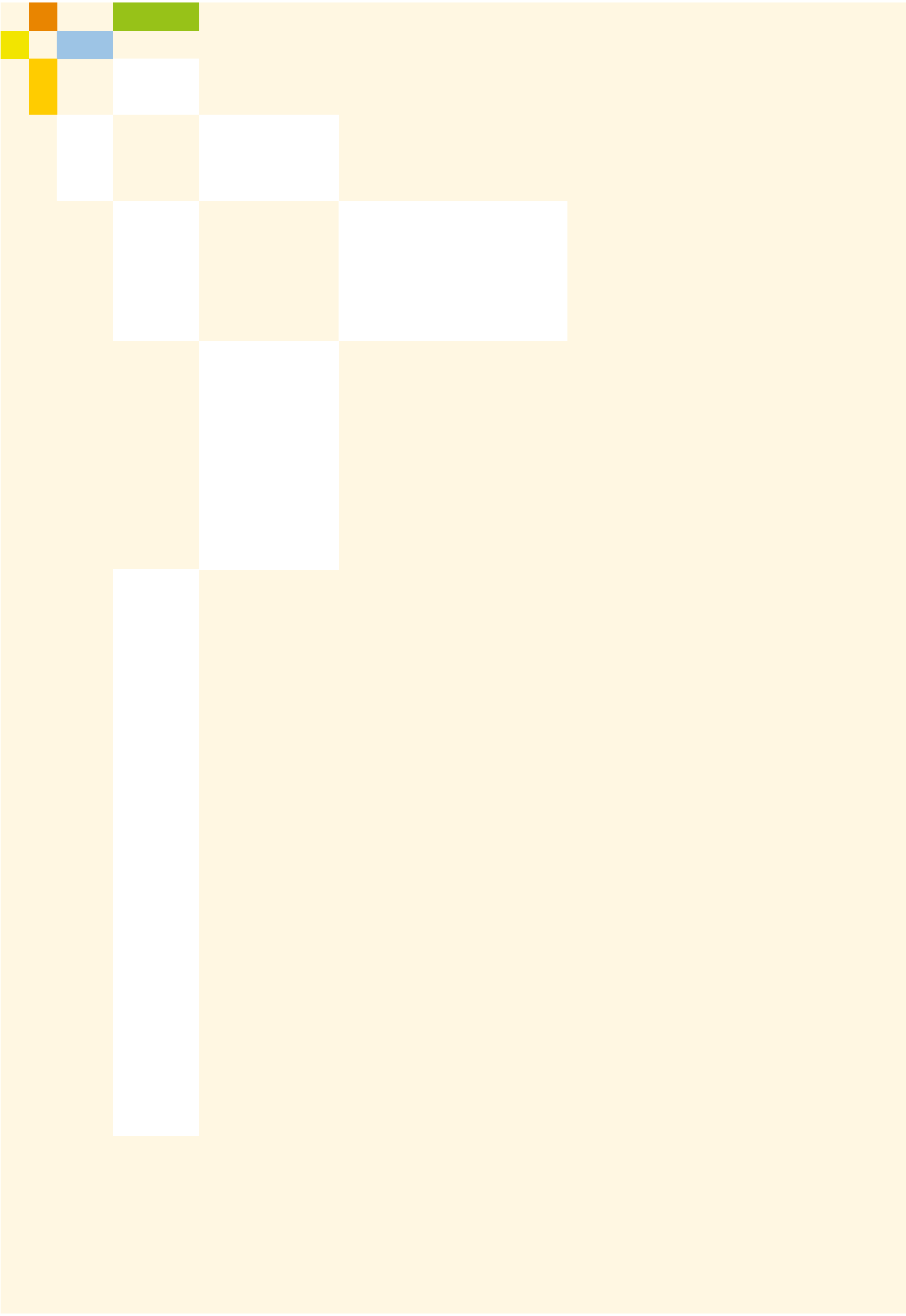




acatech IMPULSE

Security, Resilience and Sustainability

Johann-Dietrich Wörner, Christoph M. Schmidt (Eds.)



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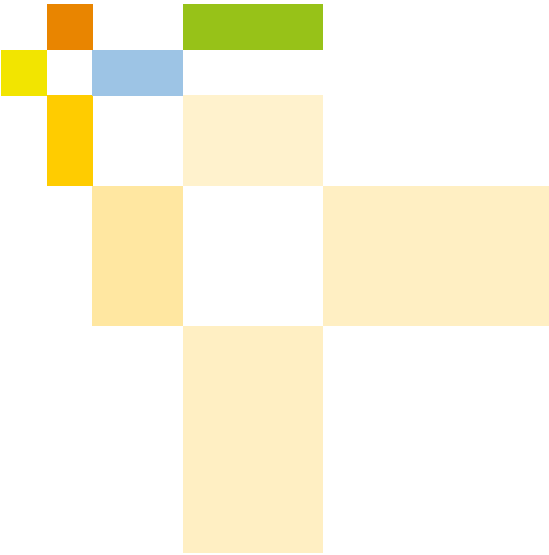
The acatech IMPULSE series

This series comprises contributions to debates and thought-provoking papers on strategic engineering and technology policy issues. IMPULSE publications discuss policy options and are aimed at decision-makers in government, science and industry, as well as interested members of the general public. Responsibility for the contents of IMPULSE publications lies with their authors.

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1 Security, resilience and sustainability

Russia's war on Ukraine and its implications call for a reassessment of the overall geopolitical situation and the challenges that Germany and Europe will have to address over the coming years. It is against this backdrop that this publication by acatech – National Academy of Science and Engineering discusses the new social and economic challenges facing Germany in the medium to long term and formulates policy options for policymakers, businesses, science and civil society. The policy options build on the findings of previous acatech projects. However, in view of the current crisis, these have been augmented by interviews in which experts from science and industry discussed the actions required by the present situation. During the course of this study, it became particularly apparent that the basis of peace and prosperity does not lie in national self-interest and autarky, but in strategic sovereignty and international cooperation geared towards achieving security, resilience and sustainability.¹

Each of these three dimensions involves complex challenges and should be given equal weight. Moreover, all three dimensions interact strongly with each other (see Figure 1). In order to find solutions that make efficient use of society's limited resources and include the perspectives of all the relevant actors, it is thus essential to approach all three dimensions together in a systemic manner. Rather than reducing the complexity of the challenge in any meaningful way, attempting to discuss the three dimensions separately and find individual solutions would simply be to overlook the connections that exist between them. Measures focused solely on attaining individual goals are thus of limited value, since they often prove to be inefficient and can have unintended effects on the other dimensions.

Cooperation across all three dimensions is therefore key to successfully addressing the challenges. This is not only true because the three dimensions are closely interrelated – cooperation is also key to determining which level should be responsible for addressing the challenges, since purely national solutions are often not possible. Consequently, cooperation should be strengthened both within the European Union and with other international partners, especially NATO. The relevant actors from government, science, industry and civil society should be included in this process in order to gain a holistic perspective on the challenges and arrive at solutions that are acceptable to everyone.

