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Making the most of EU Research and Innovation Investments: **Rethinking dual use**

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Making the most of EU Research and Innovation Investments: Rethinking dual use

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Manuscript completed in April 2025
1st edition

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PDF ISBN978-92-68-26286-3 doi: 10.2777/6637451 KI-01-25-078-EN-N

Luxembourg: Publications Office of the European Union, 2025

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EUROPEAN COMMISSION

Making the most of EU Research and Innovation Investments: Rethinking dual use

A policy brief by the Expert Group on the Economic and Societal impact of Research & Innovation

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MAKING THE MOST OF EU RESEARCH AND INNOVATION INVESTMENTS: RETHINKING DUAL USE

Summary

Significant political, geopolitical, and technological shifts are currently unfolding, with far-reaching consequences for Europe's economy and security. The war on Ukraine, climate change, and rising geopolitical tensions are destabilising long-standing alliances and partnerships. They are furthermore disrupting established global value chains and flows of goods and services. At the same time, the rapid advancement of Artificial Intelligence (AI) in the US and China highlights the need for Europe to strengthen its technological capabilities.

The changing geopolitical and geoeconomic environments are prompting increases in government defence spending across the European Union (EU) that few would have predicted just a few months ago. The speed, scale, and direction of these changes underline the importance that the EU puts in place mechanisms and structures to capture more effectively the synergies between research and innovation on the one hand and defence and security on the other. The changing nature of warfare, closely linked to the development of general-purpose technologies, not least AI, further accentuates the need for a revised and more systematic EU approach to dual use. History shows that defence is one of the most powerful drivers of technological development and innovation, at the same time as non-military (or civilian) research and innovation are critical in building military strength and guaranteeing national security. Strengthening the linkages and synergies between the two, while at the same time managing potential risks, is essential for both our continent's economic development and our ability to defend ourselves.

Dual-use technologies are at the heart of innovation in sectors ranging from space and cybersecurity to AI and advanced manufacturing. In a rapidly evolving geopolitical landscape, the ability to coordinate, invest in, and regulate dual use R&D is essential for strategic autonomy and long-term resilience. Managing these technologies smoothly enables the EU to harness their full potential for economic growth while safeguarding sensitive research and promoting responsible innovation. Effectively managing and enabling dual-use research and development is thus an integral part of equipping the EU for a more dangerous and contested future. In a time of increasing pressures on sustainability, security, prosperity and government budgets, it is critical for the EU's future that synergies are exploited more generally and actively within all areas to ensure maximum return on and efficiency of R&I investments. This requires systems thinking, with dual use R&I being an integral component of such thinking.

In this report, we argue that the EU should adopt a 'dual use by design' approach (Preparedness Union Strategy 2025), as a vital pillar for ensuring Europe's security, competitiveness and prosperity. We advocate that Europe integrates dual-use research into the next EU Framework Programme and aligns it with the European Defence Fund; fosters collaboration between civilian and military sectors while managing security through ethical governance; applies the principle "as open as possible, as secure as necessary" to balance innovation and safety; and establish ethics and safety committees in research institutions with clear incident reporting systems. Our suggested actions also entail educating both researchers and security professionals on dual-use risks and opportunities.

We acknowledge and fully endorse that the European project is, at its core, a peace project, and should remain so. Rethinking dual use in the way we propose is not in conflict with that aim – rather it is a vital component of ensuring Europe's ability to defend itself while ensuring that technology serves people, prosperity and the planet.

Background

The European Union has traditionally not used its research and innovation (R&I) funds for projects and initiatives that could lend themselves to military uses. Nevertheless, while funding research that is exclusively or primarily aimed at military applications has been excluded from the remit of programmes such as Horizon Europe, and left to other channels such as the European Defence Fund (EDF), a clear need has now emerged to reconsider this traditional approach in favour of a more significant effort to leverage dual use R&I to enhance Europe's security and competitiveness. In an earlier ESIR paper (2023), it was argued that "[i]n a time of increasing geopolitical tensions where our freedom and democracy are increasingly threatened, innovation, security and sustainability need to cross-fertilize and reinforce each other" (p.10).[1] In that publication, we also advocated for Europe to "assume a leading position in linking defence, innovation and sustainability – *triple use* – for the benefit of national security and competitiveness".

In 2024, the European Commission published a White Paper setting out different approaches to handling dual-use technologies in the forthcoming framework programme for R&I (FP10). The document highlighted the absence of a clear, universally acknowledged definition of dual-use R&I, but broadly defined it as related to "software and technology that has the potential to be used for both civil and military purposes" (p.1). In the White Paper (Section 4), the Commission explored three main scenarios with different setups for supporting dual-use technologies in the R&I domain: Option 1 consisted of maintaining the current framework (status quo) while "implementing incremental improvements" [p.13]. Option 2 involved removing "the exclusive focus on civil applications in selected parts of the successor programme to Horizon Europe" [p.14]. Option 3 proposed creating "a dedicated instrument with a specific focus on R&D with dual-use potential" [p.16].

In a public consultation launched by the European Commission on the three options and concluded in April 2024, the research and academic community expressed views mostly in favour of maintaining the *status quo*, which would bar dual-use R&I funding in future framework programmes. Associated countries, e.g. Switzerland, have been very clear in demanding that FP10 remains purely civilian, not least due to fears of exclusion from certain projects, and increase in administrative burdens. Some respondents similarly expressed concern that opening FP10 to dual-use would make collaboration with foreign partners more difficult and might undermine trust in science. This position was recently echoed by South Korea. More generally, options two and three were seen to potentially complicate the prospective association of Canada, Japan, Korea and New Zealand to FP10. In contrast, private sector companies and business associations were mostly in favour of allowing dual-use in future framework programmes. Given the evolving geopolitical landscape, however, and the EU's vulnerabilities in defence and competitiveness, some research organisations (e.g., The Norwegian School of Science and Technology) have expressed a willingness to explore the option of permitting dual use, seen as enhancing the EU's long-term competence in critical sectors such as AI, biotech, sensors and cybernetics.

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1 ESIR Policy Brief 'Research, innovation, and technology policy in times of geopolitical competition', https://op.europa.eu/en/publication-detail/-/publication/6dc11e64-6bd6-11ee-9220-01aa75ed71a1/language-en

The report authored by Sauli Niinistö in 2024 ushered in a major rethink of the *modus operandi* of the EU when it comes to security and preparedness, leading to several policy recommendations and eventually spurring new initiatives such as the recently presented Preparedness Union strategy, which goes as far as advocating the promotion of dual use by design , claiming that the EU must integrate dual-use considerations into all of its infrastructure investments and capability planning. The Niinistö report advocated stronger dual-use and civil-military cooperation at the EU level, based on a whole-of-government approach. Among the recommendations, the report highlighted the need for a review of the EU's dual use potential across all relevant domains to identify new synergies. The report also argued that there is a need to further examine and harmonise dual use definitions in various relevant EU funding instruments and policies. Within each area, the legal and regulatory margins should be fully explored, considering the specificities of the sector and defence-related actors respectively. Enhancing synergies between defence and civil security applications, the report argues, would optimise the use of scarce resources.

