would certainly be much worse. And yet…

Observations

There is room and need to make Europe's innovation support system even better.

The race for technological leadership is accelerating and geopolitical polarisation is making our world ever more complex and challenging. Europe's institutions need to ensure that we make the most of the system we have already in place.

First, it is key to improve companies' access to what is currently a fairly granular and process-heavy system.

Horizon Europe could better live up to potential if calls for applications are simplified to not deter potential participants[7].

IPCEIs, too, would become a more powerful tool, if the very lengthy and complex application and decision processes could be improved in an impactful way. The current realities of the IPCEI approval process do not adequately match the pace of market innovation and competitiveness objectives.

The Commission – with its Green Deal Industrial Plan – has announced that it will provide a code of good practices for the design of IPCEIs to speed up assessments and ease access for IPCEI-related projects by SMEs. However, this alone will not be enough to unleash the potential of IPCEIs. We also need greater pragmatism (on clawbacks, funding gaps, extensions, etc.), better synchronisation across participating Member States, and more transparent processes overall.

Second, we should think innovation support through to the end. Horizon Europe highlights excellent research and innovations but still struggles to bring them to market. As a result important innovations may not be realised (or at least not in Europe).

For some sectors, the new or enhanced Connecting Europe Facility and Digital Europe Programme should help to bridge that gap to market launch. But as long as Horizon Europe is not extended to the deployment phase, we are still lacking a general solution.

Third, let us be more ambitious learners from other innovation leaders.

KEY INSIGHTS: To make the most of the tools in place, we need to simplify access to increase participation, speed up approval processes and extend support to enable deployment.

7 Calls for applications trigger fierce competition between consortia to be selected, which requires strong investment from applicants (resources, time, costs, etc) that may not be possible for all types of potential interested entities.

3) Strategic elements of success: what to learn from other global innovation leaders?

To further strengthen the EU R&D support system and toolbox we should learn from those countries that are global innovation leaders.

What are the key factors for innovation success amongst our competitors? Europe should evaluate successful strategies elsewhere and see what should be incorporated into our system or which alternative policy action could have similar impact.

Figure 2 compares investment according to the different R&D categories for China, Japan, Israel, South Korea and the US with data for the EU.

One finding sticks out. In the EU the share of experimental development in total R&D spending is by far the lowest. Experimental research has a high risk to fail – but gives a real chance to discover the unexpected.

The US approach

In the US, many innovative activities are fostered by the Department of Defence through the Defence Advanced Research Projects Agency (DARPA). While DARPA's primary responsibility is to develop emerging technologies for military use, it also works closely with the private sector on innovations for civilian use. The internet, weather satellites and even Moderna's COVID-19 vaccine were created in part because of expertise and financing provided by DARPA.

The Inflation Reduction Act (IRA, August 2022) – although not undisputed in the US domestic debate due to taxation aspects – is expected to boost green innovation made in the US (both R&D and scale-up) by creating markets for domestically produced green energy solutions and domestically sourced components such as batteries, solar and wind components and carbon capture technologies. It provides for attractive tax credits for R&D, including for smaller enterprises.

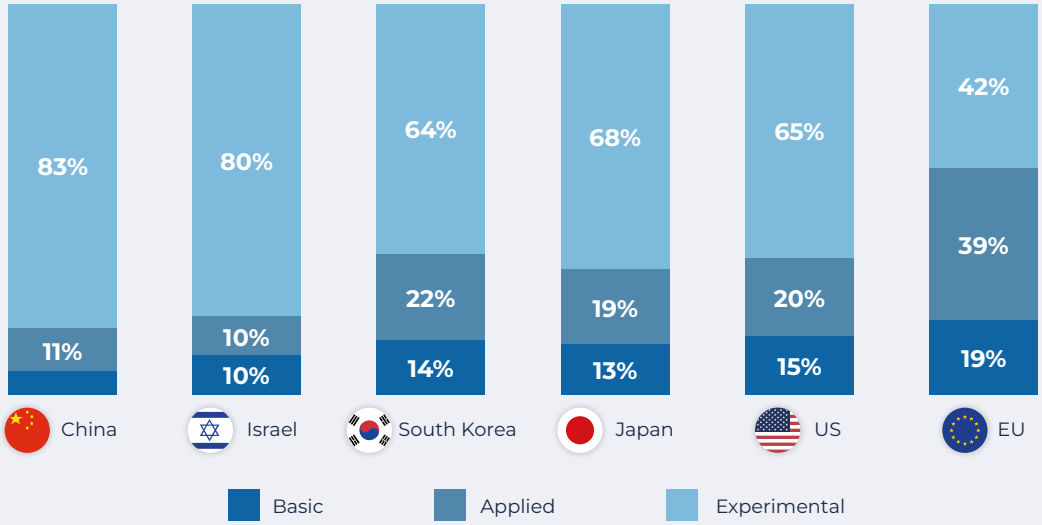
From a European perspective, the IRA creates enormous level playing field concerns as the approach taken by the IRA encourages green technology scale-up by the creation of markets, enabling regulation and tax incentives to generate competitive costs as compared to existing technologies. The IRA also includes discriminatory elements that put European companies in a disadvantageous position.