A high degree of agility as well as the willingness and ability to innovate will be required across every sector of society. Since it is difficult to foresee every detail of the regulatory changes and technological developments that will be needed in the long term, the key is to create dynamic structures that foster innovation in all of society's functional systems. Policy actors are urged to adopt a cross-party, cross-departmental approach to tackling the common goals. This joint approach will call for a strategic, systemic perspective focused not only on overcoming acute crises but also on long-term challenges and sustainability. To this end, overall policy responsibility should be assigned to a central agency, preferably the Federal Chancellery. Once this has been done, a dialogue should be initiated to negotiate which actors should be responsible for the different areas.



Figure 1: Security, resilience and sustainability: a complex relationship (Source: authors' own illustration)

As a result of the acute crises of recent times, people are now exceptionally open to discussing the strategic principles of our society and their implications. Policymakers and the public have a heightened awareness of the problems and are willing to consider radical solutions.² This means that there is an opportunity to address the big challenges in the fields of security, resilience and sustainability in a radical, systemic manner that will allow us to emerge from the crisis with stronger structures and a greater degree of strategic sovereignty. The necessary renegotiation of

1 | See acatech 2022.

2 | See Allensbach 2022.

priorities should be based on a broad, open dialogue with the public that is transparent about the strategic goals, conflicts and costs associated with finding a long-term solution to the challenges.

The aim of this publication is to provide guidance that can help society as a whole and policymakers in particular to overcome the complex challenges outlined above. We begin by defining the three goals of security, resilience and sustainability. The subsequent chapters look at important dimensions of these goals where the current situation has highlighted a particular need for action: establishing a security policy that is fit for the future, protecting value, supply and innovation chains, and tackling the climate crisis and securing the energy supply. For each of these dimensions, we analyse the status quo, discuss individual aspects and propose policy options for different actors.

Security

The first goal to be discussed is security. Security refers in general to protection against threats or damage, whether intentional (attacks) or unintentional (e.g. caused by human error):

Security is a situation where the residual risk is lower than the acceptable risk. Risk is determined by combining the likelihood of an event occurring and the extent of the resulting damage. A risk's acceptability is determined by normative evaluation.³

It is often not possible to precisely calculate the probability of occurrence. If an event is expected to cause extremely serious damage, then the mere possibility of it occurring (probability of occurrence >0) is enough for the overall risk to be deemed unacceptable.

Security has a number of clearly identifiable dimensions (see Figure 2) that are closely interrelated. For instance, a threat to external security is also usually a threat to internal security.

It is also necessary to consider the two dimensions of IT security. In this context, safety refers to the functional safety of IT systems, while security relates to security against external attacks. External security refers to outside attacks on a country's systems. While physical acts of war are a major threat in this area, cyberwars (e.g. attacks on critical infrastructure or local authorities) are also a growing problem.

Security

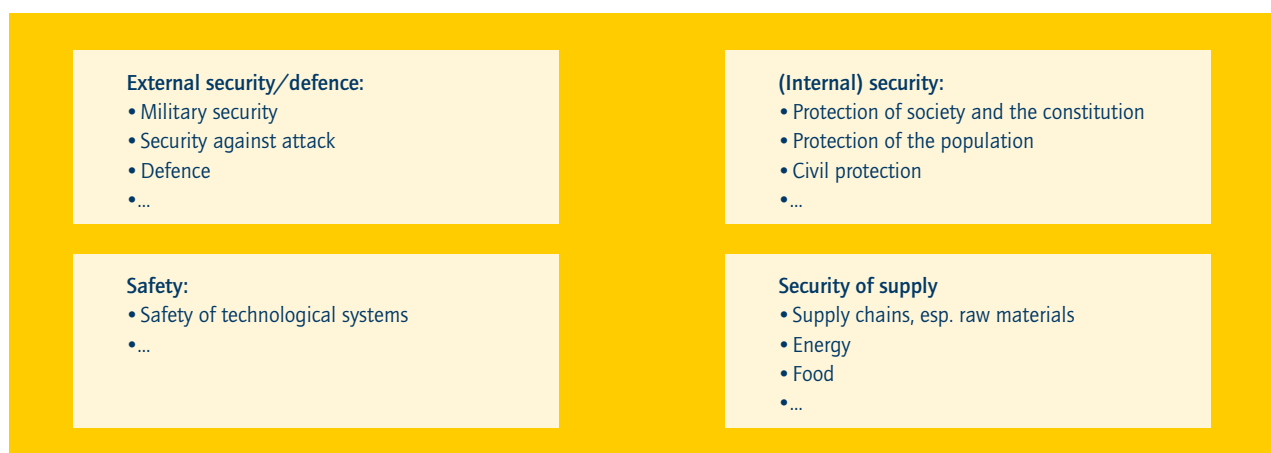


Figure 2: Dimensions of security (Source: authors' own illustration)

3 | See e.g. acatech 2009.



Perceptions of security are not objective and depend on the current situation (see Chapter 2). However, one aspect that all the different perspectives agree on is that security forms the basis of the rule of law and our prosperity as a society.

Resilience

The second goal considered here is overall system resilience, i.e. the establishment of a stable yet dynamic system that is capable of averting or at least surviving adverse events. The aim is to maintain and continuously improve the system's functions:

Resilience is the ability to predict and plan for actual or potential adverse events, detect their emergence as soon as possible and prevent them from occurring, mitigate their severity, limit the damage caused, recover from them rapidly, adapt to them successfully and learn the relevant lessons.

Adverse events are disasters or change processes with disastrous consequences that have human (e.g. armed conflicts), technological (e.g. blackouts) or natural (e.g. extreme weather) causes.⁴

One feature of resilient systems is that they return to their original pathway more quickly after a shock. A resilient system is also better able to respond to a shock by switching to an alternative pathway that leaves it better off in the long run.

The general requirements for resilience include foresight, imagination (translated e.g. into innovation), a sense of responsibility, and the agility and adaptability of the relevant actors and affected systems. More specifically, resilience can be achieved through monitoring systems, diversification (e.g. globalisation), maintaining redundancies and, where relevant, decoupling (i.e. the dissociation of previously connected entities, either technologically or in other ways).

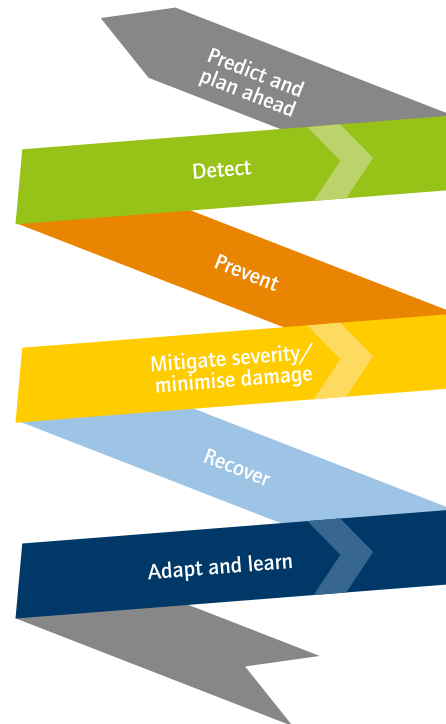


Figure 3: Phases of a resilient system
(Source: authors' own illustration)

Sustainability

The goal completing this trinity is sustainability. Sustainability is an aspect of functional systems that focuses on the long-term perspective:

Sustainability means meeting the needs of the present without compromising the ability of future generations to survive, meet their own needs and prosper⁵, for example by living within environmental, planetary boundaries.