The Draghi report also touched upon the issue of dual use, claiming that defence and dual-use-related considerations should be fully embedded in the EU's work on critical (foundational) technologies, such as AI and quantum, especially in terms of promoting the EU's advances in this field to reduce dependencies and protect against technology leakage. A stronger link will be needed, according to Draghi, between the defence industry and other strategic industrial sectors that form part of the same ecosystem, such as naval/shipbuilding, space, aerospace, etc. The defence sector forms part of a broader strategic industrial ecosystem that relies on similar or interchangeable raw materials, technologies, skills, machines, and other industrial infrastructure. The report recommended, among other things, to establish a structured civilian security capability development programme to better coordinate investments in the distinct but parallel areas of civil security and defence. Such a process should be supported by consistent EU funding schemes. This would, however, require structurally reforming planning in the highly fragmented civil security sector, moving towards greater agility, standardisation and collaboration.

In line with the Draghi report, the Heitor report advocated that the EU "[e]mbrace the fact that dual use occurs naturally given the ubiquitous nature of modern technology […] and the broad needs of a modern military" (p.9). As a result, the EU should seek to "optimise the innovation dividend arising from the need for increased national security and defence expenditure by exploiting dual use both ways" (p.9).

In line with better regulation principles, the above-mentioned 2024 White Paper explored prospective positive and negative effects of alternative scenarios but did not go as far as mapping all potential impacts, including the opportunity cost of failing to escalate European investments in dual-use R&I. This refers to the direct and indirect negative consequences that the EU would face if it decided not to move towards a more expansive approach to the funding of dual-use R&D. In 2024 this opportunity cost was already self-evident, given the ongoing war in Ukraine and the growing pressure for Europe to strengthen its strategic autonomy and security. These factors, combined with geopolitical disruptions caused by the election of Donald Trump as U.S. President, have led opportunity costs to skyrocket, prompting an acceleration in Europe's plans to "rearm" itself and boost its investment in defence for the coming years. Several countries, from Germany to Poland and Sweden, have responded by quickly redefining their priorities to massively increase spending in defence.

Why it is time to rethink EU dual-use R&I policy

Does it make sense to refer to dual-use R&I?

Since 2010, the EU has adopted an approach to funding that explicitly embraces responsible Research and Innovation (RRI). The RRI framework sets high ethical standards and mandates that recipients of funds anticipate possible misuses of the products of their research and adopt mitigating measures to avoid publicly funded R&I developing into detrimental outcomes. This means that EU institutions and funding agencies should avoid funding R&I for purely military purposes; and should apply strict conditionalities when funding the development of products or technologies that, originally conceived for civilian purposes, can also be (mis)used for military purposes. This set of responsibilities falls on both the funding authority and the recipients, who should ensure that the results of their R&I activities are not translated into military applications.

Over the past decade, **researchers and experts have gradually reconsidered the approach to dual-use R&I, acknowledging the need for a broader definition**, and emphasising how dual-use R&I can have both positive and negative purposes (see e.g. Ienca, Jotterand, and Elger 2018; Kavouras and Charitidis 2019; Oltmann 2015; Ulnicane 2020) in a broad range of domains such as political, security, military, and intelligence (Giordano and Evers 2018; Mahfoud et al. 2018). Ulnicane et al. (2023) highlight the constraints imposed by the dual-use approach of the EU Framework Programme for R&I on the Human Brain Project (HBP), as opposed to U.S.-funded brain research. At the same time, the HBP devoted a lot of attention to the issue of ethics, setting international standards with respect to responsible research and innovation in neuroscience, and drafting a separate Opinion on Responsible Dual-Use.

More broadly, **a reflection has emerged over the past decade about the need to redefine the boundaries and relationships between science, security, and society**. For example, Weiss Evans (2022) argues that, at least in some areas, for example biosecurity, "all research is dual use". This is sometimes referred to as the "strong dual-use thesis" (Miller and Selgelid 2007), which refers to the unpredictability of scientific discovery, the lack of control of the use of scientific findings, and historical evidence that many breakthroughs initially developed for civilian use (e.g., GPS, antibiotics, computing, even mathematics) later were found to have military or security applications. On the other hand, the "weak dual-use thesis" considers that only part of R&I is actually dual-use.

Importantly, the past years have seen growing attention towards the possible misuses of the results of R&I projects, mostly in the life sciences and in engineering, including computer science. There are several reasons for this emerging trend. Firstly, recent decades have seen **the rise of so-called "converging technologies"**, which leverage previous domains of study, advanced computer science and unprecedented data availability to achieve scientific results. Critical technologies such as AI, biotechnology, quantum computing, and nanotechnology are inherently dual-use. For example, CRISPR gene-editing can be used for curing diseases, but also to develop bioweapons.[2] Generative AI can produce art, assist children in education, but also spread disinformation.

Secondly, and even more specifically, the advent of powerful AI foundation models, currently based on variants of deep learning and neuro-symbolic models (e.g. AlphaFold), is changing the entire scientific enterprise, increasing the **reliance on versatile, general-purpose**

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2 DiEuliis D, Giordano J. Why Gene Editors Like CRISPR/Cas May Be a Game-Changer for Neuroweapons. Health Secur. 2017 May/Jun;15(3):296-302. doi: 10.1089/hs.2016.0120. Epub 2017 Jun 2. PMID: 28574731; PMCID: PMC5510677.

technologies which lend themselves to a variety of potential downstream applications. The expression "General-Purpose AI Systems", or GPAIS, is now used in the EU AI Act and has prompted EU legislators to define a new set of rules, regulating these models even before downstream deployment takes place, and devising even stricter rules for powerful models which create (in the legislator's interpretation) systemic risks.

Thirdly, the increased reliance on software applications (including AI) and the embedded culture of openness and reproducibility of research results are facilitating the **democratisation of science**, and the reuse of powerful scientific solutions for malicious means. In particular, open-source AI is enabling lower-cost access to cutting-edge solutions (e.g. Meta LlaMa, Mistral AI, DeepSeek R2), but at the same time it can be used to power cyberattacks or develop biological weapons.

Fourthly, the **rise of the Internet as a repository of (not always accurate) knowledge**, coupled with the limited effectiveness of the online protection of intellectual property, has led to an unprecedented availability of data and information that can be converted into malicious uses of existing technologies. This can then be converted into military or terrorist actions carried out by state or non-state actors, mostly leveraging information environments such as the "dark web"[3]). Another example on the civilian side for example involves so-called predatory publishers exploiting open access policy to disseminate pseudoscience.

