Awti Advisory council for science, technology and innovation

RESILIENT AND FUTURE-PROOF

THE POWER OF STABLE, LARGE-SCALE INVESTMENTS IN RESEARCH AND INNOVATION



Awti Advisory council for science, technology and innovation

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Resilient and future-proof

The power of stable, large-scale investments in research and innovation

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Summary

Background: Dutch society and economy are not sufficiently future-proof

The Netherlands is running up against its limits on various fronts, including care, climate, mobility, equality of opportunity, housing and infrastructure. This has consequences for the country's future resilience.

A combination of these social challenges, if they are not resolved, can have a disruptive effect on society and the economy. Tackling them requires knowledge and innovation. Public investment is crucial to foster processes and transitions, especially in areas where the market falls short. The government plays a role in fostering and facilitating the interplay between knowledge institutes, industry, business and civil-society organisations. Through targeted investment in research and innovation, the government can not only stimulate sustainable economic growth, but can also help create a fairer, healthier and more sustainable society.

The present policy for resolving social challenges is inadequate and focused on the short term. Successive governments have failed to make hard choices. Developing a long-term vision for research and innovation, and helping to address social challenges is essential if the Netherlands is to be made future-proof.

In this advisory report, AWTI accordingly addresses the following request for advice:

How can the government use research and innovation more strategically to ensure a future-proof Netherlands?

Advice: Make the Netherlands more resilient through strategic investments in research and innovation, with a focus on collaboration

AWTI underlines the importance of a future-proof Netherlands. In order to be future proof, Dutch society and the economy must be resilient; only then can the country deal with the consequences of social challenges. Research and innovation are indispensable in strengthening the resilience of Dutch society and the economy, because of the major contribution they make to a society which has well-being and a sustainable, circular economy at its heart, whilst respecting both the need to protect our planet and our competitiveness.

AWTI observes that the present policy is not optimised for addressing social challenges. First, the government has no clear vision for research and innovation in the long term, nor of how research and innovation contribute to addressing social challenges. There is also a lack of stable public investment in large-scale, long-term research and innovation. This creates uncertainty and unpredictability regarding the direction of research and innovation

and about the availability of financial resources to fund research and innovation for industry, civil-society organisations, knowledge institutes and other stakeholders. Instability of policy and financial resources will make those stakeholders less inclined to invest in research and innovation themselves. The knowledge and innovation ecosystem therefore benefits from stable policy and financial resources.

Second, both the private and public investments in R&D are currently insufficient. The Netherlands has failed to meet the 3% Lisbon target for years, and is consequently falling further and further behind its neighbouring countries. There are two explanations for the low private investment in R&D: the structure of the economy and the concentration of R&D in a limited number of companies. This makes the country vulnerable. There is a causal connection between public and private R&D investment: increasing public investment encourages private investment. Extra public funding for R&D also strengthens and increases economic activity in general. It is therefore essential that the government develops a vision for investing more and on a structural and targeted basis in research and innovation.

Recommendation: Develop strategic, collaborative research and innovation platforms

AWTI advises the government and parliament to develop an instrument for the structural long-term funding of large scale research and innovation. This instrument would have a strategic focus and aimed at collaboration. The main purpose of this instrument is to strengthen the resilience of Dutch society and the economy.

Recommendation 1: Select themes based on a vision for the future

The emphasis in the future must be on strengthening the resilience of the Dutch economy and society. It is important for an effective configuration of the suggested instrument to choose specific, strategic themes, in other words themes where the Netherlands either has an unassailable position in Europe or is clearly vulnerable, based on a clear vision for the future.

AWTI offers an assessment framework to help make these thematic choices. The following three criteria are important here:

- Ensure the theme supports the resilience of the Netherlands.
- Build on Dutch strengths at European level.
- Take account of scarcities and vulnerabilities.