Structures characterised by long-term resilience can provide a particularly good basis for sustainability. The United Nations has established 17 goals to deliver the ambition of sustainable development (see Figure 4). The individual goals are broken down into additional targets. For instance, Goal 10 "Reduced Inequalities" also calls for "orderly, safe, regular and responsible migration and mobility". In view of the major migratory movements witnessed in recent years and the associated consequences, there

4 | See acatech 2021.

5 | See WCED, 1987.

is a case for elevating “migration” to a goal in its own right. In any case, the broad spectrum of topics harbours a high degree of complexity, and the attainment of one sustainability goal can

often be at odds with the achievement of others, although synergies may also exist (this is true, for example, of climate protection and species conservation).



Figure 4: United Nations Sustainable Development Goals (SDGs). (Source: CC-BY-SA 3.0, UN)



2 Security: establishing a security policy that is fit for the future

Russia's war on Ukraine has profoundly transformed the perception of security among policymakers and the general public in Germany and the rest of Europe. Prior to 24 February 2022, external security (as opposed to cybersecurity) was largely taken for granted. However, physical security, i.e. protection against physical military attacks, has once again come to the fore in the wake of the Russian invasion. Security is increasingly being discussed as the fundamental basis of the rule of law and of our prosperity, while security of supply has also become a prominent issue (not just for energy, but also for raw materials, food, medical products, etc.).⁶

The establishment of a resilient, sustainable security policy that is fit for the future relies first and foremost on a strong national economy that can devote the necessary financial resources to defence spending, coupled with a strong culture of consultation

and acknowledgement of the importance of international cooperation. Security policy must also address major dependencies on large nations such as the US, China and Russia, especially when it comes to trade⁷ and defence (NATO). Before Russia's war on Ukraine, there was very little public discussion of security issues in Germany, and public support for the armed forces was low.⁸ As a result, the German government failed to approve adequate increases in military spending over a period of several years. This under-resourcing of the armed forces was further exacerbated by bureaucratic barriers (see Figure 5).

However, increased public awareness of security policy challenges as a result of recent developments has pushed security policy back up the agenda and boosted public support for a rise in defence spending, as evidenced by the approval of a €100 billion fund to modernise the armed forces and the government's willingness to meet NATO's defence spending target of 2% of GDP. The resulting increase in Germany's military strength will lead to it taking on a more prominent security policy role in years to come. However, it is important to keep weighing up the pros and cons of the different policy options. If Germany positions itself too assertively, its current reputation as a peaceful nation could suffer. On the other hand, if the promises that have been



Figure 5: Security policy SWOT analysis (Source: authors' own illustration)

⁶ | See Institut für Demoskopie Allensbach 2022.

⁷ | See Bundesministerium für Wirtschaft und Energie 2021.

⁸ | See Institut für Demoskopie Allensbach 2022.

made are not kept, people could end up feeling let down. Better resourcing of the military could tempt parliament to deploy more German forces in conflict zones, increasing the risk of material losses and in particular human casualties in the armed forces (see Figure 5). Ultimately, it will always be a tricky balancing act.

National responsibility, European and global cooperation

The promotion of peace and avoidance of armed conflicts have been at the heart of German foreign and security policy for many years. Nevertheless, there have been several wars since 1945, not just in other parts of the world but in Europe, too. Since it is not possible to discount the threat of future armed conflicts, Germany must be well prepared for this eventuality.⁹ A security policy that is fit for the future must have collaboration and networking at its heart, since Germany will only be able to keep up with the world's largest nations by cooperating with its partners. NATO should therefore continue to play a central role in German security policy. However, closer cooperation among the nations of Europe is also important in order to avoid over-reliance on the US.

The European Union (EU) should play a key role in this context. At present, some European nations coordinate closely and cooperate with each other within NATO. Both for economic reasons and in accordance with the principle of subsidiarity, continued close cooperation between the nations of Europe is strongly recommended, without prejudice to their respective national interests. It will be important for the European partners to discuss how to optimise their cooperation by making the best possible use of all the available capabilities. To this end, the European Defence Agency (EDA) should be strengthened and granted more extensive powers. Following on from this, more joint European military exercises should be carried out and measures taken to realise the vision of a common European army that leverages synergies in terms of resources and capabilities without impinging on established NATO structures.

Strengthening the armed forces by leveraging synergies

In recent years, other nations have repeatedly called for Germany to increase its military engagement and strengthen its armed forces.¹⁰ However, Germany has been slow to respond to these calls¹¹ and has consistently fallen a long way short of NATO's target of spending 2% of GDP on defence. One reason probably relates to the lack of public support for military interventions.¹² Rather than simply rearming, the time has come for a strategic reform of the armed forces' resources. For example, more connected systems should be acquired in order to improve efficiency by generating synergies. These measures will also help to tackle the personnel shortage that the armed forces will face in years to come as a result of demographic change alone.¹³

A mix of armament procurement methods should be employed. Armaments should be bought from allies, but also developed either independently or in cooperation with partners. It makes strategic sense to develop and expand Germany's own capabilities, especially in critical areas such as sensor technology. In less critical areas, on the other hand, there are numerous advantages to the joint production of armaments with European partners – especially if roles are assigned logically, based on who possesses the necessary expertise rather than on political criteria. As far as non-critical armaments are concerned, there is no reason why they should not be purchased. For certain applications, greater use can be made of military off-the-shelf products that were not specially developed and produced for that specific application. However, regardless of how armaments are developed and produced, it is vital that they should be interoperable.

A root-and-branch reform of the Federal Armed Forces Administration – and especially of its procurement service¹⁴ – is essential if the armed forces are to be strengthened efficiently and effectively. One indication of the need for reform is that most armament projects experience serious delays – in 2018, the average delay for major projects was five years and three months.¹⁵ Unfortunately, previous reform initiatives (such as the "Agenda Rüstung" in 2014 and the 2016 White Paper) have failed to deliver significant improvements. The US, Sweden and Australia could serve as models for procurement service reform. It will also be necessary to adjust the relevant

9 | See also Deutsche Gesellschaft für Auswärtige Politik 2021.

10 | See Werkhäuser 2018.

11 | See Bardt 2018, 2021; Sperling 2020.

12 | See Zentrum für Militärgeschichte und Sozialwissenschaften der Bundeswehr 2020.

13 | See Apt 2010.

14 | See Die Wehrbeauftragte des Deutschen Bundestags 2021.

15 | See Bundesministerium der Verteidigung 2018; for more on this topic, see KPMG | P3 Group | TaylorWessing 2014.



certification requirements so that NATO partner certifications are accepted in Germany.

Cybersecurity

One key security requirement is to ensure that the deployed IT systems are properly protected against attacks. This applies to military systems that have been purchased or jointly developed with partners and may, for example, have back doors that make them vulnerable to cyberattacks. It is also particularly important to protect critical infrastructure systems against cyberattacks, since successful attacks have the potential to cause widespread damage.

An initial analysis reveals that most of the strengths, weaknesses, opportunities and threats identified above for the field of security as a whole also apply to IT security, while a number of additional factors are also relevant. Germany is strongly positioned in many IT security technologies and several German companies are developing highly promising (niche) products. At the same time, however, there is a shortage of IT professionals.¹⁶ Moreover, failure to adequately coordinate the activities of the different federal levels has resulted in unclear lines of responsibility, meaning that project implementation is hampered by bureaucratic barriers.