Finally, and relatedly, the **boundary between military and non-military operations** has become increasingly porous and blurred over the past decade. Relevant examples include the use of disinformation campaigns as hostile, state-sponsored activities; the weaponisation of civilian devices; and the demand for military-scale responses and technologies to address climate-related events.

These trends have important consequences for EU R&I policy, making it important to observe the patterns of knowledge creation and the role of general-purpose, foundational technologies as opposed to downstream, higher-TRL applications. Figure 1 depicts a stylised model of the innovation process embedding dual-use R&I. In research phases with low TRL levels, existing scientific knowledge is combined in research programmes with new insights to produce new scientific output (left-hand side of Figure 1). Typically, this research output need not be specific with regard to military or civil use. More specifically, at this stage, it is often impossible to envision all future military or civil applications of the technology. In intermediate research phases, research includes user-oriented knowledge to steer research towards user needs. Sometimes users are included in this phase as active partners (co-designers) in the research projects. This occurs in both defence and civilian research programs. The resulting output can be transferred to the development of products and goods and upscaling processes (right-hand side of Figure 1). If the output from research has dual-use potential, it can be transferred to both the development of civilian and military goods.

More recently, it is argued that "the source of novelty is often found in secondary effects of technologies, artefacts and materials already deployed in the economy (Andriani and Kaminska 2021, p. 1).[4] This so-called "exaptive" mode of novelty production, i.e. the discovery of new functions for a technology, is not merely another form of knowledge transfer but is characterised by a discovery process based on the underlying technology for a new

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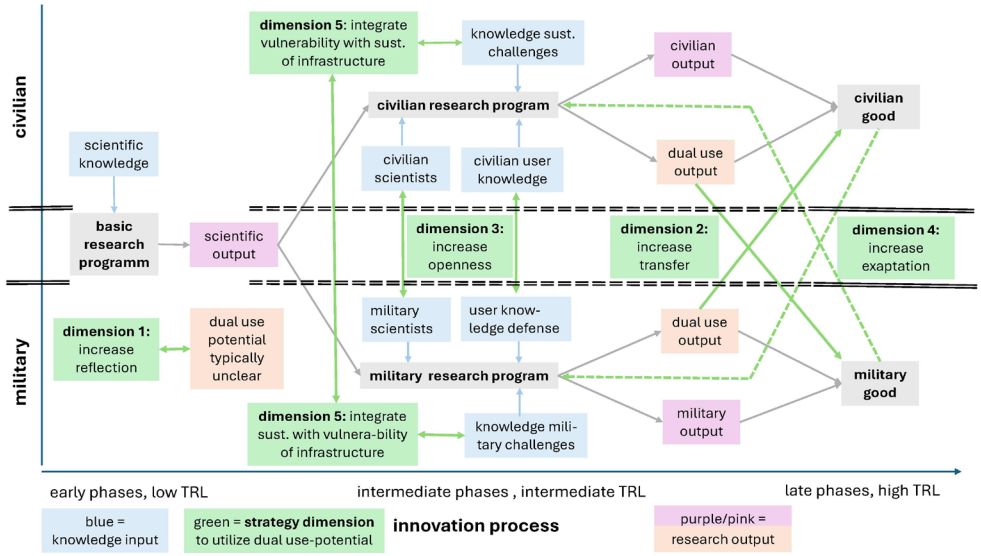
3 The dissemination of military secrets on the internet has been a growing phenomenon, and the unregulated "dark web" has played a role in furthering these concerns. NATO, for example, is devoting growing attention to military documents being sold on the dark web

4 Andriani, P.; Kaminska, R. (2021): Exploring the dynamics of novelty production through exaptation: a historical analysis of coal tar-based innovations, Research Policy 50 (2), 104171

function (Catani and Andriani 2016; Beltagui et al. 2020; Andriani and Kaminska 2021)[5]. Thus, it requires going back from a deployed good or technology towards R&D again. Such an exaptation can broaden the pool of knowledge flows from the civilian research to defence application and vice versa beyond the transfer of technologies based on the same function it serves.

The research process described here, from innovation phases with low TRL towards innovation phases with high TRL, is not linear, but recursive with feedback-loops from development and diffusion of goods in the market back to earlier research phases. Furthermore, the time frame of the innovation process, or the distance between low and high TRLs, can differ significantly, depending on the technology. For some technologies, the time lag between the phases becomes very short, and the types of research move close together.

Figure 1: Stylized model of embedding dual-use research in the innovation process and resulting dual-use strategy dimensions



Source: own compilation of authors

If we systemise and embed these aspects into a stylised model of dual use knowledge generation and diffusion, a strategy with five dimensions emerges to enhance the potential for dual-use innovation (green text fields and green arrows in Figure 1):

- *Dimension 1*: *Increasing the awareness and reflection of researchers, administrators and funders regarding the potential end use of their research but also the potential time lags for the potential use*. This is a fundamental but frequently neglected issue not only for dual use but also for sustainability research. Such increased awareness and reflection promotes early detection of the dual-use potential of scientific output, thus enhancing understanding for both risks and opportunities.

5 Andriani, P.; Kaminska, R. (2021), ibid; Beltagui, A., Rosli, A., Candi, M. (2020): Exaptation in a digital innovation ecosystem: The disruptive impacts of 3D printing, Research Policy 49 (1), 103833; Catani, G.; Andriani, P. (2016): Exaptation as source of creativity, innovation, and diversity: Introduction to the special section. Industrial and Corporate Change 25(1):115-131.

- *Dimension 2*: *Increasing the transfer of research output* from civilian research to development of military applications and from military research to civilian products and services.
- *Dimension 3: Increasing the openness with regard to integration of scientists* and providers of user-specific military knowledge into civilian research programs, and vice versa.
- *Dimension 4*: *Increasing the identification of unknown functions (exaptation) of civilian goods as input for further military research*. The same also applies for *exaptation from military goods as input into further civilian research.*
- *Dimension 5*: Linking defence-related efforts to reduce vulnerabilities with civilian sustainability challenges to enable *more integrated research especially for life-supporting services and infrastructure*, which targets reduced vulnerabilities towards military threats and increased sustainability and climate resilience simultaneously (see also section 3.1 with more details).

These dimensions to enhance the potential of dual-use R&I are not without caveats. Knowledge about military and security relevant research is typically restricted and requires confidentiality. This poses limits to the exchange of knowledge. On the other hand, ethical considerations might limit the availability and acceptance of scientists to engage in research with potential military applications (see section "Ethical implications of moving towards broader dual-use funding" below). This can limit the exchange of knowledge and participation from the civilian perspective. The resulting trade-offs are inevitable; however, their significance differs between the strategies. In the early research phases, where dimension 1 is positioned, they tend to be less pronounced, because the research output is still rather non-specific. The same holds for dimension 5 (framing of the challenges), focusing on life-supporting services and infrastructures, which are per se less specific for military technologies and use. The trade-off is most pronounced for increasing the openness between civilian and military researchers and users in the research process (dimension 3). The dual use-potential of knowledge generation only increases if civilian and military research are exchanging not only codified but also tacit knowledge - otherwise it would be only dual use research by name, but not by substance. However, this also means that the potential risk with regards to security of the research is higher.