China & South Korea

China and South Korea have created effective innovation ecosystems that facilitate rapid product development and commercialisation.

China has focused on developing a network of demonstration zones, often geographically tied to innovation and manufacturing hubs. Although China's large and relatively closed market is a key reason why corporates have managed to scale up production quickly, they would not have

Figure 2 - Comparison on R&D by business, government, education and non-profit by type of R&D (as % total R&D expenditure)



Source: OECD, data for 2020 and 2019
Notes: Data incomplete for Israel (government financed applied R&D) and China (non-profit financed R&D).
For EU-22, non-profit financed R&D missing for Bulgaria, Croatia, Cyprus, Malta and Romania.
Education funded R&D missing for Finland and Sweden, incomplete for the Netherlands.

managed to bring as many products to market without effective test beds.

South Korea's government is similarly providing enabling infrastructure – through business-friendly regulation and 'tech clusters' – that have accelerated product commercialisation and allowed large corporates to effectively collaborate with SMEs and start-ups. Such idea-sharing has proven highly effective in spurring innovation.

Israel

Israel takes a similar approach to the US with civil-military fusion innovation. For example, corporates used military data storage expertise to invent the USB flash drive.

Academia also plays a key role in the Israeli innovation ecosystem because of its connection to industry and focus on commercialisation. Not only do universities collaborate with – big and small – corporations, but they also excel at establishing companies themselves to commercialise innovations.

Observations

In comparison to other innovation leaders, Europeans tend to make less use of experimental development. Why is not clear. In part this could be down to risk aversion, availability of financing or lack of a clear business case for innovation – which in Europe may hold back more uncertain investment.

Our competitors link up research-intensive industries for better synergies. And they build structures that speed up product development and commercialisation.

Whilst US policymakers create a business case for innovation to facilitate transformation, the EU policy mindset seems stuck on the notion that transformation has to be enforced through a comprehensive regulatory approach rather than enabled by opportunity.

KEY INSIGHTS: Stepping up on experimental development could accelerate Europe's innovation scene, also considering Europe's lower R&D intensity overall. And, as showcased by other innovation leaders, synergies, speed and pragmatic frameworks for realisation and scale-up are key.

To free up Europe's potential, the EU has to incentivise and enable innovation instead of relying on reinforcement via regulation.

II. The corporate experience: collaboration at the heart of successful innovation

Large companies play a crucial role in the innovation process and their respective innovation ecosystems. It is well understood that their financial firepower and in-house R&D capabilities are important innovation drivers and enablers.

Yet successful innovation is increasingly the result of intense collaboration by a wide range of actors with complementary insights and abilities. The way in which large corporates interact and collaborate with SMEs, co-innnovators or key stakeholders evolves according to the maturity of the innovation.

Technology development runs through nine different stages – also defined as technology readiness levels (TRL)[8] – starting with the incubation of an idea to its commercialisation. The whole process can be structured into research phase, development phase and (pre-) commercialisation phase. The role of companies in these three phases is quite different and so are the challenges and requirements. See Figure 3 for an illustration.

Initial research phase

In the initial research phase (TRLs 1 through 3), large corporates are often the initiators of an R&D project – be it because of a mission set by top management, customer or government demands, or a company's strategic or sustainability agenda. Large corporates can also be the incubators of innovation through investments in in-house research and the setting up of research facilities.

When research is not done exclusively in-house, corporates provide research institutes and academia not only with private capital investments, but moreover share best practices and technical expertise.

Depending on the sector, R&D initiation can also take the form of collaboration with start-ups, SMEs, suppliers, customers, as well as other corporates. Such collaboration can range from co-design and co-development of innovation ideas and projects to setting up of business partnerships, sharing lab facilities and capacity building.