To achieve the necessary level of protection under these circumstances, it will be particularly important for Germany to strengthen its digital sovereignty.¹⁷ This will require the existing institutions (BSI, ZITIS, etc.) to be more clearly structured and to be assigned clear responsibilities. At present, although these institutions possess

the necessary expertise, they lack clear management responsibility for initiating and implementing strategic initiatives.¹⁸

Regulation also poses a dilemma. The increased use of IT has major benefits – and if regulation places too much emphasis on security, these benefits could be diminished, reducing the incentive to innovate in the IT sector. Public engagement in a transparent debate is key to striking the necessary balance between security and innovation.

Support from the (technology) research community

Bremen and Thuringia are currently the only German regions whose Higher Education Acts¹⁹ contain a “civilian clause” stating that universities and other higher education institutions may only conduct research for civilian purposes. However, the constitutions and statutes of several other German universities and higher education institutions contain a voluntary commitment to only carry out research for civilian purposes.²⁰

These “civilian clauses” should be carefully reviewed in the light of the new situation. However, technology research for military purposes should always be accompanied by concomitant research and a dialogue with the stakeholders and the general public. This synergistic use of resources can also help to promote innovations in the civilian sector. Cybersecurity research is often currently conducted in a grey area, since in the course of their work, researchers have to hack into third-party systems in order to expose their vulnerabilities.

16 | See Bitkom 2022.

17 | See acatech 2022.

18 | For more on this, see e.g. Loll 2021.

19 | See <https://www.kmk.org/dokumentation-statistik/rechtsvorschriften-lehrplaene/uebersicht-hochschulgesetze.html>

20 | For more on this, see <http://zivilklausel.de/index.php/bestehende-zivilklauseln>

Policy options

Policymakers

- Update the national security strategy, expanding the traditional definition of security to include resilience and sustainability (systemic approach)²¹. Closer cooperation between the relevant government departments and preferably the assignment of overall responsibility to a central agency such as the Federal Chancellery would also be desirable.
- Urge NATO to update its response plans.
- Remove bureaucratic barriers in order to accelerate decision-making, especially with regard to procurement.
- Engage in a public dialogue on security policy.
- Ensure sustainable financing of the armed forces (so that the 2% target can be met long-term), with adequate supplementary funding for cybersecurity.
- Consolidate the institutional landscape in the field of cybersecurity and include the global perspective.²²
- Support research by clarifying the legal situation for researchers.²³
- Remove “civilian clauses” from the relevant Higher Education Acts.

- Support the establishment of connected command and situation centres for civil protection at federal and regional level.

Government agencies

- Test how well their emergency plans work and update and expand them as necessary. The new procedures should then be rehearsed.
- Establish who is responsible for coordinating and implementing the relevant measures.

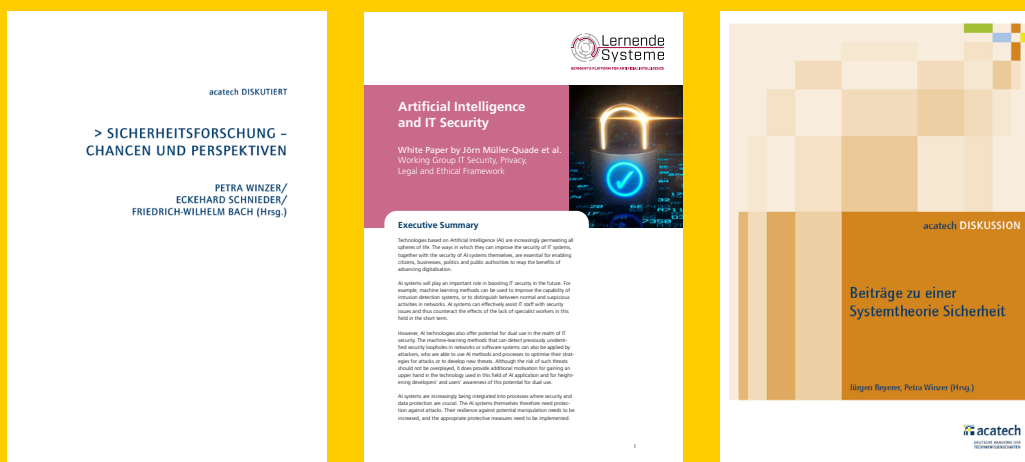
Businesses

- Review their current IT security measures and capabilities (also with a view to the future deployment of new technologies such as artificial intelligence) and, if necessary, implement measures to develop the relevant skills.²⁴

Research institutions

- Carry out more active research in the field of security.
- Remove “civilian clauses” from their statutes.

Selected preliminary studies on security



21 | See acatech 2018.

22 | See acatech 2022; Plattform Lernende Systeme 2019.

23 | See acatech 2022.

24 | See Plattform Lernende Systeme 2019.



3 Resilience: protecting value, supply and innovation chains

The resilience of the relevant value, supply and innovation chains is key to a system's overall resilience. However, it is extremely difficult to determine exactly how relevant individual chains are to the system. While it is unlikely that the entire system would collapse if individual key supply chains (such as gas, semiconductors, wheat and medical products) were interrupted, the damage to the German and European economies would nonetheless be serious. Resilient value, supply and innovation chains are thus of paramount importance.

Companies can draw on their solid skills base and extensive experience in order to achieve resilience. However, a lack of pressure to change has meant that many companies have not learned the lessons of previous crises such as the COVID-19 pandemic and have failed to establish more resilient chains. Russia's war on Ukraine has made it clear that many of these chains are still not secure, resilient and sustainable. Over-reliance on Russia for fossil fuels is just one example (see also Figure 6).

The current situation provides an opportunity to address these failings. Increasing resilience through diversification (e.g. by decoupling from Russian gas) can strengthen collaboration with other international partners and foster closer cooperation at European level. However, the current situation could also play into the hands of those who wish to promote autarky, even if this approach is ultimately doomed to fail. There have already been public calls for a move towards autarky in some quarters (see also Figure 6).

Sustainable chains: multi-dimensional European and global networks/grids

Companies must seize the opportunity to transform one-dimensional supply and value chains into multi-dimensional networks or grids, especially in system-critical areas. To ensure that these networks/grids are resilient, they should be diversified nationally, at European level and globally, with the overarching goal of advancing the Europeanisation and globalisation of economic activity. Germany can also strengthen its own international influence by cultivating strong partnerships with other nations in Europe and the rest of the world.



Figure 6: SWOT analysis for value, supply and innovation chains (Business) (Source: authors' own illustration)

Sustainable networks/grids are characterised by the following features:

- Protection through global and European diversification and maintaining redundancies, i.e. building up alternatives that are not fully utilised (e.g. multiple raw material suppliers²⁵).
- Trust within the network/grid (achieved by building stable supplier relationships and strong partnerships and by avoiding frequent changes of supplier based on price).
- Transparent information (achieved e.g. through the use of blockchain technology) and back-ups (such as extra reserves or alternative technologies that can perform the same function) throughout the network/grid.²⁶
- Protection through resilient contingency plans (including indicators that highlight any problems as soon as possible).
- Ensuring that as many individual steps as necessary but as few as possible are performed by different partners throughout the network/grid.
- Flexible production.²⁷

Conceiving and implementing resilient value chains (i.e. value networks/grids) in businesses requires additional resources, for

instance in order to build up extra reserves. When faced with a choice between resilience and efficiency, some companies consciously opt for greater efficiency and are willing to accept the associated risks. Other companies (especially small and medium-sized enterprises) simply don't have the necessary resources. Striking the right balance between efficiency and resilience is far from easy. Companies need to take the long view on this issue and shift their focus away from economies of scale and towards investing in resilience.