Recommendation 2: Set up a facilitating platform for each theme

To develop a cohesive research and innovation nexus with high potential, it is important to ensure that each theme has structure and direction. The platforms proposed by AWTI

are small, facilitating and coordinating organisations. The choice to be developed within each theme should as far as possible be made bottom-up. Configuring a platform with a broad, systematic approach will enable the instrument to prevent innovation getting bogged down in (technological) solutions without being embedded in society or the economy. Each platform brings together different disciplines, encourages collaboration between public, private and civil parties, facilitates application and upscaling and focuses attention on implementation, acceptance and governance. Finally, a platform plays a facilitating role in generating mutual trust through transparency, participation and long-term engagement.

Recommendation 3: Encourage dynamic transdisciplinary and multidisciplinary collaboration

The instrument targets investments at all activities that are necessary to develop new knowledge, apply it in new solutions, implement innovations and disseminate them widely. This requires broad, intensive collaboration across boundaries between disciplines, sectors and stakeholder categories. It is therefore key to encourage collaboration and avoid competition. A characteristic of this collaboration is that it involves a wide array of participants from the start: companies and entrepreneurs, government, knowledge and research institutes and actors in society such as civil-society organisations, associations and citizen collectives. The instrument must focus on dynamic collaboration with parties that are appropriate for the phase where they address social challenges and where the innovations are located. Transdisciplinary and multidisciplinary collaboration are very important in this context, because they can lead to innovative solutions that would otherwise not be possible.

Recommendation 4: Ensure stability and reliability whilst retaining democratic legitimacy

AWTI believes that government and parliament have a joint responsibility for the strategic themes that are selected, but that a degree of distance from the day-to-day political debate will improve the stability and reliability of the instrument. At the same time, the budgetary powers of parliament should not be constrained too much if investments are moved too far out of parliamentary control. Striking a good balance between democratic legitimacy of expenditure and securing the long-term character of the investments is therefore essential. AWTI also advises that the development of the instrument be periodically evaluated. It is important here that investments are linked to clear conditions which offer clarity regarding the expected funding and its duration.

Recommendation 5: Devote 0.5% of GDP to funding the instrument

The instrument will require additional large-scale and long-term investments in research and innovation. AWTI therefore advises investing 0.5% of GDP annually in the platforms. This corresponds to the annual additional investments needed if the government is to achieve the 3% Lisbon target.

1

Background: Dutch society and economy are insufficiently future-proof

1.1 Social challenges have a disruptive effect on Dutch society and economy.

The Netherlands is running up against its limits on various fronts, including care, climate, mobility, equality of opportunity, housing and infrastructure. This has consequences for the country's future resilience.

Meeting this challenges will require transformations: fundamental changes in how we produce and consume, including how we do farming and obtain our food, and how we move around, use energy, look after our health, use natural resources, and combat the growing polarisation and social inequality. We are also confronted with geopolitical developments, our dependence on technology is growing, trust in national institutions is declining and constitutional democracy is increasingly being undermined. These are issues which cannot be resolved overnight: developing solutions and bringing about fundamental change will require effort, investment and time (AWTI 2023a). These are moreover issues which require robust and stable policy.

The public are increasingly convinced of the urgency of the need to address major social challenges. However, government policy is marked by inconsistency. On the one hand, for example, the Netherlands has tightened up its climate ambitions considerably in recent years and translated them into specific, measurable targets which are enshrined in a Climate Act. At the same time, the government under Prime Minister Schoof has cut back on all manner of funds which contribute to finding solutions to the climate issue, such as the Climate Fund, the Nitrogen Fund and grants for sustainable energy.[1] Previous governments have also had difficulty with tackling (urgent) social challenges. This inconsistency in policy does not engender the required stability.

On top of that, the growth in (labour) productivity has been under par for years. This is a Europe-wide problem, but is more serious in the Netherlands than elsewhere,[2] partly because of lower growth within economic sectors, a shift in employment from high to low-productive sectors, and the structure of the Dutch economy (see e.g. Erken 2024 & Van

1. Outline agreement between the PVV, VVD, NSC and BBB political parties dated 16 May 2024: https://www.kabinetsformatie2023.nl/documenten/publicaties/2024/05/16/hoofdlijnenakkoord-tussen-de-fracties-van-pvv-vvd-nsc-en-bbb
2. Dutch economic growth has in recent years been achieved mainly through longer working hours, not more productivity.

