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Research and Innovation to Thrive in the Poly-crisis Age

ESIR Focus paper

Independent Expert Report

Research and Innovation

Research and Innovation to Thrive in the Poly-crisis Age

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EUROPEAN COMMISSION

Research and Innovation to Thrive in the Poly-crisis Age

What do we need from the next Framework Programme and the Missions?

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RECOMMENDATIONS TO FUTURE-PROOF RESEARCH AND INNOVATION FOR THE 2030s

In the current context of intensifying ecological, economic, social and security crises, interwoven and mutually reinforcing in their effects – a phenomenon of 'poly-crisis' – Europe must stay on course to deliver its 'earthshot' of the 21st century: that of a Europe where citizens live well, at peace and within planetary boundaries. In order to make that possible, the ESIR group advocates that Europe and EU institutions adopt a full 'protect-prepare-transform' (PPT) agenda with as much attention to 'preparation' for a broad set of emerging risks and, above all, investment in 'transformation' through challenge-led approaches to research and innovation, as concern for 'protection' through damage control and coordinated crisis responses. At the moment the EU is insufficiently geared towards the transformation needed for true resilience and prosperity in the next decades.[1]

Innovation in all its forms will be essential to enable Europe to shape its destiny and make deliberate choices. Europe's research and innovation (R&I) must make a decisive contribution to transformation at all scales, in order to equip the continent to combat climate change and adapt to its multi-faceted consequences, handle economic turbulence as well as increasing political polarization and conflicts (nationally and internationally) and, more generally, navigate a less stable and more volatile world.

The effectiveness of innovation as an instrument of European survival and success, however, depends on the extent to which Europe's R&I policy and practice is designed and governed to ensure transformative actions and outcomes and in time. Currently, that is not the case. Current innovation policy is not aligned with urgent societal challenges and needs. Over the last decades it has been biased or skewed towards economic benefits in the form of extractive (short-term) corporate profits, feeding the pattern of global unsustainable development we witness today. We face a very different world now. We need Europe's R&I policy to adapt quickly to be effective for a context of continual mega-crises, complexity and insecurity and one in which market dynamics, entrepreneurship and competitive spirit are reshaped for the purpose of implementing and scaling sustainable living, wellbeing economics and environmental regeneration.

The precedent of invoking emergency measures to respond to unprecedented challenges has been done effectively during the COVID crisis and the Russian invasion of Ukraine, and has allowed Europe to develop and deliver rapid innovations at scale. Something of a similar order is needed in R&I policy and practice going forward in order to enable and embed widespread societal and economic change – change that is paradigmatic, contextual and agile.

Future-fit R&I policy must aim at creating a new paradigm of sufficiency, circularity and regeneration – social and environmental – to guide all actions of the EU. This means not shying away from charting a different course than that of the US and China where either or

[1] ESIR publication, "Transformation in the poly-crisis age", March 2023, p.3

both are pursuing radically different objectives based on diverging core values. This also demands determination to confront interests vested in the status quo and incrementalism within the current R&I ecosystem.

In this brief, ESIR recommends that European R&I policy embrace the following four principles in order to be fit for the 2030s:

1. Take risk to manage risk

- **Adopt a portfolio approach to investing in R&I**: actively enable exploration, experimentation, implementation and discovery of alternatives by redesigning current procedures and incentives to encourage responsible risk taking: accepting that some projects will fail while others should deliver returns that far exceed the investments or expectations.

- Consider conducting key R&I initiatives under **emergency measure funding rules** to permit exceptionality, rapid test and learn cycles and full empowerment of subnational actors, local communities and businesses.

- Design democratic mechanisms that would **allow society to decide what risk to take** and for what benefits.

2. Direct the action

- **Ensure directionality through design principles**, for instance by replacing outdated incentive structures based on short-term zero-sum gains with new models that reward directionality, cooperation and rapid deployment.

- Build on the New European Bauhaus and European creative industries to harness R&I for **envisioning and depicting the future we need**, as a key precondition for societal change.

- **Identify hot spots where greater directionality is urgently neede**d such as in the cases of artificial intelligence (AI) or military R&I expenditure, to allow for example 'dual/multiple use' possibilities of EU funded research with security and climate applications and require the same from military expenditure.

3. Anticipate, adapt and learn

- **Enable anticipatory governance**, which means a greater focus on foresight and strategic learning through innovation options.

- Approach R&I as a **continuous learning and intelligence generating exercise** to support identification of options, new policy, decision-making and civic engagement.

- **Adopt new, bespoke impact frameworks** to encourage learning about transformation, by identifying and observing what emerges and whether/how decision-making and capital allocation is responding.

4. Align and integrate

- **Enable multi-scale responsibilities and accountabilities**; co-determined with diverse, multilevel actors.

- **Address critical skillset, mindset and capability gaps** through R&I policy requirements and EU Pact for Skills, in particular lack of widespread familiarity, comprehension and skill in complexity thinking and systems thinking; invest in culture building in EU institutions to increase dynamism, creativity and systemic reflexes.

- Redouble efforts to **close the gap between research, policy and implementation**, creating the conditions for early adoption, diffusion and combination with other solutions and market structuring.

- **Redesign government processes and policymaking** to overcome policy fragmentation and silos and reward a focus on outcomes and transformational shifts, rather than processes; identify policy priorities (such as sustainable competitiveness) and transformation objectives and realign DGs, ministries and governance accordingly e.g. application of guiding principles of sufficiency, circularity and environmental regeneration.

- **Redirect entrepreneurial energy** towards industries, ventures and innovation that contribute to sustainable competitiveness, encompassing both social and environmental dimensions of sustainability; support with complementary policy functions focused on market design, tailoring and governance.

The next Framework Programme (FP10) offers the opportunity to design a public R&I funding programme along these four principles and to do so with consistency. It should be focused on enabling transformations that address the poly-crisis, including but not limited to, the current social, environmental, and economic challenges. It is crucial that we anticipate the changes we want to implement now in order to ensure that FP10 is truly effective in fostering the development and implementation of innovative solutions that enable transformations and address the poly-crisis.