Seamless innovation networks/grids should also be developed in the innovation sector

Innovation provides answers to the most pressing questions of our time, helps to maintain and improve living standards and enables social and economic progress. Innovations – i.e. new products – from the technological sciences are particularly important tools for protecting value chains and infrastructure and cementing diplomatic relations.

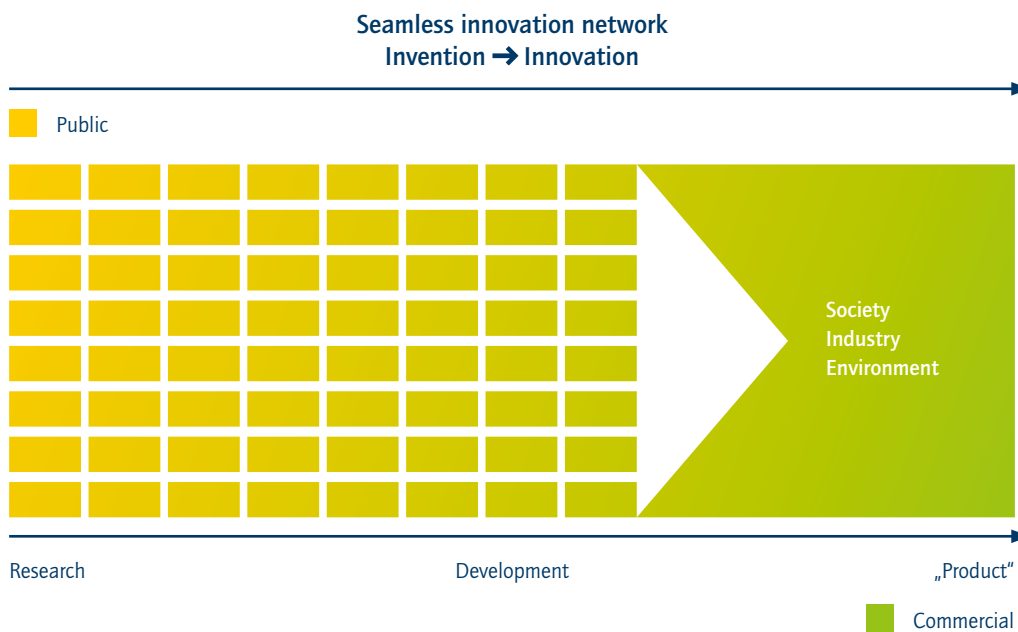


Figure 7: Seamless innovation networks (Source: authors' own illustration)

25 | See also acatech 2021.

26 | See *ibid.*

27 | See *ibid.*



The problems in the innovation sector are comparable to those facing value and supply chains, and the solution is thus also similar: seamless European and global multi-dimensional networks or grids encompassing everything from invention to innovation (see also Figure 7). The horizontal lines in Figure 7 represent the journey from the research stage to implementation as a product, with the Technology Readiness Level score denoting the innovation's maturity. The vertical lines represent the linkages between different disciplines, which help to leverage interdisciplinary synergies and gain new insights. Instead of an innovation chain, the result is a sustainable innovation network.

Ideally, the various activities throughout the network should dovetail seamlessly with each other, without any gaps. Resilience is also strengthened through diversification of R&D areas, i.e. by promoting and pursuing several research activities in parallel. Other essential factors include sustainable conditions for start-ups and access to sufficient domestic growth capital and to virtual or physical spaces for generating ideas. Furthermore, multi-disciplinary

cooperation between first-class partners from science and industry throughout the innovation process will foster an integrated approach that will often produce much better results than could be achieved by addressing the problem from a single, isolated perspective.

Regulatory implications

Strengthening resilience is a challenge that must be addressed jointly by policymakers and businesses. The traditional division of responsibilities, where policymakers focus on creating the framework but do not actively intervene thereafter is unlikely to be enough to systematically increase resilience. The first step should therefore be to analyse the risks and identify the value chains that need to be studied in more detail. Government and business should then engage in a dynamic negotiation process to discuss how to spread the risks and divide the responsibility for different actions.

Policy options

Policymakers

- Review government guidelines on resilience and remove any barriers identified as hindering the establishment of resilient structures. Initial measures might include introducing resilience reporting instead of risk reporting, reviewing insurance requirements and establishing independent monitoring and regulatory institutions for high-risk activities.
- Provide adequate research funding to help science and industry carry out an extensive analysis of dependencies and critical products and develop alternatives.
- Ensure that policymakers can play an active role, for example by establishing a joint platform or a centre for risk management and resilience where resilience issues can be discussed in a wider context²⁸

Businesses

- Attach greater importance to resilience in their risk assessments and provide the resources needed to strengthen the resilience of their own value-added activities and supply sources²⁹
- Offer other companies pre-competitive access to their own experience and resilience expertise so that they can learn from each other.³⁰
- Work closely with researchers to analyse and safeguard their value-added activities and supply sources.

Research institutions

- Strengthen vulnerability research and work closely with the affected companies (e.g. to quantify the resilience of production systems and networks).

Selected further studies on protecting value, supply and innovation chains



28 | See acatech 2021.

29 | See ibid.

30 | See ibid.



4 Sustainability: tackling the climate crisis and securing the energy supply

One of the greatest challenges in creating a sustainable society is to transform the economy so that it is environmentally sustainable and operates within the planetary boundaries.³¹ The planetary boundaries are the Earth's environmental limits – exceeding these boundaries could jeopardise ecosystem stability and the very basis of human life. Some of these boundaries, such as biosphere integrity, are already being exceeded today (see Figure 8). These are closely linked to the energy system, for example through industrialized, energy-intensive agriculture. Defossilisation of our energy systems is a key goal on the road towards environmental sustainability. It involves replacing fossil fuels with renewable energy sources, primarily wind and solar power and fuels made with renewable energy, such as hydrogen.

The German energy system illustrates the importance of strategic sovereignty and the relationship between security, resilience and sustainability. The system's strong reliance on Russian gas imports undermines its resilience, seriously limiting the German government's security policy options and jeopardising achievement of its sustainability targets.