These different stylised strategies also provide some insight for the debate about the three options proposed in the White Paper on dual use (see section "Background" above). Option 1 of the White Paper targets in particular the strategy to increase the transfer of research output with dual-use potential from civilian research to development of military goods. Option 2 of the White Paper also targets the increase of the available knowledge base by facilitating the access of actors from the civilian respective military side to participate in both civilian and military research. Thus, option 2 targets not only the transfer from civilian to military research (dimension 2), but also the production of the research itself (dimension 3). Option 3 of the White Paper targets the same dual-use strategies as Option 2, however with a more separated institutional setup. It also becomes clear that the strategy of increasing reflection, of integrating military and civilian challenges and of exaptation are not addressed by the White paper. At first glance, the strategy of exaptation (dimension 4) seems to have parallels with Option 1 in the White paper, as both address the identification of the dual-use potential of existing knowledge.

However, exaptation is the identification of unknown new functions for a technology, not the transfer of the same function to another application. Thus, fostering exaptation would require establishing mechanisms to scrutinise research output systematically with regard to unknown

functions. This is a systematic research process in itself. The strategy to integrate civilian and military challenges as guiding research deserves special attention, as it provides important opportunities for synergies between security/defence, sustainability, climate resilience and innovation, as also shown in section 2.1. To utilise these synergies, it is necessary to integrate the military and security challenges with several other challenges already in the framing of both the civilian and military research programs.

Overall, in a time of increasing pressures on sustainability, adaptation to climate change effects, security, prosperity and government budgets, it is critical that synergies are exploited more generally and actively within all areas to ensure maximum return on and efficiency of R&I investments. Thus, the current era, perhaps more than previous eras, requires systems thinking in its approach to R&I, with dual use R&I being an integral component of such thinking. Only such an integrated framing assures that the potential synergies are then integrated into the research goals of the respective research proposals. However, this does not constitute a civil-military fusion of research, but relates to life-supporting services and infrastructures, which are per se less specific for military technologies and use.

Recognising the Strategic Importance of Dual-Use R&I Funding

Against the background portrayed in the previous sections, funding dual-use R&I today becomes of utmost importance for the European Union, and its ability to rise to the combination of security, strategic autonomy, competitiveness and potentially even sustainability challenges our continent faces today. While the European Defence Fund, with its 8 billion Euros for 2021-2027, mostly prioritises interoperability between national military equipment and forces, and the development of weapons (e.g. iMUGS, OCEAN2020, etc.), R&I funding should explore research pathways that, while satisfying Europe's imminent need for security, also provide new ground-breaking solutions for European competitiveness, sustainability, and its future security and resilience.

In the coming months and years, a surge in defence investment, with the deployment of EU and national funds, as well as private sector funds, is to be expected. It would be naive to imagine that such an increased spending level would not affect the availability of funds for civilian R&I. Accordingly, dual-use R&I funding becomes a needed avenue for ensuring that the funds that will be inevitably channelled to defence do not come at the expense of civilian solutions. Fortunately, avoiding competition for funding between dual-use and civilian research is still possible since, as explained in Section 1 above, most life sciences, computer science and engineering domains today are either part of low-TRL, convergent science; or belong to eminently dual-use sectors.

A further aspect that deserves attention is that, as pointed out by the European Commission, currently "EU defence investments predominantly prioritise the acquisition of defence equipment over R&D" (p. 109). As the prospect of war rises, this prioritisation is likely to become even more pronounced. This tendency further underlines the importance, firstly, of establishing closer interaction between relevant parts of the civilian research system and the military, and secondly, of considering introducing a quota for the share of military defence expenditure.

While there is a clear need for differentiation in the application of dual-use research regulation to different research activities and programmes, there is also a clear need to remove some of the traditional barriers for developing dual-use research in order to extract greater benefits from the EU investment in research and innovation. The way to handle this issue is to:

- **Strengthen the focus on general-purpose technologies, such as Artificial Intelligence**, by ensuring a comprehensive approach to research and possible higher-TRL civilian and military applications.[6] The proposed "CERN for AI", as suggested by various sources (including the Scientific Advice Mechanism to the European Commission) should focus on achieving scientific breakthroughs in AI (e.g. trustworthiness) as well as in related layers in the technology stack (computer, semiconductors, but also data governance, privacy-enhancing technologies, etc.). This, as also mentioned recently in the Competitiveness Compass, should then lead to downstream activities in the domain of science (where as explained, practically every sub-domain is dual-use), industrial robotics (where dual-use domains should be prioritised to maximise the availability of resources) and digital public services (where pure civilian applications are likely to emerge).
- **Strengthen the instruments devoted to technology transfer between military and civilian applications.** Both the United States and China have made so-called dual-use technology integration (DTI) governance a feature of their innovation systems, by promoting technology transfer across defence and civil systems (Meng and Wang 2023). Models of technology transfer from the military to the civilian space have been extensively studied and implemented around the world, including by the European Defence Agency. In the future, the establishment of ARPA-like institutions and dedicated, agile platforms for startups under the future MFF could boost tech transfer, enabling a civilian future for technologies and solutions initially developed for the defence sector. ARPA-style institutions could adopt a sandbox approach to commercialising miliary technology for civilian purposes. Not surprisingly, the European Commission recently clarified that the European Innovation Council (EIC) and the planned TechEU Scale-up Fund will be permitted to invest in dual-use technologies.

[6] "General-Purpose Technologies" do not mean "low TRL", but rather a technology that interrelates with many different fields and can support the development of new technologies.

Policy Implications

On Research and Innovation

Achieving a more efficient allocation of scientific and research funding necessitates a shift beyond merely reactive financing and fostering innovation. Policymakers can generate significant positive added value by strategically directing public funding toward supporting research with broad societal benefits. This requires political institutions capable of mobilising resources through targeted subsidies and incentives, including market creation, ensuring that innovation progresses rapidly while aligning the research with long-term public interests. Mobilising dual-use R&I in the EU to boost innovativeness, resilience and competitiveness is already recognised through a need to enhance the EU technological and industrial base, improve security, and maintain global competitiveness. Dual-use research could be crucial to reaching these goals by leveraging synergies between the civil and defence sector, as many cutting-edge technologies developed for defence purposes, such as cybersecurity, AI, quantum computing, and materials science, can have significant civilian applications.