More immediately, the forthcoming review of the new Horizon Europe (HE) Missions, as part of the mid-term evaluation of HE, constitutes a timely opportunity and an imperative to apply some of these principles as an important stepping stone for building an R&I strategy, policy and governance fit for the 2030s. The creation and implementation of missions in Horizon Europe is a potential game changer. **Missions provide a unique opportunity of live testing innovation as a driver for transformation** and of thus building the capabilities, procedures and practices for future-fit R&I in Europe along the lines of the recommendations in this brief.

Missions have introduced a bold and courageous vision into the European landscape of public programming and raised significant hope in Europe's commitment to practical, participatory actions that are substantive, contextually relevant and transformative for local urban and regional contexts and communities. Missions have been framed as a 'by and for the people/cities/regions' and are beginning to be replicated at national and regional level. Much is expected of them and much is riding on them; above all Europe's credibility and coherence as a Union that commits and follows through on the transformations that are necessary and timely, no matter how difficult. Europe's trust in subsidiarity and in the delicate "we're in this together" balance between Union, member state and subnational community is also at stake, together with its international leadership at a difficult geopolitical moment, having established significant structural momentum for change.

The review and assessment of Missions' performance in 2023, demanded by the existing legislative framework, needs to acknowledge the importance for a steady partnership and consistent directional signal for investment and appropriate public-private partnerships to come fully on board. Furthermore, given that their implementation phase has just started, it is too soon to expect and ask for evidence of results according to standard expectations of demonstrable project and programme deliverables and key performance indicators (KPIs) that are currently still assumed in the programmatic assessment process. Rather this is an opportunity to learn what has emerged so far and what might be needed in the next years to enable the Missions to succeed.

Missions are about taking responsibility for the effort to achieve transformation. A review of the Missions does offer the opportunity to introduce reinforcing mechanisms in the form of governance, ownership, roles and agency to ensure accountability and capability in the task of accelerating transition away from the status quo – in the Commission and at member state and subnational level. This is a culture-building opportunity: how to create the conditions in EU institutions and partnerships to enable Missions to develop new policy, build knowledge and capabilities in real time, and work effectively through empowerment and synergistic actions.

In the current context, ESIR recommends that the upcoming assessment and review of the HE missions should:

- Aim at identifying and addressing **enabling factors for a successful implementation** of the missions based on feedback from key stakeholders at national and subnational levels.

- **Put in place the means to explore and evaluate transformation** through more prospective analyses and evaluative learning approaches that allow quantitative estimates and qualitative engagement through time, while exploring learnings, constraints and causal effects so far, e.g. 'realist' evaluation. Revise the 'key impact pathways' framework with theories of change for each of the missions based on distance to target, back-casting and systems analysis, including scenarios informed by foresight, and identify acupuncture points on which to focus strategic learning. Fit the cadence of review to allow the work to move ahead quickly as needed and pause as needed. Anticipate that failure in some cases is inevitable and will provide critical learning.

- **Provide financial security and flexibility** along timelines aligned with Mission objectives (e.g. decarbonisation by 2030) and therefore beyond the current 3-year cycle of programming. This is key to create incentives for the research and innovation ecosystem, and to create strong directional signal that reassures key stakeholders, essential to mobilise blended finance.

- **Identify and address existing policies, frameworks, regulations and discretionary powers** (e.g. discretion to opt out or offer minimal engagement) that undermine the ability of the Missions to deliver transformation. Policies across all sectors in Europe will need to change dramatically; Mission processes need to facilitate that.

- **Introduce reinforcing mechanisms**: based on theories of change, the review should shed light on accompanying measures including policy frameworks, funding programmes other than R&I, governance mechanisms as well as citizen engagement initiatives which

must be re-designed to contribute fully to transformation and widespread adoption of change.

1. What do we need from the next Framework Programme and the Missions: an introduction

For many years, Europe's approach has been to focus primarily on the need to increase the percentage of funding dedicated to R&I. The COVID-19 pandemic catalysed an unprecedented release of public funds at European and member state levels directed at prevention and at recovery measures for the economy, with a focus on investment in R&I and (notionally) on the principle of building back better. War in Ukraine since, soaring energy prices and inflation, catastrophic climate change related events coming thick and fast, and looming crises in harvests and therefore food supplies as well as materials, signal a new era of polycrisis and possibly 'permacrisis'. This is likely to worsen significantly as climate change, resource limits and related social and economic impacts intersect and intensify. Recovery funds are already debt based; recurrent future crises will see fewer funds to draw upon. Hence innovation in Europe will need to do more, or rather to do better, with less, and will need to promote systemic transformation across the European Union.

For R&I to meet the demands of the present and the future, we need to move beyond 'business as usual'. To be fit for the 2030s, Europe should reform its R&I policy according to four principles, which we set out in the following sections: taking risks to manage risk; steering action; anticipating, adapting and learning; and aligning and integrating. While changes in line with these principles will need to be applied to all instruments of R&I policy, including Horizon Europe and its potential successor, we will illustrate our thinking by looking more closely at the EU missions. Under the current Multiannual Financial Framework (MFF), Europe is increasingly focused on the role of R&I in delivering key impact pathways. One of the new instruments to help deliver such impact through innovation implementation are the new Missions, alongside many existing mechanisms and programmes of Horizon Europe (HE) and beyond. As the European Commission starts thinking about FP10 and prepares its first review of the Missions, and as the mid-term evaluation of HE commences, it is essential to consider what we need from R&I policy in the current context:

- What R&I policy would be fit to help Europe secure its ambitions into the 2030s, by which point SDGs should be implemented and global emissions must have peaked and started to reduce dramatically?

- What questions might be asked of the Missions to assess whether this new approach is set up for success given that they aim for transformative change? What criteria should be used for evaluation at this stage given that they have just started?

Given the extreme uncertainty of the context in which these evaluations will take place, and a global polycrisis intensifying in the next decade, now is the time to consider the long-term future of research and innovation and make design and policy choices – start building a vision of the next cycle of R&I policy from 2027-2033. As it currently stands, the implementing frameworks, procedures and evaluation practices, underlying assumptions, expectations and structures governing R&I, applied to all instruments, new and old, have not substantially changed. Europe's R&I policy in its current form, and on its own, will not achieve transformation.

Building on the foundational logic of the 'protect-prepare-transform' approach proposed by the ESIR group, this paper proposes four key areas for attention and institutional revision in order to make the substantial changes needed to the enabling structures and vision of European R&I – many of which we would recommend anticipating in the forthcoming review of the Missions.