As part of its strategy to defossilise the energy system, the German government is phasing out both coal and nuclear power,³² opting instead for heavy reliance on natural gas as a bridge technology. This is because gas generates fewer emissions than other fossil fuels and because its highly controllable supply means it can be used to balance out fluctuations in the supply of renewables. Germany is heavily reliant on imports, since it no longer extracts almost any fossil fuels of its own (e.g. natural gas). In the main, the deregulated energy market has favoured cheap Russian gas transported to Germany in pipelines and has opted against a strategy of diversification and redundancy. In 2021, over half of Germany's imported gas came from Russia. Against this backdrop, Russia's war on Ukraine and its geopolitical implications pose

Planetary boundaries

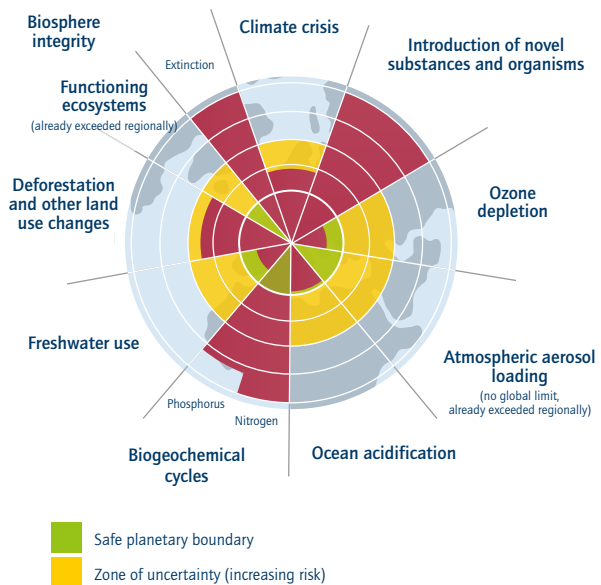


Figure 8: Planetary Boundaries (Source: authors' own illustration based on Steffen et al. 2015 and Persson et al. 2022)

a serious threat to security of supply and Germany's planned transition to a sustainable energy system.

Since Germany began its energy transition, it has gained extensive experience in the rapid expansion of renewables and has also acquired the necessary technological capabilities. At the same time, it has become apparent that bureaucratic barriers are hampering the growth of renewable installations and in particular the expansion of grid infrastructure. However, this experience is largely confined to the electricity sector. The heating and mobility sectors are still heavily reliant on fossil fuels and have a lot of ground to make up. The electrification of these sectors poses additional challenges for Germany's power grids and will require modifications to the electricity market design.³³

The COVID-19 pandemic and Russia's war on Ukraine have to some extent shifted the focus of public attention away from climate policy.³⁴ At the same time, however, energy security and geopolitical dependencies have moved up the public agenda.³⁵

31 | See Steffen et al. 2015.

32 | See Section 4 KVBG (Act on Phasing Out Coal-Powered Energy), Section 7 AtG (Atomic Energy Act).

33 | See ESYs 2020c.

34 | See Institut für Demoskopie Allensbach 2022.

35 | See *ibid.*

The current situation thus provides an opportunity to integrate Germany's climate policy into a new, systemic strategy for ensuring security, resilience and sustainability. It will be essential to leverage synergies in measures aimed at achieving the different goals (see Figure 9), not least due to the limited availability of public resources.

National responsibility, European and international cooperation

The EU as a whole and especially Germany will remain heavily reliant on energy imports in the medium to long term, since both fossil fuels and renewables are more abundant and accessible in other parts of the world. The energy systems of the EU's members states have very different structures and face different challenges. Nevertheless, it is in all of their interests to reduce their (strategic) dependence on individual countries in order to ensure their own strategic sovereignty. This applies both to the current dependence on Russia and to potential future dependencies.

Stronger networking of Europe's energy systems would make its energy supply more resilient and could quickly help to reduce

the national dependencies of individual member states. Stronger networking of the energy infrastructure is a priority in order to facilitate access to more pipelines and liquefied natural gas (LNG) terminals. Expanding the European electricity grid and internal electricity market would also make it easier to take advantage of regional weather differences in order to balance out fluctuations in the availability of wind and solar power.

National energy policy decisions have implications for the energy security of Europe as a whole. Some of the decisions that the German government has taken without any meaningful consultation of its European partners are perceived as putting national self-interest first in some quarters outside of Germany. These include the decision to simultaneously phase out coal and nuclear, and the focus on (Russian) gas as a bridge technology. Coordination of Germany's national energy policy with its European partners could thus also support European integration.

The EU is already a key energy and climate policy actor. A stronger common European energy policy has enormous potential, for example to strengthen the EU's bargaining power when purchasing energy and fuel and also with regard to the implementation of international climate policy. However, the EU's ability to act is constrained by structural deficiencies such as the principle

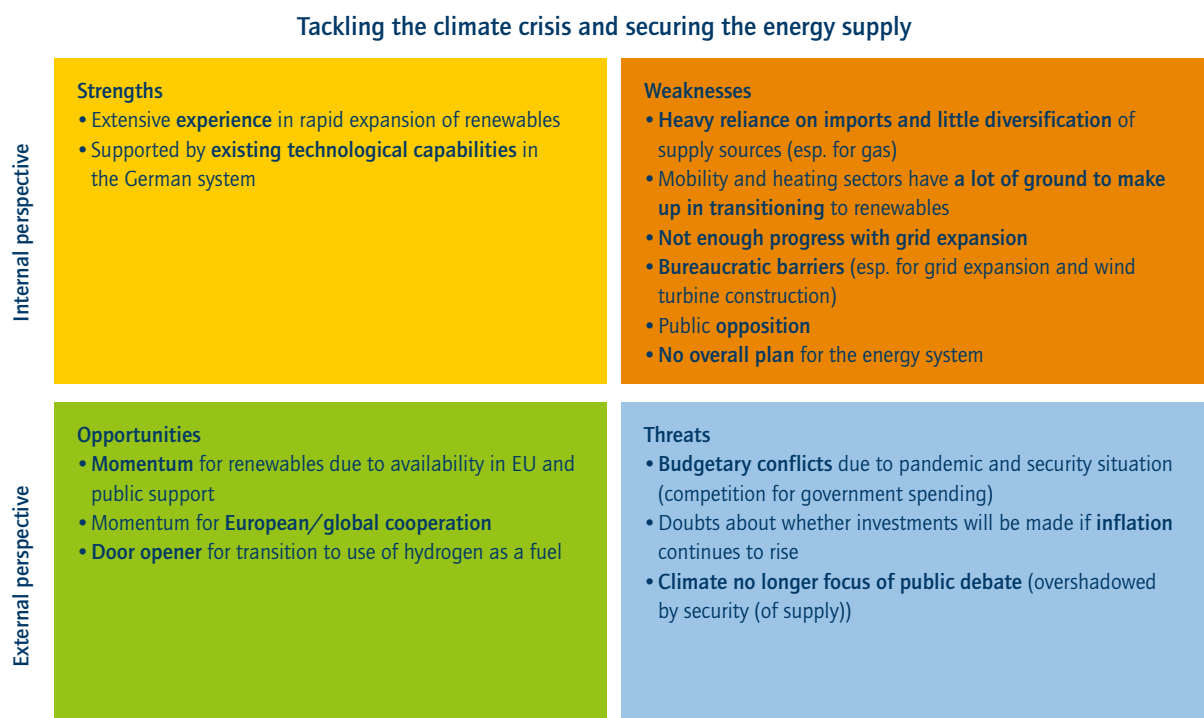


Figure 9: SWOT analysis for the climate crisis and securing the energy supply (Source: authors' own illustration)



of unanimity and by conflicts between national and European legislation. Due to its size, economic power and voting weight, Germany – especially in cooperation with France – should be at the forefront of the future development of the EU and of European energy policy.