The EU can accelerate the transfer of these technologies to markets by fostering collaboration between the defence and civilian sectors, driving innovation in both industries, which would also contribute to the cost-effectiveness. Sharing research and infrastructure costs between civilian and defence sectors allows for more efficient use of resources, reducing duplication of effort and accelerating development. Strengthening of the EU technological leadership is enabled by a collaborative framework that allows for joint research among the Member States. Public-private partnerships, especially those between academia and industry, play a vital role through enhanced market-oriented outcomes, which improves the likelihood of successful commercialization. Such a collaboration could contribute to the strategic autonomy and reduce the EU's dependence on foreign technologies, especially in strategic sectors like cybersecurity, defence, and critical infrastructure. This would enhance the EU’s strategic autonomy and ensure it remains competitive in the global market. Dual-use research approach would attract international partnerships, investments, further strengthening the EU’s technological competitiveness. However, the participation of talents, especially in international context where defence requirements involve scrutiny and national preferences would make the involvement of researchers, even PhD students, difficult. Furthermore, defence requirements are much more specific (and costly) than civil requirements; sharing resources requires also adequate treatment of confidential information and security clearances. At the same time, ethical considerations must be carefully designed to ensure security, as well as maintain public trust and support.

The perspective on dual use most often thinks in terms of technologies, which can be used for either civilian or military uses. This perspective is transferred to research as a prerequisite for technologies with a dual use character. However, dual use is not only about specific technologies, but also shows up within innovation and sector strategies. This shows up in the rationale behind the dual-use strategy of integrating sustainability and vulnerability challenges in the framing of research programs (see section “Does it make sense to refer to dual-use R&I?”). Most apparent is this within the debate on critical infrastructures. The EU Directive on critical entities (2022) points towards the need to increase the resilience in respect to all hazards, whether natural, accidental or intentional. From a military perspective, the EU-NATO Taskforce on the Resilience of Critical Infrastructure (2023) emphasises the importance of infrastructures for both civilian and military purposes. Thus, from a technological perspective, it seems obvious that research within the Horizon Europe Clusters

4 (Digital, Industry and Space) and 3 ("Civil security for society") are linked to dual use. Horizon Europe Cluster 5 on Climate, Energy and Mobility looks at fostering an energy transition. From the civilian perspective, the guiding line is an innovation strategy which builds on a logic of achieving cost optimization for decarbonisation to achieve sustainability. The resulting energy sector should support both a decarbonised and competitive economy. However, from a security perspective, the strategic decisions on future structure of the energy sector are also important decisions for resilience by design, e.g. with regards to the level of centralization and associated different needs for protection of the infrastructure. Thus, it is important to consider both the cost optimisation logic and the security by design logic together. In the instance where there is a focus on the same innovation domain (critical infrastructure) but with different goals from the civilian (sustainability) and security (vulnerability) perspective, the integration of both goals can achieve a dual-use potential of research. There are various other areas for such synergies with regard to sustainability. Circular economy and resilient supply chains enhance security. Sustainable supply chains reduce dependence on foreign resources and increase resilience. This includes access to rare earth materials for defence electronics and green energy solutions. Climate adaptation and disaster response are vital components of national security. Innovations in security and defence should aim to reduce the risks associated with climate change and build resilience in critical infrastructures, supply chains and provisioning systems such as food, water and energy. Military resources and expertise play a crucial role in supporting disaster relief and responding to climate crises.

Such an integrated strategic dual-use perspective in strategy building can reduce the costs of achieving both decarbonisation and security much more efficiently than a divided perspective of designing the structure on the one hand and developing security measures for a structure which has not utilised the potentials for resilience by design, on the other hand.

Ethical implications of moving towards broader dual-use funding

The ethical aspect of dual use rejoins the ones present in military research. Even in democracies, public opinion on the use of military force and technology has often been divided, reflecting a range of perspectives and concerns. Historical examples of dual-use innovations garnering widespread public condemnations abound:

- The U.S. intervention in Vietnam, which saw large-scale use of herbicides such as Agent Orange, with widespread consequences[7]
- The use of and continued opposition to nuclear weapons, which has also civilian purposes in providing green energy
- Encryption software is classified as dual use because it can significantly enhance civilian applications, such as data security and medical devices, while also potentially supporting military objectives like surveillance, missile guidance, and cybersecurity.

The role of scientists in war has been crucial both in ensuring military advantages but also in helping the public shape its expectations and hold their governments into account[8]. The

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7 Gough, Michael. "Agent Orange: exposure and policy." *American Journal of Public Health* 81.3 (1991): 289-290.

8 Sean L. Malloy, Sarah Bridger. *Scientists at War: The Ethics of Cold War Weapons Research*., *The American Historical Review*, Volume 121, Issue 2, April 2016, Pages 605–606, https://doi.org/10.1093/ahr/121.2.605

scientific community is actively engaged in reflecting on the broader implications of its research, acknowledging the complexities and potential consequences of its work:

- "Scientists in the twentieth century may have been continually frustrated at the limits of their influence, but it is also true that government is still dependent on the expertise of scientists and engineers." [9]
- Scientists have struggled to exercise control over the policy implications of their work, and many feel they have a responsibility to do so. As the World Federation of Scientific Workers asserted that "all scientists have the obligation to examine the likely consequences of their scientific work and, as far as lies in their power, to prevent its use for evil anti-social and destructive ends."[10]
- The relationship of trust between scientists and the public is evolving and in constant need of being supported: In many cases "nonexperts have attacked scientific consensus through criticism of the conditions under which scientific knowledge is created and disseminated." [11]

Overall, Malloy & Bridger argue that "Scientists cannot expect to control how their work is interpreted and applied by others, but they can and should scrutinise the context of their research and its potential uses, taking action when necessary, working within and without government. Policymakers must also take seriously the warnings and concerns of experts. Most importantly, the maintenance of a just, safe, and humane world depends upon the actions of a well-informed and scientifically literate public.[12] This reflects the reality that once scientific knowledge is shared, its application often lies beyond the direct influence of the researchers. However, this perspective can be problematic if it absolves scientists of responsibility for anticipating or addressing potential misuse of their work. Ethical discourse emphasises that scientists have a moral duty to consider the societal and ethical implications of their research. While they may not have full control over how their findings are used, they are encouraged to engage in discussions about responsible applications, oppose misuse, and advocate for ethical guidelines to mitigate harm. Ignoring these responsibilities could lead to undesirable unintended consequences, especially in cases where research has dual-use potential or significant societal impact.