2. Take risk to manage risk

Volatility and uncertainty need responses that are flexible and agile, that create options and that consider parallel possibilities. **To achieve transformation and resilience, Europe needs to get serious about taking risk with determination for the purpose of achieving breakthroughs and structural change** to current ways of living in order to avoid and contain far greater risks. As described in the ESIR "Transformation in the Poly-Crisis Age" paper[2] and anticipated in numerous foresight exercises, the risk and cost of too little and too late action in the face of environmental, security, health, food, water and energy crises, all of which Europe faces today and likely to be exacerbated in the next decade, significantly outweighs the many feared or perceived risks that existing R&I policy and process is designed to avoid or minimise. The single greatest risk that Europe faces at this point is that of the *status quo*.

Telling ourselves that transformation is possible and at the same time avoiding or seeking to minimise risk taking in research and innovation, contradicts the very purpose of EU multi-level public funding to support a much broader spectrum of public experimentation in order to create the enabling conditions for breakthrough solutions and creative, inclusive adoption of differences.

The default behaviour of current R&I funding instruments and policy approaches seeks to optimise for fairness, transparency, accountability and distribution through calls and call requirements that are often fragmented, overdetermined and over-bureaucratised as a result – death by a thousand calls and project procedures. Risk aversion shows up in the form of award requirements and administrative expectations: overdetermination of deliverables and specification of outcomes in order to secure funding and pick 'winners'; time consuming application processes that privilege applicants with the resources to hire professional bid writers, avoidance of investing in unproven solutions or solutions without clearly defined, recognisable deliverables, punitive requirements for distributing funding to organisations running on start-up finances, limited direct commissioning, over-specified budgets, compartmentalisation of synergistic actions, pejorative framing of co-creation and collaboration between competitors and across supply chains in favour of relying on competition law to drive market dynamics. The net effect is to award funding to projects, activities and outcomes that are more often than not siloed, substitutional and incremental, delivered by consortia whose primary objective is to comply with the call text and a set of demonstrable deliverables rather than instigate processes or initiatives engaged in edge experimentation, exploration and learning across a diversity of actions and actors or instigate activities that integrate solutions and orchestrate systemic outcomes, now urgently needed. An overhaul of the structures and support mechanisms for public funding is needed. FP10 presents an opportunity to address these problems and make changes to the current public R&I funding landscape. By streamlining the calls and requirements, allowing for more risk-taking, promoting a more collaborative and exploratory approach, FP10 has the potential to

[2] European Commission, Directorate-General for Research and Innovation, Dixson-Declève, S., Renda, A., Isaksson, D., et al., Transformation in the poly-crisis age, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/360282

drive innovative and impactful solutions that go beyond incremental advances. This shift in focus towards a more supportive, flexible and outcome-driven approach to funding, could encourage investment in potentially ground-breaking solutions, foster greater co-creation and collaboration, and ultimately support more diverse and impactful R&I initiatives.

To enable these changes and to allow innovation to play the role that it should play, especially in the public sector, R&I policy needs processes and frameworks for i) counterfactual risk analysis and ii) risk enabling frameworks, processes, methods and KPIs to support risk taking and learning from experimentation and failure as a priority objective for R&I actions and iii) designing, shaping and structuring markets. Given that the role and purpose of innovation is to explore new possibilities at edges of what we know, understand and are used to, R&I instruments should generate learning from experience and through learning, understanding of how to achieve transformation and engagement in it. **Innovation portfolio approaches – implementing multiple interventions or solutions simultaneously in a city, region or value chain to test and drive connections and combinations among them – are key in this regard since they spread risk, encourage creative collisions and accelerate learning.** The Missions have started to experiment with innovation-to-accelerate-learning approaches supported by derogations of funding with sub-granting rights to organisations and institutions using portfolio composition and orchestration methods combined with impact frameworks that optimise for systematic learning, knowledge generation and cross-pollination. Building on learnings so far and on the experiences of programs which are operating differently such as EIC, EIT-KICs, Partnerships, ERA-nets might be a good place to start to institutionalise such practices, develop capability, create effective synergies rather than overlaps and draw up enabling frameworks.

We recognise that introducing major changes in expectations, mindset and precedent, quite apart from the capabilities required at all levels to execute, is no easy feat, especially in the current context. We therefore recommend that the Commission explicitly **invoke emergency measures and powers, used to good effect to enable Europe's COVID-19 response, to free up and frame the operating space and deployment of funding for the Mission on Climate Adaptation**. Given the scale and nature of the issues the Mission on climate adaptation addresses, the urgency of local, context relevant responses, this would make sense as a policy position – the mission defined as a climate emergency response – and would have the benefit of providing a mandate to implementing organisations and the Mission Board for flexibility, agility, speed of action, and wide-ranging scope for experimentation in risk taking, participatory decision making, innovative fiscal and governance solutions and accelerated learning.[3] Learnings from this experiment could then be used to bring the other Missions onto a similar footing or to introduce enabling structures to support transformative outcomes, and could be fed into the design principles for next generation R&I policy.

Responses to the COVID-19 crisis in the US and the EU, vaccine and testing development, supply chain disruption, vaccine diplomacy and its failures, provides a recent experience of dealing with risk through emergency measures that we must continue to learn from, so we are able to confront future crises and black swans with the speed and scale required and with a care to greater resilience and justice.

[3] The START network (see https://startnetwork.org/), established in 2010 to achieve system-level shifts in the way humanitarian support is approached and delivered, offers a notable example and precedent for setting up mechanisms to operate effectively under pressure in multi-stakeholder implementation contexts through empowerment, distributed decision making and flexibility.

Box 1: Taking risk to enabling fast, at scale innovation: the case of saliva-based test in the United States

In a context in which the US market was being flooded with ineffective tests, having oversight to ensure that tests meet a certain standard was essential. To ensure oversight would not thwart innovation capacity, the FDA used unusual procedures such as weekly Town Hall zoom meetings where any test developer could attend. The Director of the Office of In Vitro Diagnostics, Tim Stenzel himself would answer questions on the zoom call and his team would respond to emails within 24 hrs.