International cooperation with countries outside the EU is also vital. As a rule, energy supply resilience increases in line with energy source diversification – avoiding dependence on a single source helps to absorb local shocks. Moreover, global cooperation is even more important when it comes to tackling climate change. The EU is directly responsible for less than 10% of global greenhouse gas emissions³⁶ and is home to a very small proportion of the world's most productive natural carbon sinks such as rainforests and mangrove forests. A purely national or European solution is not possible due to the global nature of the problem and the limited influence of individual nations. It is thus vital to take a global approach to sustainability in general and climate action in particular, and to ensure that joint initiatives are supported by key actors such as the US, China and India.

Regulatory implications

An overall energy system strategy that clearly identifies the relevant actors, objectives and deadlines would provide an invaluable framework for jointly addressing the challenges in the fields of security, resilience and sustainability. The formulation of such a strategy will call for close cooperation between the relevant government departments/ministries. The initiative should be centrally coordinated by the Federal Chancellery, with project

groups focusing on individual challenges.³⁷ It will be important to carefully analyse which challenges can be addressed by the market and where market liberalisation has actually caused problems. In practice, companies often have to deal with nation states or state-controlled enterprises rather than free market actors, especially when it comes to fuel and raw material procurement. The construction and reliable operation of key infrastructure are also critical. A careful assessment is required to determine whether more state intervention is needed in this area in order to protect sovereignty and public services.

The policy options outlined below draw on the extensive experience gained during the ongoing transformation of the German and European energy systems. System-wide, cross-sectoral regulations (such as the EU Emissions Trading System) are usually more effective than micro-regulations (such as specific feed-in tariffs or efficiency standards). While the latter can be a highly effective means of delivering objectives, they can often be inefficient due to extensive regulator information requirements. Moreover, the large number of frequently amended regulations means that they can also be bureaucratic and lack transparency. In areas where additional regulatory measures are necessary, it will be vital to consider how they interact with existing system-wide approaches.³⁸

In the energy sector in particular, future developments and discoveries should not be ruled out a priori by political decisions. It should not be forgotten that solar and wind power were seen as impractical instruments as recently as the 1960s. Within certain limitations, we should adopt a technology-neutral attitude towards future developments.

36 | See Crippa et al. 2019.

37 | See ESYS 2021b.

38 | See ESYS 2022; ESYS 2020a.

Policy options

Polymakers

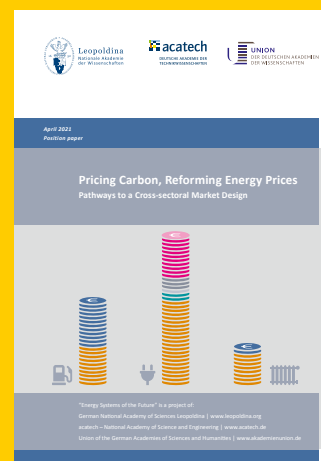
- Continue to actively drive the transition to sustainability (expand renewables, electrify heating and mobility sectors, increase efficiency, expand the grid).³⁹
- Drive the adoption of international climate and environmental treaties that establish globally efficient measures and take potential synergies into account (climate action and biodiversity).
- Accelerate decision-making and licensing procedures.⁴⁰
- Understand price signals as a powerful incentive to curb demand for fossil fuels and promote alternatives. High prices should not be brought down through state intervention. Instead, targeted support should be provided to lower-income households that are particularly hard hit by rising energy prices.

- Strengthen measures to reduce demand such as energy bills for tenants and information campaigns.
- Strengthen circular economy initiatives across all sectors and especially in the construction industry.

Research institutions

- Communicate and drive research on the main forms of renewable energy (wind and solar) and other alternatives (e.g. carbon capture and storage (CCS), carbon capture and utilisation (CCU), nuclear, geothermal energy).
- Communicate and drive research on storage technologies (such as batteries) and Power-to-X (e.g. hydrogen).
- Critically but impartially analyse opportunities for utilising the resources available in Germany.
- Communicate and drive research on the circular economy and resource recovery and reuse.

Selected further studies on tackling the climate crisis and securing the energy supply



39 | See ESYS 2020b.

40 | See ibid.



5 Conclusions and outlook

The lesson from Russia's war on Ukraine is that in order to enable peace and prosperity we must achieve and consolidate strategic sovereignty so that security, resilience and sustainability can be guaranteed. The analysis summarised in this publication reveals that the different dimensions of this overall goal are multi-faceted and have a highly complex relationship with each other. A systemic approach accompanied by substantial monetary and non-monetary resources will be required to deliver the relevant objectives. It will be vital to ensure that these resources are deployed efficiently when selecting and developing the solutions. Synergies should be leveraged as effectively as possible when implementing measures to achieve the stated aims, while conflicts between the goals should be transparently acknowledged and openly discussed.

The sheer size and complexity of the challenge means that it will often be impossible to find purely national solutions – the problems can only be successfully tackled through close cooperation with our European and international partners. Cooperation should therefore be strengthened both within the EU (which should also have a stronger role) and with international partners, especially NATO. The relevant actors from government, science, industry and civil society should be included in this process in order to gain a holistic perspective on the challenges and arrive at solutions that are acceptable to everyone.

At national level, too, close cooperation between the relevant actors will be key to achieving the objectives. Policy actors are urged to adopt a cross-party, cross-departmental approach to tackling the common goals. To this end, overall responsibility should be assigned to a central agency (preferably the Federal Chancellery) in order to provide a permanent overview that facilitates a joint approach to the cross-cutting issues. Once this has been done, it will be necessary to negotiate which actors should be responsible for specific areas. Rather than being confined to crisis management, this cooperation should be implemented on a long-term, strategic basis. In addition, the evidence base for policymaking should be strengthened by the establishment of intradepartmental and interdepartmental project teams, while the agility and thus resilience of administrative structures should also be improved. These activities should be guided by the principles of networking, interdisciplinarity and individual responsibility.

It will be vital to consider the goals from a holistic perspective and ensure that the relevant measures are designed systemically. It will also be crucial to engage in a negotiation process that includes the general public, which has shown itself to be capable of this type of engagement during the current crisis. A one-factor-at-a-time approach to strategy and action will not deliver the desired results fast enough – science, industry, government and civil society must all work together.

This publication outlines the initial steps that can be taken to strengthen security, resilience and sustainability. acatech will continue to promote strategic sovereignty and security, resilience and sustainability as overarching goals of future individual projects.