Bree et al. 2025a).[3] Increasing labour productivity is important for maintaining the level of welfare and prosperity; but in a society characterised by a growing number of older people, who are living longer and longer, and with a steadily decreasing number of young people, it is not possible to increase the number of people in work or have people work for longer. Key drivers of labour productivity are public and private investment in R&D, (process) innovation, entrepreneurship and intangible assets such as data, specific software and human and organisational capital (see e.g. OECD 2021, Kim & Loayza 2019, Baarsma & d'Orey Neves 2024, Draghi 2024).

There are a number of major disruptive factors in the geopolitical arena, too: the war in Ukraine, the banking crisis, the COVID-19 pandemic – these have all exposed the strategic vulnerability of the Netherlands and the EU. The global balance of power is shifting; the US-dominated world order is changing. China is rapidly becoming a major force on the scientific, economic and technological fronts. There are concerns about knowledge and economic security. There are growing calls for strategic autonomy.[4] Governments worldwide are injecting subsidies and investments into research and technology, often on an ad hoc basis, and developing new trade and industrial policies and protectionist constructions. There is a global battle raging for access to (critical) raw materials, energy, technologies and markets.

Then there is our dependence on technology and digital services. That creates opportunities, but also dependence and a reduction in our strategic autonomy. Non-European companies develop and manage our digital infrastructure; in the current geopolitical context, that makes us very vulnerable, especially as that dependence seems to be being used more and more as a tool for exerting power. This dependence also tests our democracy and European values, for example when it comes to influencing elections or dealing with privacy-sensitive data. Generative AI, addictive and misleading algorithms and disinformation also have consequences for our society, especially with regard to science, media, political culture and identity.

Recent geopolitical developments, like the social challenges that have been on the agenda for some time, have major consequences for the economy, society and democracy in the Netherlands and Europe.

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3. Examples of high-productive sectors are mechanical engineering and ICT services; Low-productive sectors include hospitality, healthcare, the arts, culture & recreation, and other business services such as cleaning or security.
4. AWTI (2025) defines strategic autonomy as follows: In essence, strategic autonomy is concerned with the question of who/which parties we are willing (or unwilling) to be dependent on. There is both a geographical and an economic dimension to this.

1.2 Successive governments fail to make clear choices, causing logjams in society and the economy

The competitiveness and earnings model of the Netherlands and the EU are under pressure. In a razor-sharp analysis, former ECB president Mario Draghi (2024) observed that the EU is in danger of losing its right to exist. He proposes a wide raft of measures and calls for a boost in investments in research and innovation in order to close the innovation gap with China and the US. But this raft of measures is costly: governments and industry in the EU would need to invest a minimum of 750-800 billion euros per year. This naturally begs the question of where that money should (and can) come from.

There are also signs that the future resilience of the Netherlands, and in particular our economy and democracy, is under pressure. Based on the Resilience Dashboard[5] developed by the European Union,[6] we might conclude that the Netherlands today is not especially vulnerable. However, that would be to ignore the fact that the Dashboard is based on data from the past and fails to take into account present and future social challenges.

Several recent studies accordingly place major question marks *against* the future resilience of the Dutch economy and society. They expose a number of pinch points which undermine the future resilience and competitiveness of the Netherlands (European Commission 2024, IMF 2025, OECD 2025), such as:

- Labour market shortages hamper economic activity, innovation and the digital and green transitions.
- Lack of government investment and the announced spending cuts on research and innovation have adverse consequences for economic activity, labour productivity and digital and green transitions.

5. The European Commission developed the Resilience Dashboards in 2021. Their aim is to provide a holistic assessment of resilience in the EU and its member states. They provide insight into the resilience and vulnerability of EU member states on four dimensions: Social and Economic, Green, Digital and Geopolitical. Resilience is defined in these Dashboards as the ability not only to withstand and cope with challenges but also to undergo transitions in a sustainable, fair, and democratic manner. The Dashboards are an operationalisation of a policy framework developed by Manca et al. (2017). This framework helps policymakers decide which policy interventions can increase the resilience of a society. The Dashboards are updated annually.
6. The Dashboard shows that the EU performs relatively well compared to China and the US; the EU is less vulnerable or better equipped on most fronts than the US and China, with its principle vulnerability being geopolitical. The EU is less vulnerable in the social and economic, green and digital dimensions. As regards the starting point (*capacities* on the Dashboard), the EU scores better than the US and China on Green and Geopolitical, but has a gap to make up in the digital dimension. In the Social and Economic domain, the EU scores between the US and China.