Within this context, a network of smaller labs started working together led by Yale's School of Public Health/Saliva Direct's Anne Wyllie who happened to be working with saliva and the detection of viral infections in that sample specimen before the pandemic. When she filed the FDA EUA, she enrolled 190 labs in 41 states and a couple of non-US locations as well to perform the test which was in-expensive, fast and robust, and open source. There was no intellectual property and any clinical lab could sign up as long as they validated the protocol in their lab and shared the data with SalivaDirect. This was the first FDA EUA of this type, where multiple labs operated under one umbrella EUA and contributed with data to the further validation of an at-home collection kits.

Being able to detect COVID-19 in saliva opened up for at-home testing and less PE required by health care providers because saliva collection is per definition self-collected. Today the SalivaDirects member labs aggregated test capacity is more than 1 million tests/day.

Embracing risk should not lead to a denial of democracy, quite the contrary. Given the current stakes, it is important to design democratic mechanisms that would allow society to decide what risk to take and for what benefits. For instance, how we decide whether or not to deploy geoengineering solutions and where to set critical thresholds for testing a range of geo-engineering approaches, must be thought through now, especially given how far we are far from the 1.5 degree scenario.

3. Direct the action

Already in 2009, the Lund Declaration aimed at directing the focus of European R&I towards providing solutions that address grand societal challenges high on the political agenda. 14 years later, we are far from having reached such goal: a different R&I policy is still desperately needed to drive directionality. Innovation in the consumer field – unchecked and undirected – has led to unsustainable consumption paths. The emphasis put on linking innovation to technology development and commercial success, economic growth and productivity with a competitiveness orientation very apparent in some European programs, favours the understanding that capital markets and commercial entrepreneurship are the primary change actors and reinforces the role of innovation in continuing to drive the consumption paradigm and the demand for an unsustainable supply of materials, one of the root cause issues of environmental destruction and runaway climate change. In the current context, innovation should be urgently focused on wellbeing, social sustainability and on economic transition away from linear, extractive growth and high emissions living.

Given the specific combination of challenges and transformation imperatives Europe faces, grounding research and innovation efforts in principles of ecological balance, generosity and redundancy, for example, would seem wise. Inspiration could come from Janine Benyus' work using social reference theory and mapping of ecosystems services in the natural world to be used as reference points for biomimicry principles applied to industrial, infrastructural

and social transformation.[4] This would ensure the coherence of R&I assessment approaches and evaluation with directional principles and desired outcomes – e.g. regenerative, circular, nature-based designs for life, materials, sustainable, sufficiency-based economic models and business models; participation of actors in the value chains in all R&I projects to ensure transition of economic fabric.

Directionality for innovation with a transformative intent and much riding on its success, would be best supported by the introduction of design principles and minimum requirements, embedded in R&I policy and evaluation approaches and measures. The value of using design principles as a concept – rather than prescriptive measures – is that they are themselves coherent with the role and purpose of innovation as experiential learning and discovery, rendering directionality effective by bringing in a combination of minimum requirements, intentionality and play – simultaneously geometric and loose. Design principles can be set up within R&I policy to acknowledge the imperative to change underlying assumptions and structures and at the same time provide guidelines that reflect European values and commitments to unity through diversity, just transition and radical collaboration.

When we turn to specific sectors, there is no better example of the need to direct action than with the development of artificial intelligence (A.I.), which is currently developed in the US and China in ways that are incompatible with European core values. Using a people, planet and prosperity framework to direct support to A.I. funding will be essential.

Box 2: Mobilizing A.I. for People-Planet-Prosperity

The A.I. revolution is taking the world by storm. We can only be mesmerized by how quickly intelligent machines are learning complex human skills – from driving cars to writing poetry. If this powerful technology is harnessed and steered by an overarching people-planet-prosperity framework – it can massively contribute to social good.

People: The net effect of A.I. on humans is very much up to us to decide. A.I. could make human life better and longer. The dominant use cases here are about reducing job hazards and removing alienating repetitive tasks thanks to blue and white-collar tasks automation. Healthcare A.I. is also a massive field of research and innovation. Deep learning has massive potential to reduce costs and improve the accuracy of diagnosing critical diseases. Another field with great potential is education - both via tutoring and personalized teaching. On the other hand, the obvious potential negative impacts are economic inequality, job losses and loss of freedom. We need to make sure that regulations, compensations, and lifelong learning are in place - while surveillance and algorithmic bias are not left unchecked.

Planet: The impact of A.I. on our planet is one of the most controversial and therefore one where we need the most immediate and impactful policy actions. A.I. has significant use cases to protect our planet while making it more habitable but servers, cloud computing, and machine-learning training consumes a lot of energy and critical materials. A.I. has shown potential to improve farming techniques, and reduce carbon footprint with smart logistics, emission tracking, and intelligent waste management. To materialise these benefits, we urgently need to invest in energy-efficient DL/ML algorithms but more importantly, we need to enforce the exclusive use of clean energy to run A.I. models. This in turn would provide a strong economic incentive for private markets to invest in clean tech, as the demand for clean

[4] See https://biomimicry.net/project-positive/ Biomimicry offers a new way of valuing nature based on the principle of learning from nature, drawing on the insight that each of the four basic categories of ecosystem service identified in the Millennium Ecosystem Assessment (supporting, provisioning, regulating, and cultural services) each of which correlates with a principle of biomimicry (nature as physis, model, measure, and mentor).

technologies would be forecasted to mechanically grow. The good news here is that the distributed nature of digital technologies makes them the ideal candidates to use clean tech (even in remote parts of the world). The EU - again - needs to become a major A.I. player to further accelerate the links and synergies between the A.I. revolution and the green transition.

Prosperity: The rapid technological change that has occurred over the past 300 years is the main driver of prosperity and poverty reduction. In short, technology makes the production process more efficient and further increases the division of labour. A.I. is spurring an unprecedented sharing of knowledge between humans and machines, which in turn propels prosperity. However the role of A.I. raises many more ethical issues, challenging democracy, decision making and the concentration of power. This needs careful shaping towards a balanced and representative logic of wellbeing.