Scientific research thrives on transparency, openness, and international collaboration, as these principles accelerate innovation, foster knowledge-sharing, and drive technological advancements. However, in the context of dual-use research, the ethical considerations that are already in place at the European level should be further developed. Dual-use research could have profound social consequences, generating both positive advancements and potential negative repercussions that must be carefully managed through mandatory ethical governance actions and initiatives in individual projects. Establishing and facilitating cooperation among the public, civil, and private sectors in the EU while considering dual-use research involves navigating complex governance structures, aligning diverse objectives,

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9 Sean L. Malloy, Sarah Bridger. *Scientists at War: The Ethics of Cold War Weapons Research*., *The American Historical Review*, Volume 121, Issue 2, April 2016, Pages 605–606, https://doi.org/10.1093/ahr/121.2.605

10 https://fmts-wfsw.org/1990/05/manifesto-on-scientists-rights-and-responsibilities/?lang=en

11 Sean L. Malloy, Sarah Bridger. *Scientists at War: The Ethics of Cold War Weapons Research*., *The American Historical Review*, Volume 121, Issue 2, April 2016, Pages 605–606, https://doi.org/10.1093/ahr/121.2.605

12 Sean L. Malloy, Sarah Bridger. *Scientists at War: The Ethics of Cold War Weapons Research*., *The American Historical Review*, Volume 121, Issue 2, April 2016, Pages 605–606, https://doi.org/10.1093/ahr/121.2.605

and balancing security concerns with innovation. The primary approach to the ethical considerations should include regular dialogue between representatives from the public, private, and civil sectors, engaged in the advisory bodies whose aim would be to provide guidance and oversight on dual-use research projects. As outlined in the EU Regulation 2021/821 on the control of exports, brokering, technical assistance, and transit of dual-use items, strict measures should be in place to regulate and oversee dual-use research. Clear ethical guidelines should be established, ensuring that technologies developed with dual-use potential adhere to human rights and mechanisms for safeguarding sensitive information. We also need standards on how to monitor sensitive ethical issues and incorporate the monitoring results into new guidelines for the assessment and monitoring of ethical aspects of dual-use research. Alongside, civil society organisations and independent ethics boards should be involved in assessing the potential societal and ethical impacts of dual-use technologies, which can help ensure that the development of such technologies does not undermine human rights or societal wellbeing.

Transparency is of the utmost importance in the development of a sound system of dual-use research in the EU, which entails involving civil society in public consultations and decision-making processes about the direction of research and its potential impacts. Public consultations and addressing risks and public concerns related to the applications of dual-use research orientations should be a part of the process to involve citizens in shaping policies. In this respect, continuous evaluation and adaptation of the ethical guidelines should be undertaken in order to ensure that the collaborative framework remains effective and relevant, aligning with the Council of the European Union Principles and values for international cooperation in research and innovation (2022). However, the levels of public awareness of the information should be determined based on the sensitivity of the data and the intended use of the research output. This approach would ensure that sensitive data is not disclosed improperly, while still allowing for transparency and engagement where appropriate.

The general frameworks for ethical processes and outcomes of dual-use research should include at least the following components: 1) Independent ethics bodies within universities, research institutions, and governmental agencies to evaluate dual-use projects, ensuring compliance with ethical guidelines and legal regulations; 2) Guidelines for responsible conduct (codes of ethics) that emphasize accountability, transparency, and integrity in conducting and publishing dual-use research should be developed at the institutional levels. These codes of ethics should comply with the ethical regulations, such as such as the Charter and Code for Researchers (Council of the European Union, 2023)[13]; and 3) Campaigns and instruments directed at raising public engagement and awareness among researchers and policymakers about dual-use aspects, which would foster dialogue between scientific communities, civil society, and regulatory bodies to ensure ethical decision-making should be introduced at the national and at the EU level.

Public engagement and awareness are essential in addressing the ethical challenges of dual-use research within the European Union, as they help bridge the gap between scientific advancements, regulatory frameworks, and societal concerns. Raising awareness among researchers about the potential risks associated with their work ensures that ethical considerations are integrated into research practices from the inception phase of the projects.

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C_202301640#page=18

Universities, research institutions, and funding bodies should implement mandatory training programmes on dual-use ethics, responsible innovation, and compliance with EU regulations, fostering a culture of accountability. Policymakers, in turn, should engage with the scientific community to develop evidence-based regulations that protect security without holding back research progress. Moreover, fostering open dialogue between researchers, civil society, and regulatory bodies is crucial to ensuring that ethical decision-making is inclusive, transparent, and reflective of common European standards and values. Initiatives such as citizen science programmes, public consultations, and interdisciplinary forums can help discussions on dual-use research, allowing diverse perspectives to inform policy development. Considerations about dual-use research should also include establishing a dedicated educational portal for ethical dual-use research that would equip educators, researchers and policymakers with essential training materials, webinars, and guidelines, fostering a well-informed approach to emerging challenges.

Impacts on international collaboration

The transfer of knowledge with potential military use is already subject to policies such as export controls. However, knowledge outflows also can pose a risk via cooperation in the design and execution of research. The rationale for international cooperations differs already without consideration of the dual-use potential of research. ESIR in its report "Research, innovation, and technology policy in times of geopolitical competition"[14] distinguished different risks for three classes of research with different cooperation rationale:

- Research with regards to economic competitiveness: there is a trade-off between the gains from knowledge inflow and the risks from knowledge outflow for both European and international cooperation partners
- Security related research: Depending on relations with and geopolitical positioning of the non-EU country, there is high interest in controlling knowledge outflows with mutual restrictions of cooperation. There is also a need to provide guidance for understanding risks and conducting risk assessment of dual-use R&I.
- Research aiming at addressing global challenges: There is mutual interest in research cooperation, and no incentives for restrictions of knowledge inflows and outflows, while avoiding foreign R&I interference[15]

Taking the potential dual-use character of research into consideration might change the perspective on international cooperation for both EU and non-EU participants. The EU does not want to have knowledge flows which have dual use potential to flow outside to (some) non-EU partners, and (some) non-EU partners will not want to bring in knowledge into collaboration which has dual use potential, and which will be utilised by EU later. So dual use might have not only implications for whom to accept as partner from EU side, but also who is willing to participate (and whose knowledge the EU wants to tap into). This would lead to different dual-use regimes MS, associated countries, like-minded countries and others.

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[14] ESIR Policy Brief Research, innovation, and technology policy in times of geopolitical competition, https://op.europa.eu/en/publication-detail/-/publication/6dc11e64-6bd6-11ee-9220-01aa75ed71a1/language-en

[15] Staff Working Document on Science Diplomacy https://op.europa.eu/en/publication-detail/-/publication/3faf52e8-79a2-11ec-9136-01aa75ed71a1/language-en

The dual-use potential of research will change the interest in cooperation. In general, the dual use potential of research is more likely to be in a similar risk category to security related research. Opening the EU research programs for dual use means that the allocation of the risk categories (economic, security, interference) to the different rationales somehow become blurred, because a dual-use potential of research means that each rational might get entangled in security related risks as well. Table 1 illustrates the effects of a high dual-use potential of research versus a low one. For research with the rational of science diplomacy and addressing global challenges, the EU interest in cooperation now depends on the trade-off between positive effects and negative effects on security. But the same trade-off also exists for the potential cooperating non-EU country. The already existing trade-offs for research with regard to economic competitiveness become even more complex, because the trade-off with security has to be evaluated on top of the trade-off between positive and negative competitiveness effects. Only for security related research the dual-use character does not change the evaluation of risks very much.