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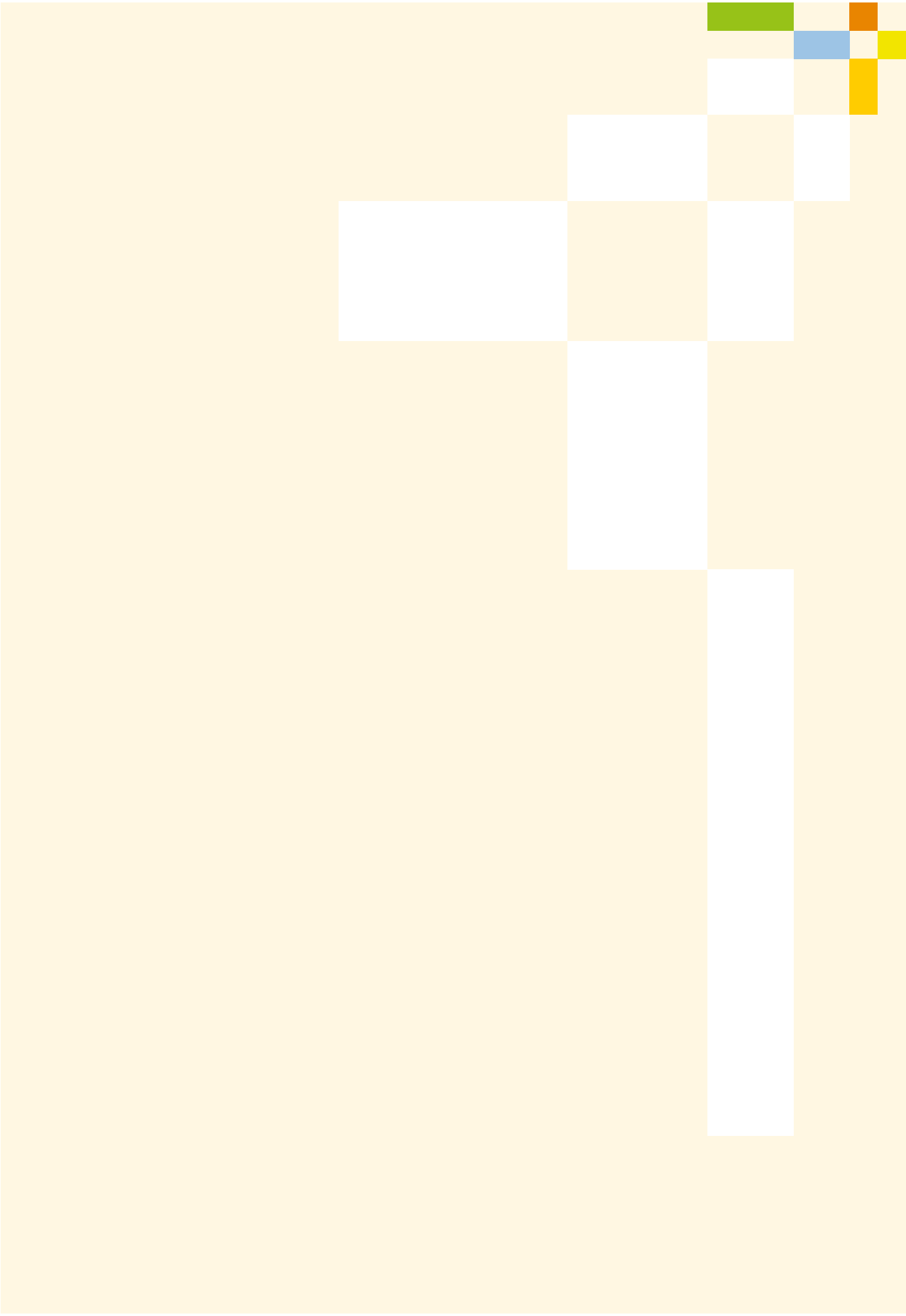
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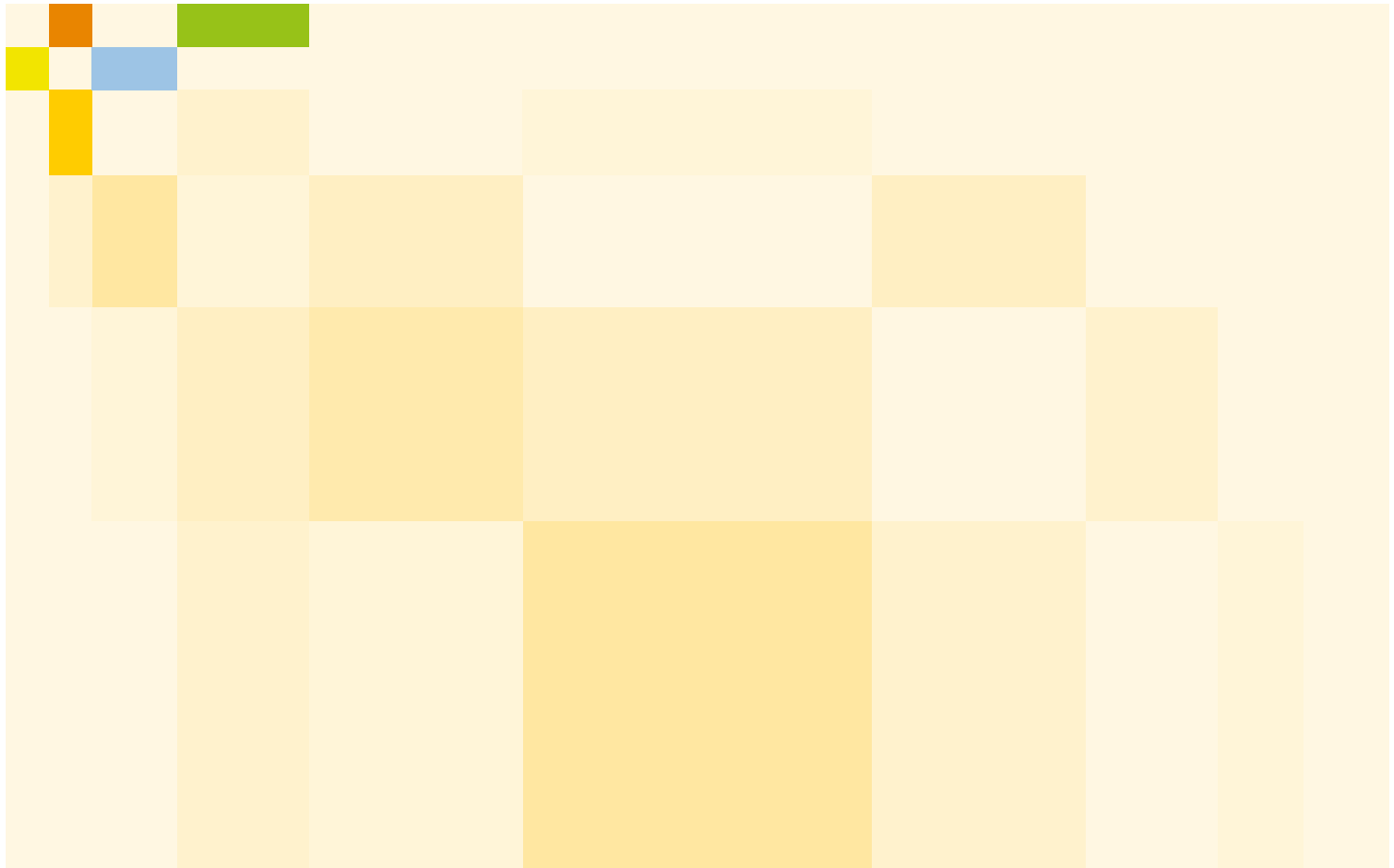
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Russia's war on Ukraine and its implications call for a reassessment of the overall geopolitical situation and the challenges that Germany and Europe will have to address over the coming years. An analysis of these challenges makes it clear that the basis of peace and prosperity lies not in national self-interest and autarky, but in strategic sovereignty and international cooperation geared towards achieving security, resilience and sustainability.

This acatech IMPULSE publication outlines the new social and economic challenges facing Germany in the medium to long term and formulates policy options for policymakers, businesses, science and civil society. The policy options build on the findings of previous acatech projects. However, in view of the current crisis, these have been augmented by interviews in which experts from science and industry discussed the actions required by the present situation.