Another such example of the urgent need for directionality pertains to R&I for defence. In light of Ukraine's invasion, Europe needs to ensure defense R&I serves its purpose, that of **protecting peace in a changing climate and bolstering sovereignty which requires greater sustainability.**

Box 3: The role of defense R&I

In the context of Russia's invasion of Ukraine and growing geo-political tensions, European Heads of States have decided to strengthen the European defence capabilities and strategic autonomy (Versailles declaration, March 2022). The US currently spends six times as much on research and technology as European Member States put together. In 2007, EU defence ministers agreed to allocate 2% of defence spending to research and development. Yet the current reality is a mere 1.2 %, with only 11% of this spent in collaboration with other EU member states, against a target of 35%.[5] Fragmented European defence markets have jeopardised and undermined both the competitiveness and the sustainability of the European defence industry. The defence sector is today an expression of national security commitments of each Member State rather than an expression of European values.

According to defence specialists much more must be done to increase readiness and deployability and none of the Member States has the human and financial capacity do it alone. Increasing the resilience of the military in a changing climate context and reducing its carbon footprint is paramount. NATO's climate change strategy calls for promoting cooperation around and investment for *emerging disruptive technologies and innovative energy efficient and sustainable technologies* as well as scaling up innovative low carbon technologies through procurement practices. Considering rising natural disasters, the role of the military will need to expand in scope, with a rise in civilian missions to address catastrophe and provide refugee support as is happening elsewhere. Last but not least, the military is a major landowner and defence bases are sometimes home to very diverse ecosystems and could play a major role in Europe's biodiversity strategy.

In the context of poly-crisis, R&I expenditure needs to be capable of and enabled to develop knowledge and innovation synergies with civil R&D. In part, this is because the flow of knowledge and tech is often civil --> military, but more importantly, advanced technologies have multiple purposes; in order to get the most out of them, we need as much of such R&I as possible in an open domain. This is especially important for instance in key technologies such as multiple domain applications, system of systems applications, and investments

[5] Gustav Gressel/Nick Witney (2022) Out of the dark: Reinventing European defence cooperation, European Council on Foreign Relations.

related to secure and resilient infrastructure, where it is difficult to separate military/civic needs.

Defence R&I directionality, in this sense, and with a single market logic, would not only serve Europe's collective purpose, energy sovereignty and resilience but also create greater potential for the development of dual/multiple use technology, with civilian applications. Much will need to change in the management of the European Defence Agency to become an innovation hub for Europe as a whole, by borrowing from the principles outlined in this paper in terms of approaches and processes. Conversely, the R&I ecosystem could learn from the knowhow of military and defence innovation in terms of closing the gap and time lag between development and deployment, acknowledging the value of rapid, relevant responses.

One of the less conventional but most influential aspects of directionality that Europe will need to dial up through R&I policy and practice – addressed in part by the launch of the New European Bauhaus and the EIT Culture and Creativity KIC – is the work of envisioning and depicting the future we need. Europe's emphasis so far on a science-based and evidence-based rationale for action to halt climate change, address pollution and reverse environmental degradation, relying on leadership comprehension and decisiveness to implement regulatory, policy and capital market mechanisms for industrial transition, has produced a broad-based understanding of cause and effect and therefore of categories of modern living that we need to move away from - high emissions energy sources, frequent consumption of meat, non-biodegradable chemicals and plastics, single use materials etc. What is missing are widely shared, locally nuanced, inspirational and aspirational visions of the life and the economy that we need to move towards. Europe has a long history of creating cultural, social and political identity through powerful acts of imagination written into space and over time through architecture, urbanism, art, theatre, story, fashion and film. The time has come for European R&I policy to comprehend and bring to the centre this critical element of mobilising hearts and minds.

4. Anticipate, adapt and learn

Carrying out transformative R&I policy, including by implementing the Missions, as well as the pursuit of other Commission initiatives, such as Next Generation EU, RePower EU and the Green Deal is taking place in an era of disruptions and in environments characterized by great uncertainty, volatility and necessary adaptation to new knowledge. The ability to predict the changing environment is limited and will be increasingly so as complexity and the speed of change intensifies. This holds true for FP10 as well, with its operational period stretching from 2028 to 2034.

The first basic lesson we can take from the past two years is that Europe must start looking upon disruptions to change policy course and break policy silos (something ESIR has attempted to highlight in the papers published during the COVID-19 crisis). The establishment of **foresight as an institutionalized tool,** as was already highlighted in the 2018 ESIR Memo II: Implementing missions[6], will help to further challenge conventional wisdom and encourage disruptive thinking, which is a path the Commission has been trekking carefully in the past few years, as well as allowing the Commission to work on "the future" as a 360º affair. Scenarios, from the very worst to the most desirable must be proactively used to stress test the relevance and robustness of all policies and strategies, not just for R&I.

[6] European Commission, Directorate-General for Research and Innovation, *ESIR Memorandum II : implementing EU missions*, Publications Office, 2018, https://data.europa.eu/doi/10.2777/900764

Along with foresight, we should also **institutionalize backcasting** – identify the end target first, and then address the problems on the way afterwards through innovation-led processes of testing, learning and developing options for choice and adoption. This will allow for increased resilience when it comes to the European ambitions and the capacity to manage the changes and future crises better, instead of allowing sudden short-term problems to negatively affect long-term goals.

Given high levels of uncertainty and the nature and scale of current challenges, there will be no silver bullet. R&I policy generally, and enabling structures for Missions specifically, need to **see innovation less as an activity of generating static solutions with discrete deliverables and more as a continuous learning and intelligence generating exercise** to support decision-making and civic engagement through innovation options. The demand by many actors for 'perfect solutions' ("Goldrandlösungen") – expressed in overly ambitious requirement specifications for new solutions – kills or limits the power of innovation to generate adaptive responses and unlooked for, serendipitous applications and combinations, as well as effective co-evolution with users. In such a context, Missions offer Europe an opportunity to create rapid learning and demonstration frameworks for exploratory, experimental probes, accelerated solutions development and deployment, and rapid response to achieve adaptive, systemic change.