Figure 1: Evaluation of risks of international collaboration in research depending on research rational and dual use potential of research

		Dual use potential of research	
		Low	**High**
Research rationale	**Global challenge**	mutual openness	trade-off global challenge and security
	Economic com-petitiveness	trade off knowledge inflow and outflow	trade-off with security on top of economic trade-offs
	Security related	mutual restriction	mutual restriction cooperation

Economic and Societal Impacts

The enhancement of dual-use research within the European Union **holds considerable potential to significantly enhance the EU's Gross Domestic Product (GDP) by stimulating cross-sectoral cooperation, innovation, investment, and industrial growth.** Dual-use technologies, which serve both civilian and military purposes, frequently originate from cutting-edge scientific research and facilitate the development of advanced products and services across diverse sectors such as aerospace, cybersecurity, biotechnology, and medical appliances. By fostering synergies between defence and civilian research initiatives, EU member states can establish high-value markets and attract international collaborations that subsequently invigorate national and regional economies. Additionally, public investment in dual-use research acts as a catalyst for private sector co-investment, thereby generating a multiplier effect that amplifies economic output and enhances the EU's competitive standing in the global arena.

The progression of dual-use research in the EU is intricately **linked to enhancements in productivity, both at the organisational level and across larger industrial ecosystems.** Innovation in dual-use technologies often entails the creation of sophisticated processes and tools that can be adapted or transferred across sectors, thereby improving operational efficiency and minimising redundancy. For instance, advancements in data analytics or material science developed for defence applications can have a spillover effect on civilian industries such as manufacturing or healthcare. This cross-sectoral exchange fosters resource optimisation and facilitates the dissemination of good practices, ultimately improving productivity indicators. Furthermore, dual-use research promotes collaborative frameworks involving academia, industry, governmental bodies and private sector, creating environments conducive to knowledge sharing and innovation. The resultant productivity gains would not only contribute to economic resilience but also position the EU as a leader in sustainable high-tech development capable of addressing both security-related and societal challenges.

Beyond economic considerations, the advancement of dual-use research within the EU encompasses a variety of societal dimensions, including shifts in public perception and cultural transformations. **A notable cultural evolution is the growing societal acceptance of the convergence between civilian and defence-related research domains, especially in light of contemporary global challenges such as cyber threats, pandemics, climate change and geopolitical instability.** The paradigm shift highlights how dual-use research arises from the convergence of seemingly disparate fields, requiring collaborative frameworks to responsibly unlock solutions for urgent global problems. This cultural evolution underlines the importance of dual-use research as a mechanism for addressing multifaceted global challenges while simultaneously driving innovation, strengthening academia-industry collaboration, and equipping students with the skills required to navigate an increasingly complex labour market.

The relationship between dual-use research and education in Europe is integral to fostering innovation, bridging the gap between academia and industry, and preparing students for the evolving demands of the labour market. The main rationale for incorporating dual research into educational systems across Europe is to enhance employability, innovation capacity, and European competitiveness on a global scale. Dual-use research, which involves collaboration between academic institutions and industry stakeholders, plays a crucial role in knowledge transfer, technological advancements, and economic growth. This synergy would ensure that research remains application-oriented, while allowing students to gain exposure to real-world challenges. For European higher education institutions, integrating dual-use research into

educational frameworks is not merely an option but a necessity to maintain global competitiveness and support the continent's knowledge-based economy.

Universities play a pivotal role in equipping graduates with the skills and knowledge for research and development across diverse sectors. To ensure students acquire both robust theoretical foundations and practical competencies essential for real-world applications, **academic institutions should integrate innovative pedagogical approaches into their curricula.** By embedding hands-on training, fostering interdisciplinary collaboration, and providing exposure to cutting-edge advancements, universities can equip students with the expertise necessary to navigate complex landscapes of interdisciplinary and intersectoral cooperation. Additionally, dual-use research fosters a culture of continuous learning and collaboration, which is crucial for addressing pressing global challenges, from climate change to digital transformation. The pathways for incorporating a meaningful framework for dual-use research into the European educational system includes adopting policies that support flexible learning pathways, encourage interdisciplinary collaboration, and provide incentives for institutions to engage in dual-research initiatives.

To effectively prepare students for education that could have a spillover effect onto the societal level, educational systems across Europe should introduce a multidisciplinary and practice-oriented approach that aligns curricula with the needs of different sectors. Universities and high schools should establish strong partnerships with research centres, businesses, and public organisations, ensuring that students have opportunities for internships, collaborative research projects, and hands-on training alongside theoretical learning. This requires the integration of work-based learning models, joint degree programmes, and co-supervised research projects, where students can engage with both academic mentors and industry professionals.

In this process, it is essential to recognise that just as dual-use research brings significant benefits to industry and engineering, the outputs of dual-use research primarily (but not exclusively) generated within industry, engineering, and STEM disciplines should also contribute to other sectors. To develop a system capable of delivering results on a broader societal level, various stakeholders must actively engage in the exchange of knowledge, expertise, and tangible research outputs. This is particularly important when it comes to advancing social integration, improving mental and physical health, building experience and capability in adaptation and resilience, and enhancing support systems that contribute to the quality of life and well-being throughout an individual's life. An integrative dual research model should facilitate interdisciplinary collaboration, ensuring that technological and scientific advancements are not confined to their originating fields but are leveraged to address complex societal challenges.

Conclusion

Europe needs to improve its innovative performance to tackle both defence and civilian challenges, and increasing research is an important means to achieve this. Together with the increasing level of eminent dual-use technologies, and the inclusion of civil infrastructure as military targets, this has led to a reconfiguration of the definition of dual-use from something negative, which has to be avoided to prevent malign and unwanted use of technologies, towards something positive which should be fostered in order to better harness the potential of general purpose technology, to ensure efficient resource allocation and synergies, and to tackle military and civilian challenges jointly.

The debate about dual-use R&I has focussed on access of military research to research funding in civilian programs, and on mechanisms to prevent the unwanted outflow of security-relevant knowledge. ESIR sees the need to broaden this debate. Fostering dual use R&I is foremost about increasing the productivity of research. Innovation is a social process in which different forms of existing knowledge are combined with new insights. Openness and new combinations of actors increase the level of knowledge available for the generation of new knowledge, and transfer of the resulting knowledge towards application increase the speed and magnitude of upscaling and deployment of innovations and quality of learning about the effectiveness of applications. These principles also hold for dual use R&I. Access of military research to civilian research programs without changing the availability of knowledge flows is a re-labelling only of the research, but no increase in the knowledge base for improved dual use R&I.