- The congestion on the electricity distribution network and the shortage of nitrogen space are slowing the rollout of renewable energy resources and holding back the building of new residential neighbourhoods.
- The climate goal of a 55% reduction in CO_2 emissions by 2030 is not being achieved due to a lack of policy direction and cohesion.
- The complexity of the tax and benefits system discourages labour market participation, despite the shortages on the labour market.
- Finally, there are concerns about the sustainability of the public finances in the long term owing to the ageing population and the likely associated costs, the pressure on spending due to climate change and the undertakings to increase defence spending.

These pinch points exist, with no prospect of a breakthrough in sight. The studies also lambast the short-term focus of recent governments and their failure to invest structurally in (addressing) the social challenges facing the Netherlands.

The IMF and the OECD have criticised a policy that is aimed mainly at boosting purchasing power and reducing burdens in the short term, at the same time as the government is cutting spending on education, research and climate. This has major consequences for the longer term. Combined with high inflation and an economy that is already at full capacity, this policy can lead to structurally lower economic growth, because it not only undermines productivity growth and international competitiveness, but also impedes the progress of a number of necessary transitions. The IMF makes an urgent call for more investment in education, research & development and infrastructure, to enable the government to guarantee economic stability and open the way to real growth. The OECD observes that the Netherlands is hampered by indecisiveness. There is enough knowledge concerning the social challenges and even appropriate solutions, but there is no consensus on how to tackle or prioritise the challenges. The result is that problems are not addressed and are kicked into the long grass. In other words, the Dutch government makes too few choices, thereby putting pressure on the resilience of society and the economy. The OECD advises developing a cohesive strategy in which choices are made; This would enable challenges to be addressed and help make the Netherlands future-proof.

The Dutch environment is also a cause for concern, as the Netherlands Environmental Assessment Agency (PBL) observes in its 'Environmental Status Report 2025' (*Balans van de Leefomgeving 2025*'). The Netherlands is failing to meet a number of (international) agreements and targets. The improvements in environmental quality have stagnated since 2010. Several environmental challenges cause major political and social problems (climate, nitrogen, raw materials, housing). These are complex challenges that are not readily solved with new measures and technologies. PBL argues that

fundamental political choices need to be made, whereas the government has actually begun taking more of a backseat role. This has created scope for bottom-up developments. In parallel with this, responsibility is increasingly being placed on citizens, businesses, lower tiers of government and civil-society organisations The policy is also largely based on market forces. PBL observes that, while this has led to prosperity and economic growth, insufficient progress has been made towards improving the environment, water and soil quality and human and animal health. The focus on other (urgent) political issues, such as care, migration and defence, moreover means that there is insufficient attention for environmental challenges. PBL also argues that there is insufficient stability in policy, with several governments reversing or watering down the policy of their predecessors, such as the CO_2 levy and the netting off scheme for solar power, whereas deferring necessary measures simply exacerbates the problems, in turn pushing up costs and necessitating more severe measures when the challenges are finally addressed. PBL also notes that policy inconsistencies have a negative impact on acceptance and willingness to invest on the part of citizens and businesses. Environmental challenges are complex and addressing them demands clear, coordinated political choices.