A more pragmatic, resilience and agility-based approach to R&I would encourage ongoing, emergent interaction and exchange through sensemaking and 'sandboxing' with regulatory questions, political and bureaucratic risk-averseness, open-access engagement, intergenerational obligations (counterfactual risk) and deliberate optionality. To enable transformation as an outcome of R&I investments, policy processes, including regulatory change, need to focus more on breaking path dependencies – in areas such as behaviour, regulations, incentive structures and policy design – that lock us into old patterns of consumption, production and organization. Policymaking needs greater awareness of how to achieve 'unlearning', address lock-ins and overcome inertia of patterns, policies and processes that prevent necessary and desirable change.[7]

Adaptability is also required because mission-driven research comes with a significant degree of uncertainty of outcomes and therefore political and reputational risk. The assertive nature in which some of the five European missions are being described runs the risk, with time passing by of disbelief and disillusion in such mission policies.[8] In other cases, there are also "unintended consequences" of innovation which might require, next to mechanisms of timely feedback, also **a substantial degree of flexibility based on what has become known as a 'whole government' approach**. Secondly, decisions taken in other policy arenas may well have disruptive consequences, for example, phasing out certain forms of energy or agricultural practices, and introducing new technologies whose consequences over the medium to long term are not yet understood.

Flexibility is required to ensure relevance in different national and sectoral contexts: Research and innovation funding needs to be (re)designed to actively encourage and finance a

[7] See the work of the EEIST group (https://eeist.co.uk/) which has developed alternative approaches to economic appraisal based on complexity science – risk/opportunity analyses – that better capture the real economics of innovation and transition, particularly in relation to the challenge of deep decarbonisation, and the opportunity to shape policymaking to trigger positive tipping points for change.

[8] For example: Cities Mission - achieving net zero in over 100 cities by 2030; Adaptation Mission - to have at least 150 regions "to become climate resilient by 2030"; Cancer Mission - "to improve the lives of more than 3 million people by 2030 through prevention, cure and solutions to live longer and better".

constant iterative exchange between research activities and research infrastructure and innovation development and deployment in specific contexts so as to create positive incentives for the application and testing and constant improvement of new ideas and solutions with community and business involvement, and structured feedback or learning loops from the implementation of innovations in situ. Actively encouraging different and/or complementary initiatives to **combine and design multi-dimensional solutions together** should be a structural requirement of R&I instruments and funding, including collaborations amongst competitors addressing related problems. In this regard, increasing institutional trust, through derogation of funding and responsibility for outcomes combined with monitoring of process and impact frames rather than outputs, once again requires a greater emphasis on multi-scale subsidiarity.

The last point requires **new, bespoke impact frameworks** to recognise and observe what emerges and whether/how decision-making and capital allocation is responding. Future fit R&I policy, including FP10, needs to introduce additional, *ex-ante* approaches to modelling, exploring and observing impact through feedback loops and learning approaches that are more suited to complex, adaptive, systemic transformation. Innovation policy to date has tended to focus its impact assessments on evaluations of programs and institutions at the 'micro' (funded institutions/companies) and 'meso' (research system, companies) levels. In the case of the Missions, however, innovation policy is increasingly focusing on impacts at the 'meta' and 'macro' level, i.e. questions about the effects of innovation on achieving the missions on the level of the economy and the environment and changing the paradigms of economy, value and prosperity. The question is not only whether innovations occur, but also whether the generation and diffusion of innovations achieve the mission goals and impact pathways. To answer these questions is of utmost importance for the rationale and the acceptance of the policies and for policies to structure markets. To enable innovation to achieve the goals of the missions and to generate positive reinforcement loops through a sense of possibility and creative experimentation is even more important. This means that flexible revisions and adjustments of Mission implementation will be necessary.

Measuring whether transformation is happening requires a different mindset altogether and might necessitate a further adaptation of the Better Regulation framework so transformation is not only measured in R&I but also in all impact assessments of legislation and regulation.

Box 4: Measuring transformation

Using impact pathways in order to depict different transformation steps towards desired missions has become a consensus in evaluation research. But how should we tackle the challenge of attribution and ex-ante assessment? Within the project "FONA-Impact" a mixed method approach is developed for the German Framework Research Program on Sustainability (FONA 4), which rests on three pillars:

- A combination of proven impact measurement and new impact monitoring procedures with qualitative impact pathways based on the theory of productive interactions, resulting in identification of short-term impact.
- Linking impact monitoring and qualitative impact pathways with future-related knowledge in the form of foresight and impact scenarios to estimate the long-term contribution of research.
- Providing "strategic intelligence" for the further development of the mission oriented research strategy by identifying existing bottlenecks of goal achievement and analysing the interaction processes between stakeholders within the innovation system.

In the case of the EU Missions, their forthcoming evaluation provides an opportunity to put these principles into action. To do so, the review should be designed as a constructive, supportive and genuinely curious/committed effort to look for the enablers/levers that the missions don't have, that would be critical for their success, including: fit-for-purpose impact frameworks and success criteria, support for multi-level stewardship with a mandate for agility and a clear understanding of risk/opportunity decision frameworks, regulatory sandboxes and policy labs to facilitate alignment and reform, capability and capacity building, and derogations to enable flexible portfolio building.

5. Align and integrate

R&I cannot act in a vacuum: its effectiveness depends on linkages with other policies and regulations so as to create an enabling framework that can optimise a systemic approach to change and grow the right kind of demand.

Increasingly, R&I policy also needs to reduce the gap between innovation and deployment, ensuring that emerging disruptive technologies and innovations responding to societal challenges do access the market. How we define R&I determines the distribution of effort: we put an enormous effort into mobilising resources to develop solutions and significantly less into shaping the conditions and the processes for adoption and iteration through adoption and combination with other solutions, making change and transformation happen as a result. In a context of crisis and urgent transformation, **investment in innovation and innovation policy needs just as much focus on the design of change and support for change and adoption processes**.[9]

European governments and the European Commission have demonstrated an ability to mobilize unprecedented volumes of funds in response to (in the face of) the COVID-19 crisis and Ukraine conflict. Now Europe needs to complement this with the willingness and ability to design instruments and policies, rethink processes, mobilize stakeholders and drive much more effective vertical and horizontal coordination and orchestration; in other words, to realign governance and funding approaches to meet the needs of transformation and long-term resilience and overall sustainability."[10] The claim of a prioritization of the sustainability transition in Europe as most explicitly formulated in the European Green Deal, calls for **more careful consideration of alternative policy mixes of the wide variety of instruments that cut across several policy domains** which have hitherto been isolated from, or poorly connected with each other. These range from research and innovation to industrial and agriculture policy, and often include environmental policy, health policy, social policy, transport policy, trade policy and other policy fields. Simply put, the European Commission is organized around policy areas and instruments, which are not suited to tackle the cross-cutting nature of the transition(s) required. DG RTD might have the responsibility over the financial resources through the Horizon Europe programme but not over the appropriate implementation tools. FP10 is an opportunity to re-evaluate the current division of labour and to bring DG RTD closer to the implementation phase. This strategic repositioning should equip DG RTD with the necessary policy tools to ensure the successful uptake of innovation.