Technology development phase

In the technology development phase, TRL stages 4 to 7, large corporates drive Research & Innovation through business cooperation and capacity building. In addition to supporting start-ups and SMEs with capital investments and expert advice, large corporates also offer a built-in innovation culture of collaboration and knowledge sharing.

Finally, to speed up the process of going from idea to product, large companies play a role as co-innovators, for example in the establishment of innovation testbeds. TRL 7 also sees large investments, including when participating in public-private partnerships and major project consortia such as Important Projects of Common European Interest (IPCEIs).

Pre-commercialisation phase

In the final TRL stages – the pre-commercialisation phase – a large corporats' experience in the entire product lifecycle management process is a key advantage, from design and testing through manufacturing to the preparation for bringing a technology/ product to market. Start-ups and SMEs can draw on corporates to enable cost-efficient product manufacturing as well as on large-scale manufacturing organisations.

Corporates would also often initiate major market analyses to test a product's fitness for the market and to discover further use cases. In addition, large corporates play a key role in the development of commercialisation strategies that fit the specific characteristics of distinct regional markets.

KEY INSIGHTS: Collaboration between different stakeholders is becoming an increasingly important enabler for innovation.

Large corporates are often the ones to trigger collaboration projects. They partner with and enable research communities, start-ups, and SMEs in the development of new ideas, and are crucial in pulling in value chain participants and involving public authorities.

To be effective, innovation support systems need to cater for a very diverse and interlinked ecosystem.

See the ERT Innovation Microsite ert.eu/innovation for concrete examples of best practices and the full collection of ERT Member companies' Innovation Stories

8 TRL stages as defined by the European Commission in the Horizon 2020 programme as a means of measuring the maturity of an innovation project or technology.

Figure 3

Collaboration during Innovation: The role of large corporates

From idea/lab to mass market

Technology Readiness Levels reflect technology maturity

1	2	3	4	5	6	7	8	9
Basic principles observed	Technology concept formulated	Experimental proof of concept	Technology validated in laboratory environment	Technology validated in relevant environment	Technology demonstrated in relevant environment	System prototype demonstration in an operational environment	System complete and qualified	Actual system proven in operational environment

Research / applied research phase

Large corporates collaborate with...

Start-Ups	Private capital, corporate VC funds, expert advice, know-how, capacity building, business cooperation, equipment
SMEs	Co-innovation, business cooperation/ partnership, best practices sharing, private capital, new opportunities, know-how
Complementary Corporates	Business partnership, best-practices sharing, know-how, co-innovation
Research infrastructures*	Financial and human capital, shared labs/ equipment, industrial expertise, corporate VC funds, cost-sharing
Academia	R&D collaboration stipends, project co-sponsorship, knowledge sharing incl. on new industrial requirements or areas of interest
Employees	Company's entrepreneurship programmes, pro-innovation mindset, design thinking / agility, internal organisation
Suppliers	Co-innovation, collaboration, product specifications or design/material needs
Customers	Co-design and co-develop products that correspond to users' needs
EU and Member States**	Private capital, business cooperation, co-innovation

Technology development and demonstration phase

Large corporates collaborate with...

Start-Ups	Private capital, corporate VC funds, expert advice, capacity building, business cooperation, real data to test equipment, products...
SMEs	Private capital, know-how, business cooperation, real data to test equipment/ facilities/ new technology
Other large corporates***	Cooperation, best practice sharing, co-innovation, cost-sharing
Business incubators and accelerators	Private capital, know-how, corpoarate VC funds, technical expertise
Innovation test beds/hubs	Business cooperation, co-innovation
Customers	Collaboration, co-development
Suppliers	Enhancing value chain, collaboration, cross-sectoral solutions for new business lines, real data for tests of technologies, facilities
Sector regulatory bodies	Best-practices sharing, know-how, alerting on regularity barriers, participation in sandboxes
Public-private partnerships (PPPs)	Co-financing, joint de-risking technologies, in-kind support
EU and Member States**	Private capital, business partnership, best-practices sharing, know-how

Product pre-commercialisation phase

Large corporates collaborate with...