ESIR recommends that dual-use research be incorporated into EU research and innovation policy. An adaptation of the Next Framework Programme to handle dual-use research will improve coordination with the European Defence Fund, enhance the Union's resilience and preparedness, and facilitate collaboration with other dual-use research organizations. This adjustment will reduce the risk of overlapping research grants and promote knowledge transfer between civilian, military, and dual-use sectors. A complementary study with independent experts should address the synergies in specific critical technology areas, challenges for researchers and innovators, and international experiences.

The Next Framework Programme should clearly articulate a balanced approach that does not compromise on either scientific transparency or global security. This can be done by combining risk assessment, responsibility and ethical guidelines to create a framework where innovation and safety coexist. The principle starts with "As open as possible, as secure as necessary". The policy advocates for maximum transparency whenever feasible, while implementing restrictions for research that may pose serious security risks.

A strong security awareness is essential for compliance with dual-use research. Everyone involved in the upcoming framework program must actively take responsibility for minimizing significant security risks. Policymakers should clearly outline the implementation of security protocols and the monitoring of compliance. Research and university departments should establish safety and ethics committees to review research prior to publication and participation in visits and exchanges. It is essential for departments to develop ethical and legal support to ensure that both the department and researchers can comply with complex guidelines, regulations, and international agreements. Additionally, institutions should implement an incident management system that includes reporting procedures and guidelines for addressing potential security incidents. This system should also outline how to handle and communicate security risks as they arise. Researchers should be educated and encouraged to identify and report potential security risks as early as possible. Researchers and institutions should be encouraged to collaborate with security authorities and other research entities to balance risks and benefits. One approach is to utilize delayed publishing or selective data sharing to achieve a balance between transparency and security. ESIR recommends the following principles:

- Educating both the scientific and the security community about both the potential risks and benefits of research with dual use potential (as the National Action Plans (NAP) 2004 refer only to the scientific community)

- Combine academic self-governance with appropriate government oversight, including dealing with an ethical dimension
- Integrate a sustainability and resilience dimension (security, innovation and resilience and sustainability)
- Earmark a portion of defence spending for research and development (to be excluded from Maastricht criteria)
- Promote increased dual use synergies bottom up e.g., let researchers self-assess the potential that their research could contribute to national security/defence; if they see such a potential, they could access a 'different' funding source (e.g., EDF and other innovation support instruments) but this also means they have to follow stricter security, confidentiality and other regulations

The European Union should arrange its R&D policies in such a way as to utilise all five strategies for increasing dual use potential discussed in our policy brief. These strategies are:

1. Increasing the awareness and reflection of researchers, administrators and funders in low TRL level research allows for early detection of the dual-use potential of scientific output, thus enhancing understanding for both risks and opportunities.
2. Increasing the transfer of research output from civilian research to development of military applications and from military research to civilian products and services.
3. Enabling and encouraging the integration of scientists and providers of user-specific military knowledge into civilian research programs, and vice versa.
4. Increasing the identification of unknown functions of civilian research output and civilian goods for military goods by exaptation. The same also applies for exaptation from military research output towards civilian use.
5. Linking defence-related efforts to reduce vulnerabilities with civilian sustainability challenges to form more integrated missions especially for life-supporting services and infrastructure with reduced vulnerabilities towards military threats and increased sustainability and climate resilience (see also section 3.1 with more details).

Thus, the strategies proposed in the White Paper, to enhance dual use potential and increase the availability of diverse knowledge bases for research by improving access of military and civilian actors to the respective research programs are necessary but not sufficient.

Clearly attributing responsibilities and duties to relevant actors will be paramount to ensuring the ethical development of dual-use technologies. Increasing dual-use research requires a careful balancing of advantages with risks and avoiding pitfalls. There is a trade-off between openness of research and security of research. Research with high dual use character requires greater caution with regard to security of research. This reduces the availability of broad access and knowledge dissemination, which are necessary to integrate the best available knowledge. Managing this trade-off becomes a key priority in research planning:

- The trade-off is particularly strong in the case of opening up the research programs for joint teams from civilian and military research, because it allows for exchange not only of codified but also tacit knowledge. Thus, we see a rationale for opening up research programs for mutual participation only for the areas in which these trade-offs are considered to be small.
- The trade-off is particularly relevant with regard to international openness beyond the EU. Research with a high dual-use character must be more cautious with regards to international cooperation. This calls for a strategic approach, including resources and support structures, which distinguishes between both countries and research

characteristics. It must be noted that there should not be any restrictions imposed by third countries on EU access to outcomes of R&D projects. Considering Art. 17 of the SAFE regulation could give insight on of what a similar provision would need to amount to with respect to dual-use research.

- The trade-offs are less pronounced in the dual use R&I strategies which call for increasing the awareness and reflection of researchers, administrators and funders in early phase research (dimension 1), and integrating security challenges to reduce vulnerabilities of life-supporting services and infrastructure towards military threats with the sustainability challenge to transform these innovation domains towards decarbonisation, circular economy and climate resilience (dimension 5). The security concerns of military research are very high per se, which restricts free flow of knowledge about technology towards civilian research per se more than flow of information the other way.

There is a need for targeted education to help researchers understand better the complexities of dual use research, i.e. both risks and opportunities. Moreover, there is a need to promote collaboration between civilian and military sectors, within and across EU member states, to advance dual-use R&I, accelerate innovation, and support responsible and secure technology development.

Dual-use research, which encompasses both civilian and military applications, presents complex ethical challenges that demand careful governance and engagement of diverse stakeholders. Such research drives innovation and addresses critical global issues, but it also carries risks of misuse and unintended consequences. To ensure ethical oversight, the European Union emphasizes transparency, cross-sectoral cooperation, and adherence to the common European standards and values through frameworks like EU Regulation 2021/821. Ethical considerations and ethical governance are both a goal on its own merit, but also an instrumental prerequisite for successful dual use strategy. Otherwise, there is a risk that some researchers would not participate in the research, which prevents important knowledge resources from being utilised. Establishing independent ethics bodies, fostering public consultations, and integrating mandatory training on dual-use ethics within research institutions are pivotal steps to align scientific advancements with the European values. By promoting dialogue among policymakers, researchers, industry, civil society, and the public, a balanced approach can be achieved that safeguards security and ethical governance while fostering responsible innovation.

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The ESIR Policy Brief highlights the importance of dual-use research and innovation (R&I) in the EU. It recommends that the EU adopt a "dual-use by design" approach, integrating dual-use research into the next EU Framework Programme and aligning it with the European Defence Fund. Overall, the paper aims to promote a comprehensive approach to dual-use R&I in the EU, balancing security, innovation, and ethical considerations

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