[9] All initiatives within the Horizon, apart from ERC (pure blue sky research) should be seen as embedded in the TRL and topical framework. EIC is an example of such integration. It has its flaws still: Widening non-effective; Higher TRLs bring a specific and strong private interest, which is hard to harbour and affects the direct evaluation procedures. For the outcomes not to be affected, the complex processes imposed might bring on complex decision-making and time-consuming procedures.

[10] Schwaag Serger, S. and L. Soete (2022), "Addressing crises: In search of synergies of funding and governance", Paper prepared for the JRC Seville Forum April 7, 2022

This is also visible in the case of EU Missions which depend upon engaging key stakeholders, including industry, SMEs and local communities, in co-design of change and on diffusing innovations, including social innovations, on a large scale, which brings regulation, procurement and demand-side finance and policy into focus. The responsibility for these policies, however, are usually sitting at national level with ministries responsible for individual, separately budgeted sectors (e.g. energy, climate, water, soil, health) with the result that horizontal coordination of innovation policies between the different ministries is particularly challenging and yet essential for mission-oriented innovation policies. Governance of the Missions within the European Commission has been experimenting with more distributed and shared accountability among Commission DGs which has proven challenging but necessary and is showing signs of success, in part by throwing into high relief disconnects between policies and priorities across different DGs and between the Commission and Member States. To achieve sustained transformation through poly-crisis, European R&I policy in general will need to continue in this vein with substantially more systemic approaches – in funding architecture, funding instruments and funding governance – that are suited to enable holistic systems thinking, risk taking, discovery and transformative efforts. We need **governance that is enabling and integrative not limiting**, including a significant broadening of the policy focus from the earlier strong emphasis on research and innovation as invention and strengthening of innovation capacities towards paying closer attention to various deployment and diffusion barriers within a much wider societal context than the one of research and traditional research institutions. This means a much broader number of constituencies involved and a much larger spectrum of specialized policy fields given the nature of the grand challenges that the different missions are supposed to address.

Subsidiarity takes on a new meaning in such a context, with regional and local authorities assuming a much bigger role in implementing and experimenting locally within the framework of the five missions, but also in coordinating – bilaterally, multilaterally, and across national/borders – the essential monitoring and evaluation exercises. Regions and municipalities could be said to be at the frontline of having to combine the three dimensions of sustainability as set out in the 2030 Agenda– environmental, economic and social. In particular, they will be most directly and immediately impacted by developments affecting the balance among the three, for example economic and social consequences of large employers expanding or contracting in their jurisdictions, the required clean energy transition, environmental disasters such as flooding, drought and wildfires, etc. At the same time, manifestations of many of the EU's external policy challenges – geopolitical conflicts and wars, trade wars, climate change – affect regions and municipalities acutely and tangibly as in the case of large influxes of refugees or the sudden need to become independent of Russian oil or gas.

Up until now, the role of regions and municipalities in innovation policy, and particularly in driving directionality and striving for overall sustainability has been neglected. This holds both for the internal European mission-oriented innovation policies, as well as for the broader global external policy challenges of the EU within the framework of the UN SDGs. A future-fit R&I policy and the forthcoming review of the Missions needs to embrace much more explicitly the critical role of regions and municipalities and enable local levels of action. **Multiscale and multilevel engagement should be a feature not a bug in R&I policy** with derogations and tools to better support and enable subnational actions where need for accelerated transformation and resilience are palpable and opportunities for integrated systemic R&I development and deployment are evident. Such an approach i.e., re-aligning instruments more towards local and regional transformation imperatives, dynamics and potential, would amplify the impact of a range of programs by improving coordination across possible policy silos and enhancing the ability quickly to address missing synergies between the efforts of stakeholders. From this perspective, national and supranational governance levels would then need to support the regions' ability to drive transformation.

This will require new ways of working across government departments and levels focused on addressing local challenges. Doing so, such policy can be firmly anchored in the EU policy framework, supporting on the ground a place-based approach towards the implementation of the European Green Deal, the EU industrial policy strategy, Horizon Europe, Cohesion policy and the Recovery and Resilience Facility. It implies a realignment of policies addressing the fragmentation of funding instruments and policies in the territories, and the disconnection of regional/national initiatives from those of the EU. **Actual involvement needs to be significantly stronger and this needs to be further emphasised and enabled in the detailed requirements and expectations of R&I policy** so as to shift to a wider and deeper engagement in innovation, both for legitimisation and for contextual quality.

Box 5: Multiscale and multilevel engagement in Spain: the national Cities Mission platform

In 2022, the Government of Spain launched a national, multi-stakeholder platform aimed at accelerating decarbonization and transformation of Spanish cities by 2030, linked to the EU Mission on Climate Neutral and Smart Cities. The platform is aimed at providing services to Spanish cities to facilitate and accelerate systemic transformation. Its main beneficiaries are Spanish cities that wish to make a commitment to move towards climate neutrality by 2030 – including the 7 Spanish cities selected into the European Cities Mission – with a focus on cities with more than 50,000 inhabitants or provincial capitals that wish to achieve total or partial climate neutrality by 2030. In addition, the platform will also offer certain services to cities with more than 20,000 inhabitants.

The platform provides a space for dialogue and multi-stakeholder action (public-private) for the collaboration of Spanish cities on the path towards climate neutrality. It has inspired and facilitated the launch of other initiatives as citiES2030, building on which it is now possible to broaden and deepen the collaboration between Spanish cities with a mission-driven approach. The services provided by the Spanish national platform include:

- training, learning and capacity building;
- incubation of “multi-city” transformative projects with a focus on urban regeneration (massive energy retrofitting of buildings), nature-based solutions, circular economy and mobility;
- citizen participation and activation;
- assistance to cities for the structuring of Climate Investment Plans, involving actors from the financial field;
- strategic communication;
- evaluation and monitoring of progress towards climate neutrality and systemic transformation within the framework of the European Cities Mission.