Start-Ups	Business cooperation, business relationship product-market fit, cost-sharing introduction to new business opportunities
Scale-ups	Private capital, know-how, product lifecycle management
SMEs	Business cooperation, business relationship, cost-sharing
Other large corporates***	Cooperation, best practice sharing, cost-sharing
Customers	Market analysis, testing of new products and services
Suppliers	Product manufacturing and deployment
Sector regulatory bodies	Alerting on regulatory barriers that impede scale-up of innovation
Standardisation bodies	Technology licensing & standardisation
EU and Member States**	Co-financing, technical expertise

* labs, parks & centers **institutions & agencies ***complementary & non-competing

III. Policy Messages: Corporate priorities to make a better business case for 'Innovation made in Europe'

Europe's corporates play a key role in driving and enabling innovation in our economy. And innovation is key to Europe's industrial growth and international competitiveness.

The corporate sector has a responsibility towards society in supplying progress, employment, and prosperity.

At the same time politics and society have a responsibility to provide the best possible framework for launching and implementing innovation efficiently and with impact.

In the following, we set out three priority recommendations to create a better environment for 'Innovation made in Europe'.

Additional recommendations can be found on our Innovation Microsite – ert.eu/innovation

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1) Rethink regulation

Political goals and supporting policy frameworks must create a pull for investment in innovation.

Europe can only be a frontrunner in innovation if EU decision-makers put the business case for innovating and investing in Europe at the centre of EU regulation.

Coherence and incentives are key. Long-term strategic priorities have to incentivise and reward innovation from a business perspective.

Incentives are key because they provide a business case for innovation that goes beyond mere compliance with requirements. Well-tailored incentives generate a much greater drive for innovation that also improves competitiveness more broadly and allow for greater creativity. Regulatory incentives moreover de-risk innovation investment and therefore free up resources for more R&D and faster deployment.

Coherence is key because incoherent regulation discourages investment and R&D in new innovative solutions. Without coherence, regulation is unpredictable or even self-contradictory – this creates uncertainty and increases the financial risk of investing and engaging in R&D activities for all actors along the innovation chain. Successful innovation builds on the collaboration of many stakeholders and organising this collaboration is itself already a considerable challenge: protracted uncertainty on whether, when and where an innovation can be commercialised can further discourage key stakeholders from investing their resources even into otherwise promising innovation projects.

Follow-through is essential. To achieve real coherence, political goals are not enough. It is nearly as important that sectoral and product legislation are aligned to foster the same goals and are free of contradiction and silo-thinking. Here the European Commission has an important role to play, but Europe's co-legislators also need to exert great discipline during the adoption process.

Keep regulation up to date. Political coherence is an empty shell without the determination to dynamically adapt and update product and services regulation to keep track of technical innovation. Here, too, silo-thinking can be a barrier to adaptation. Moreover, solutions are needed to overcome rigidity or lack of speed at the policymaking or policy adaptation level.

Why is this so important? If, due to outdated or inflexible product legislation, innovation cannot be brought to the market in Europe, it will not benefit our economy. Instead, it will strengthen the competitiveness of our peers and/or rivals who can then easily outrun European companies in the commercialisation phase.

Moreover, if companies need to price in the cost of time lost due to unfit regulation, they will adapt – whether by investing less in innovation, tailoring innovation to more promising markets or reducing the level of ambition to what can be commercialised under current rules. Each scenario means lost opportunities for Europe.

These concerns weigh heavily – and especially so in highly regulated markets and for the development of new materials. EU and national legislators should systematically build in mechanisms for time-efficient and timely updates when designing product regulation.

Speeding-up approval processes for new products/substances is key for instance for food contact materials, cosmetics, biocides or pesticides where consumer and environmental safety are of paramount importance. This tends to be the responsibility of national authorities – who often do not internalise that overly drawn-out processes spanning over many years present a significant handicap to innovation: they prolong uncertainty for commercialisation in often highly competitive markets and lead to losses in IP. Strengthening the business case for innovation would therefore also imply greater ambition in speeding up approval processes.

Europe's lawmakers and regulators must walk the talk when it comes to testing. Testing is as a key step in innovation, but we are miles away from a state where testing under real-life conditions is the rule, not the exception.

Innovation builds on lessons from trial and error. Everyone accepts that testing is key in the innovation process, but still there is little readiness to actually allow it under real-life conditions (provided of course the risks involved are limited and understood). Europe needs a change of mindset and to embrace openness to testing as a logical (even desirable) part of its innovative identity.