The 18th Budget Advisory Group (SBR)[7] (2025) highlights the major challenges facing the Netherlands which have a direct impact on society and the economy (population ageing, housing, climate, nitrogen, energy). There are also scarcities on the labour market, in physical space and financial resources. Given the present and future challenges, it is key that future governments take genuine steps. The Advisory Group therefore calls on politicians to make choices and develop targeted policy for the long term. The Advisory Group cites two basic principles here: the perspective of Broad Welfare (Brede Welvaart) for making judgments and choices, and realistic budgets based on the reliability of the government. In order to address social challenges and serve as a basis for the future prosperity and welfare of the Netherlands, the Advisory Study Group argues that reforms are needed on several fronts. It gives the example of future-proofing the tax system in a bid to tackle the stagnating (labour) productivity and rising costs of population ageing. Investment is also needed in education, research, innovation, human capital and technological development. These measures demand a long-term perspective and investments now which will only pay off in the future. This is diametrically opposed to

[7] The Budget Advisory Group (Studiegroep Begrotingsruimte) was created in 1971. It Is chaired by the Secretary-General of the Ministry of Finance. Its members include senior officials and directors from the Ministries of General Affairs; Interior and Kingdom Relations; Economic Affairs; Finance; Social Affairs and Employment; Health, Welfare and Sport; the Netherlands Bureau for Economic Policy Analysis (CPB) and De Nederlandsche Bank. The Netherlands Environmental Assessment Agency (PBL) and the Netherlands Institute for Social Research (SCP) play an advisory role.

the current short-term perspective and the policy of recent governments with its focus on the here and now.

An analysis carried out for TNO (Netherlands Organisation for Applied Scientific Research) by Geurts et al. (2024) shows that the present economic growth path of the Netherlands will lead to problems in the future. It is focused on earning capacity and growth in prosperity (measured in GDP) and devotes too little attention to social challenges, sustainability and well-being. The authors argue that a new growth path is needed for the Netherlands. Achieving it will require the government to play both a steering and facilitating role. TNO also calls on the government to adopt the Broad Welfare perspective as a framework when making judgments and (policy) choices. It also argues that the government must recognise and address transition failures.[8] Government intervention is needed to address these failures and accelerate transitions. The government must give direction to transitions and to research and innovation. According to TNO, research and innovation can be used to resolve social challenges and bring about transformative change.

1.3 Request for advice

Social challenges are becoming bigger and more complex, with examples such as electricity distribution network congestion, equality of opportunity, nitrogen and housing. We expect even more problems to arise in the future, such as the growing demand for care. Together, these social challenges – if they are not resolved – can have a disruptive effect on society and the economy. The present policy to resolve these challenges is short-sighted and inadequate. Tackling the challenges demands knowledge and innovation, but above all it requires politicians who dare to make choices; politicians who develop a long-term vision for research and innovation and how they contribute to addressing social challenges to help the Netherlands become future-proof.

Research and innovation are indispensable for addressing complex, interrelated social challenges. Public investment is crucial to foster processes and transitions, especially in areas where the market falls short. The government plays a role in fostering and facilitating the interplay between knowledge institutes, businesses, entrepreneurs and civil-society organisations. Through targeted investment in research and innovation, the government can not only stimulate sustainable economic growth, but can also contribute to a fairer, healthier and more sustainable society.

8. Transition failures are situations where market mechanisms and existing systems are insufficient to bring about transitions.

In other words, continuing on the well-trodden path is not an option. Targeted investment in research and innovation is needed to achieve the necessary transitions and reforms so that the Dutch economy and society are able to withstand disruptive events and flourish into the future. But (scientific) research and innovation are not able on their own to address social challenges; That requires political and social choices. Large-scale changes require an accumulation and synergy between all kinds of individual innovations, whether technological or institutional. There is a need for more direction in research and innovation policy and for policy that can make the difference in eliciting innovation; a need to develop and strengthen systems which ensure that innovations are able to grow and achieve sufficient scale. That demands consistency, volume and collaboration between knowledge institutes, industry, government and civil-society organisations.

Stability and a carefully considered perspective are essential here, but it is precisely these attributes that are missing. Future-proofing Dutch society and the economy therefore demands a different policy for research and innovation. It is vital that the following aspects are at the heart of this new policy: 1) a long-term vision for how research and innovation contribute to addressing social challenges; and 2) stability of both policy and financial resources. A shift in focus is also needed. To achieve this ambitious shift, the Netherlands must be willing to invest more, and more structurally, in research and innovation, in order to make the Netherlands future-proof.