Many of the most interesting innovators in Europe, especially in the social space, do not try to engage with publicly funded innovation and European programming because it is too difficult, complicated and time consuming with the result that those who participate in EC R&I applications and funding are those who can afford to professionalise their understanding of the system and repeat bid. Similarly, the design of R&I efforts needs to **engage and empower SMEs as drivers of local transformation** in regions through tailored – transformative rather than incremental – SME instruments and engagement, recognising that the vast majority of European industry and business are SMEs whose access to and capacity for R&I are constrained and not always effectively integrated into actions.

Another area for alignment pertains to skills**. Europe’s R&I policy needs to pay careful attention to the readiness of mindsets, capabilities and skills**, investing more explicitly

in relevant capabilities and leadership. In the wake of COVID-19, skills and labour shortages are visibly widespread and causing significant disruption. Less visible and more critical is the deficit in skills needed to deliver deep decarbonisation, environmental regeneration and climate adaptation: for example, servicing installation and maintenance of renewable energy technologies, scaling regenerative farming practices, designing circular business models, and nature-based solutions. These are problems in content of technical knowledge, experience, educational incentives and vocational training, social norms and access to research and education infrastructure.

One important dimension of the skills gap, which represents a very significant barrier to transformative change and innovation is the lack of widespread familiarity, comprehension and skill in **complexity thinking and systems thinking.** Such mindsets and skillsets that are rarely taught systematically in schools and universities and are actively marginalised or disincentivised in the majority of employment contexts where a reliance on linear, mechanistic thinking and engineering paradigms is tangled up with notions of performance, commercial success and management development and practice. Few people are sufficiently prepared for agile learning, strategic, systemic, complex adaptive approaches to running businesses and government in the current context and to making sense of what is going on around them. Political and economic decision making, R&I policy, financial policy and resource mobilisation all suffer from dominant paradigms of linear, problem-solution thinking and an assumption of logical rationality. To achieve transformative innovation and transformative resilience, developing complexity-friendly mindsets and effective leadership in complexity needs to be a priority, embedded in every initiative and required as a condition of engagement. The EU Pact for Skills needs to reflect this much more explicitly and come alongside the implementation of Missions and other Horizon Europe programmes[11] with particular focus on areas where new skills and vision are most urgently needed, including governance and economic thinking so as to move away from the paradigm of growth towards wellbeing, sufficiency and regeneration.

6. Conclusion

The first time EU leaders set a target for EU energy consumption coming from renewable energy was in 2009. 14 years later, when faced with the decision of changing energy consumption habits or funding a war, only two countries in the EU were able to rely on their renewable energy production to avoid this moral dilemma. In the current context, and looking forward, Europe will need to ensure that R&I policy, discussions, legislation and increasing ambition manage to get European responses to grand challenges – now framed as 'missions' – on the right track quickly and exponentially.

In a context of uncertainty and volatility, innovation is above all a means for achieving deliberately chosen change (rather than crisis-induced change) through exploration, experimentation, rapid iteration and hence experiential learning. Innovation – used as recommended in this paper – provides the vehicle to involve all actors, in creative and generative ways; it brings hope and positive reinforcement for action towards a future that inspires and reassures, it facilitates managed transitions rather than stumbling through reactive responses to events; and it generates viable alternatives to enable transformation of otherwise habitual patterns of investment and short-term thinking. Both the upcoming FP10 and the existing Missions offer the opportunity to embrace change and innovation as a positive response to the age of poly-crisis. The Missions serve as a valuable test-bed to explore some of these principles, while FP10 provides the chance to completely re-design a

[11] See forthcoming ESIR policy brief ""Industry 5.0 and the future of work: making Europe the centre of gravity for future good-quality jobs in the poly-crisis age".

European research programme from the ground up, incorporating the four principles that we outlined in this policy brief: taking risk to manage risk; directing the action; anticipating, adapting and learning; and aligning and integrating.

Given the intensifying puzzle that Europe faces: protect citizens and the economy in the short term, prepare both for future shocks by creating greater resilience "by design, not by disaster", and at the same time, sow the seeds of transformative, systemic change to promote prosperity in the long-term, Europe needs to make courageous choices with respect to its approach to R&I. Only by achieving all these goals in an integrated way and in time, will the EU be able to protect its values and ambition, without compromising on its vision of sustainable prosperity and strategic autonomy.

Now is the time to make a difference, step aside from a business-as-usual approach to legislative frameworks, policy assumptions, funding practices and established assessment processes; to have the courage to do different in order to achieve something radically different.

These conclusions are aligned with the key recommendations of ESIR to date, as follows[12]:

- **An integrated 'people, planet and prosperity' R&I policy agenda** that creates greater resilience "by design, not by disaster" through a 'protect-prepare-transform' design that helps Europe achieve its transition goals within a context of a continuum of crises.

- **Deep transformation of the European Industry with a key role for R&I**. This transformation will support Europe's ambition to become more sustainable, resilient, regenerative and circular. ESIR proposes a deep systemic transformation of the European Industry that will secure people's lives and livelihoods whilst living within planetary boundaries.

- The European Commission should champion a **transformation of the European research and innovation ecosystem** fostering radical, new ways of thinking, and turning ideas into new powerful policies and funding instruments. Within this transformation, local and regional authorities, universities and other higher education and training institutions, local communities and stakeholders are key actors to consider.

[12] European Commission, Directorate-General for Research and Innovation, ESIR 2020-2021 : main achievements, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/303

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This ESIR policy brief explores how Europe's research and innovation (R&I) policy can make a decisive contribution to Europe's 'earthshot', i.e. creating a Europe where citizens live well, at peace and within planetary boundaries. It calls for R&I to adapt quickly, to be effective for a context of continual mega-crises, complexity and insecurity, and to fully align with the resulting societal and policy challenges. The authors recommend European R&I policy, the next Framework Programme, and the EU Missions, to embrace four principles in order to be fit for the 2030s:
Take risk to manage risk; direct the action; anticipate, adapt and learn; and align and integrate.

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