Europe could and should improve the conditions for testing new innovations:

- more comprehensive rollout of **regulatory sandboxes across all industries, including at European level**. Some Member States have understood this – for example Spain is planning to roll out sandboxes for AI innovation.
- **increased and fast funding for test beds** would also help speed up the innovation process by facilitating concept testing and adaptation to lessons learnt and customer needs. This proved effective in the product development phase for 5G.

Improving the industry's ability to test innovation would benefit all parts of the innovation ecosystem and not only speed up innovation but also increase the readiness to launch new projects as well as the appetite for collaboration between industry and academia. We hope the Commission's forthcoming Guidance on Regulatory Sandboxes can unlock potential across industries.

Walking the talk also means that instruments that have been put in place need to be made usable. Let us look at IPCEIs.

Fast funding processes are key. Public funding can be very important, but processes are often too slow. An extreme example are the approval processes for IPCEIs. By definition, IPCEIs are of a strategic interest to Europe, but too much valuable time is lost in administrative decision making. The fact that eight years into the creation of IPCEIs, only four have been approved speaks for itself. For the IPCEI approach to provide effective solutions to Europe's strategic challenges, approval processes need to be accelerated.

More generally, when designing or re-designing approval processes, greater speed is essential. Delays increase uncertainty, opportunity costs and the risk of being overtaken by rivals in more dynamic jurisdictions.

Foster private sector investment in R&D and start-ups. For private sector funding to support innovation going forward, the EU taxonomy can play a major role. If Europe is serious about its commitment to innovation and the twin digital and green transition, the taxonomy has to be adjusted to foster investment in R&D driving transformation. As it currently stands, the taxonomy includes bottlenecks that hamper investments in (activities that are prerequisite for) economic activities and technologies widely regarded as necessary for a successful twin transition. Especially innovation and best practices further up the supply chain are not duly recognised because of onerous technical screening or 'do no significant harm' criteria. The taxonomy can and should be adjusted to facilitate investments consistent with the EU's long-term strategic objectives. For this European policymakers would need to commit to coherent rules, allowing themselves a strategic long-term view and overcoming silo-thinking.

The long-discussed EU Capital Markets Union has huge potential to raise private capital for innovation but remains elusive for now. One point where greater coherence of EU policy would be key is to enable institutional investors, including corporate pension funds, to directly or indirectly invest in innovation-related activities, for example in start-ups. This overarching interest of the European economy should be reflected in financial services regulation, which at the moment seems to lack a greater vision. To initiate this, the ball lies in the court of the European Commission, but support by Member States and the European Parliament would be essential, too.

2) Re-focus on robust intellectual property rights and international standardisation

Solid and globally competitive intellectual property rights are key for the business case of innovation.

Investments in innovation are costly in terms of financial and personnel resources. Innovation processes can result in success or failure and imply taking risks and exploring the unknown. At the beginning of this process – which depending on the sector can span over years, even decades – there is no guarantee that the investment will pay off eventually by commercialisation to market.

Without soundly protected and efficiently enforceable intellectual property (IP) rights, there is even less predictability on commercialisation and pay-off is even more at risk. The reason is that competitors will find it attractive to copy new products, as this is easier and cheaper than a fully-fledged R&D project and shortens time to market. In short, for innovation to have a business case, sound and well-functioning IP protection and enforcement are key.

European companies need a solid IP system. This is important in all highly competitive sectors: Where development time for new products is long (such as the pharmaceutical sector), where the IP landscape is dense and competitive (e.g. renewable energy, new decarbonised molecules or CO2 storage in the energy sector) or where copying of products is comparatively easy (e.g. in software-related areas).

Effective IP protection also enables collaboration and technology sharing – indeed this has been the key success factor in the development of cellular technologies and underpins the global success of EU actors in this area.

The European Unitary Patent System, about to be implemented, is a model that looks promising, but still has to demonstrate its effectiveness and competitiveness in terms of the costs for applicants. One weakness is that so far not all EU Member States have joined.

In some sectors it will nevertheless be necessary to maintain strong complementary IP protection. For example in the pharmaceutical sector, Regulatory Data Protection remains key for clinical data generated during clinical trials and Supplementary Protection Certificates compensate for an early expiration of patents due to compulsory lengthy testing and clinical trials before commercialisation.

Leverage the existing IP system for digital innovation. Europe needs to build on its existing strong and competitive IP system with its special relevance to the digital industries. This is crucial for Europe's ability to develop next-generation technologies (such as artificial intelligence, the Internet of Things, data) as well as for digital economic development.

A joint challenge in moving forward is finding the right balance between a) the European Patent Office's guidance towards patent examiners regarding the protection of next-generation technologies and b) the related case-law based decision making. Why is this important? Protecting next-generation technologies is key to help strengthen Europe's competitive position – and for this we also need to provide greater clarity and certainty for innovators.

Step up on international standardisation. Beyond the EU's borders, policymakers need to address issues of complexity and geopolitical bias in international standardisation processes to avoid delays in innovation and product commercialisation.

EU Member States and the European Commission should support European industry in standardisation efforts. This can be done by ensuring framework conditions that provide incentives for technology contributions to standardization and promote a widespread adoption of the resulting standards.

A balanced and transparent licensing system for standard essential patents based on Fair, Reasonable and Non-Discriminatory (FRAND) terms needs to be preserved, as well as fair access to standards for all market players. The continued and effective protection of IP rights, including standard essential patents, is key to ensuring that European technology companies can earn a fair return on their investments and continue to bring innovative solutions. This is one of the key factors which EU companies need to pursue to develop their investment in open standardised technologies.

Prioritise and strengthen Europe's role and values in international standard development. A smart, focused, inclusive and balanced policy approach to European standardisation is needed. Incentives for innovators and technology-leading companies to participate in European standardisation activities in ETSI, CEN and CENELEC need to be maintained and strengthened, and standards activities need to continue to be industry-led. Advisory groups of the European Commission, governments and other political bodies should continue to include experts of non-EU stakeholders.

Global standards will be key for the green and digital transition going forward, because they ensure interoperability and economies of scale e.g., for next-generation networking technologies such as 6G and PON evolution. For the increasingly trade-relevant product circularity domain, European preferences for Digital Product Passports (DPP) should be internationalised with high priority.

The overall standard-setting approach and objectives need to be balanced with Europe's ambition of open strategic autonomy and economic interests.

In short, it is essential to ensure that international standards do not stray from core EU values built on WTO/TBT principles for international standards development. We also need to avoid a scenario where (national) standardisation in third countries, market access (EU FTA agenda), technology-specific regulation or government funding become vehicles for other jurisdictions to gain competitive advantage in innovation and commercialisation.

3) Realise the scale-up of investment-intensive innovation

To move forward with the green and digital transition we have to de-risk technology development through public-private partnerships and innovation-oriented public funding

True partnerships are key! To gather pace for the transformation of our industries and remain a global leader in the green transition, the public sector has to keep its sights on the scale-up phase of innovation. To some extent, it can do so by encouraging partnerships at company level or with research institutions to scale up (e.g. test beds), but efforts cannot stop there.

Especially for capital-intensive or infrastructure-demanding projects, hands-on public support is common in other jurisdictions which have long recognised that deploying the newest technology at scale – and fast – offers competitive advantages for their entire economy.

The unprecedented US Inflation Reduction Act only underlines that for large-scale innovation made in Europe to remain competitive – and indeed for European industry to remain competitive – Europe's leaders must adapt to global reality. Europe's decision-makers and public sector have to step up their support as partners to industry – without entering into a transatlantic and/or intra-European subsidies race.

For Europe, the minimum would be to support investment-intensive projects that respond to a real demand and would have immediate industrial applications. But public support / de-risking can also take the form of outright partnerships, targeted subsidies as well as economic or regulatory incentives that would allow companies to achieve scale-up faster and at a larger scale.

Pair-up public support with tax-based incentives for R&D activities to free up considerable company resources that could then be invested in the scale-up of more mature innovation projects.

The public sector could become a better customer for innovation. Beyond de-risking of deployment investment, public procurement is also an important accelerator of market penetration or replication of innovation.

Looking at past experiences, a European Sovereignty Fund may turn out to be a useful instrument to finance innovation, but the debate is at an early stage. An agreement on a new fund, its firepower and its conditionality, not to mention its actual set-up – are likely to take time and there is little guarantee that the new fund will not be beset by similar complexities as experienced for existing instruments.

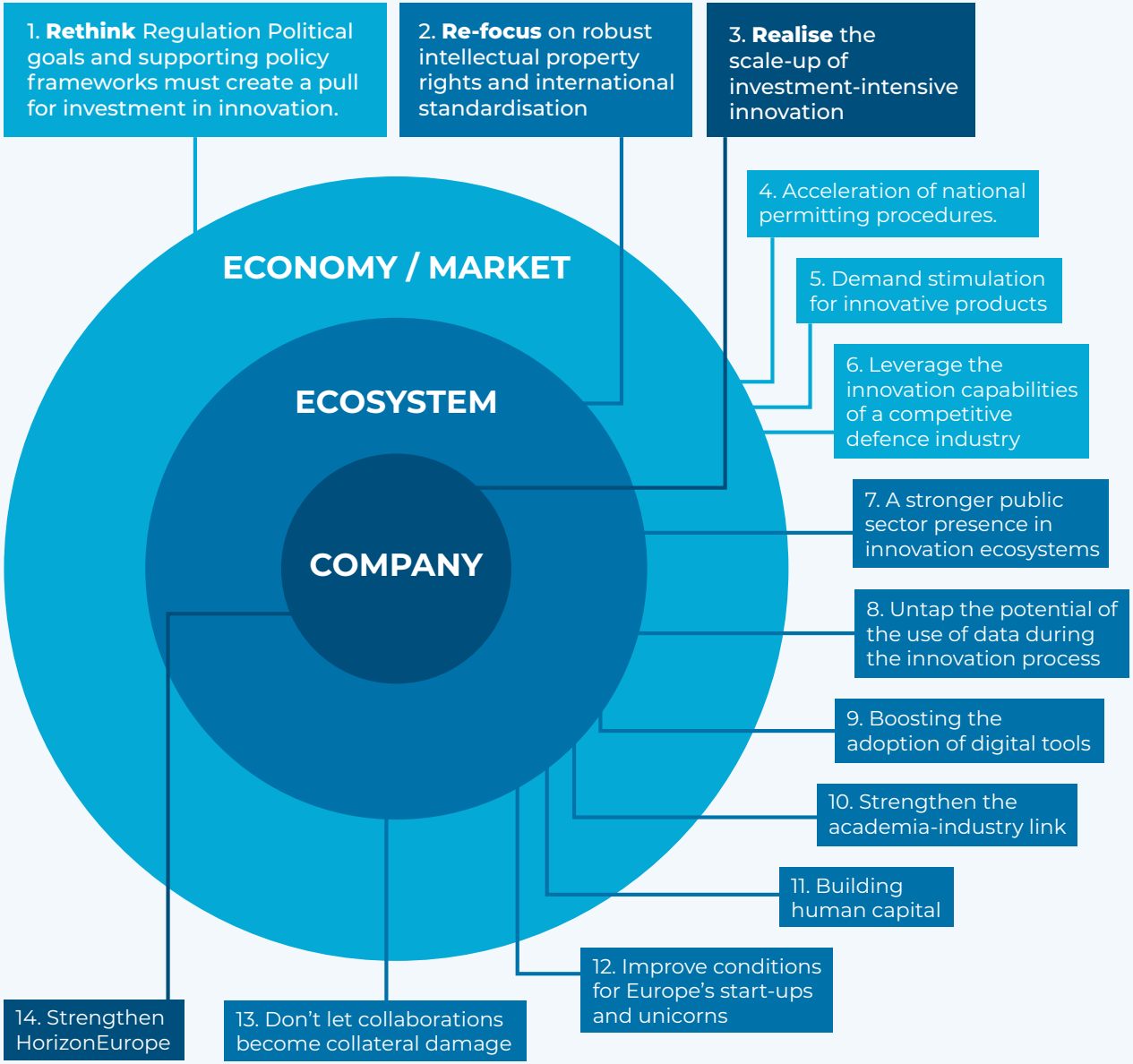
In this light, policymakers should keep it a priority to look closely into all other means to de-risk innovation in the short to mid-term. This would alleviate current pressures and provide further confidence in Europe's ability to act and support innovation.

Would de-risking generate more innovation? It certainly would. One obvious impact is that it directly frees-up private sector resources. Moreover, it would stimulate additional investment in new R&D projects: first, opportunity costs of innovation projects decrease; second, the business case for innovation improves because a larger scale can be achieved both more easily and faster. The latter is key in light of intense global competition for technological leadership.

All ERT policy messages

The **three ERT Priority Messages** highlight actions that are essential for boosting innovation made in Europe. Together they will create the dynamics needed to encourage innovation, and to do so with a lasting impact.

At a more detailed level, other factors also play a role. For more explanations on some aspects and related suggestions, please refer to our website.



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Launched at the ERT Euronews Debates Innovation event in Brussels on 27 March 2023.