Since doing nothing (differently) is not an option, in this advisory report AWTI addresses the following request for advice:

How can the government use research and innovation more strategically to ensure a future-proof Netherlands?

This advisory report is not about rejecting existing public expenditure on research and innovation. It is about additional funding. Addressing the complex social challenges to future-proof the Netherlands requires additional, strategically driven investments in research and innovation.

Creation of this report

This report was compiled in a number of stages. AWTI performed a literature, stakeholder and policy analysis, held talks with numerous experts and organised a roundtable meeting (see Appendix 1 of a list of interviewees). This meeting was attended by stakeholders involved in various ways in funding research and innovation. The central question addressed during this meeting was: *How can the government best organise and safeguard long-term funding of large-scale research and innovation*?

The analyses were discussed during Council meetings to distil a uniform line of reasoning with recommendations. A draft version of the report was submitted to two external

reviewers (see Appendix 2), who were asked to reflect on the consistency of the draft. Any gaps identified by the reviewers were incorporated in the report under the responsibility of the Council. We would like to thank the reviewers and all interviewees for their time, openness and insights.

Project group

This advisory report was prepared by a project group consisting of Council members Marleen Stikker (Chair), Gerben Edelijn and Jolanda Kluin and staff members Annelieke van der Giessen, Jeffrey de Hoogen and Marleen van de Vate.

Structure of this report

Chapter 2 presents the results of the above analyses and interviews. AWTI believes it is very important that the Dutch economy and society are resilient so that the Netherlands is able to cope with the consequences of social challenges. Strengthening the resilience of society and the economy requires large-scale and long-term research and innovation. The analyses and interviews showed that stability of both policy and financial resources for large-scale, long-term research and innovation is essential, as is a long- term vision on the role of research and innovation in addressing social challenges.

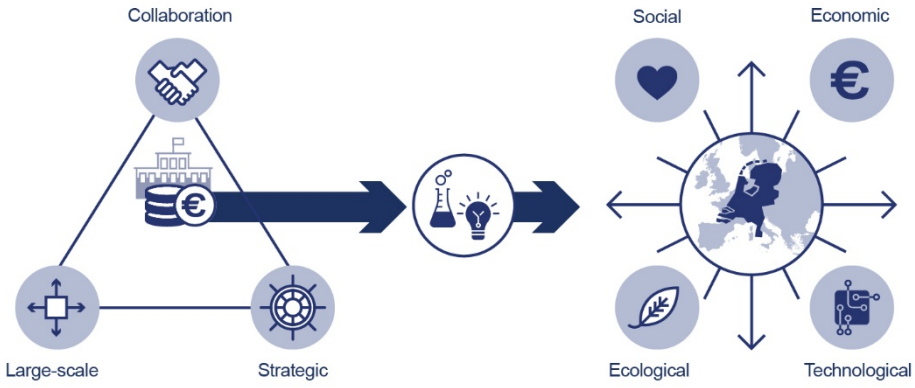
Chapter 3 contains five recommendations for the creation of collaborative, strategically driven research and innovation platforms. Implementing these recommendations will enable research and innovation to resolve social challenges and strengthen the resilience of the Dutch economy and society.

2

Advice: Make the Netherlands more resilient through collaborative, strategically driven investment in research and innovation

AWTI underlines the importance of a future-proof Netherlands. In order to be future-proof, the Dutch economy and society must be resilient; only then can the Netherlands deal with the consequences of social challenges and continue to safeguard welfare and prosperity in the future, whilst respecting the planet and safeguarding human justice. Research and innovation are indispensable here, and it is therefore essential that the Netherlands makes serious and targeted investments in research and innovation; this means politicians must choose the social challenges in which to invest. With this in mind, AWTI's advice is: make the Netherlands more resilient through collaborative, strategically driven investment in research and innovation. To achieve this, politicians will have to make extra funding available.

Advice: Make the Netherlands more resilient through collaborative, strategically driven investment in research and innovation.



AWTI observes a lack of a long-term vision by the government and parliament for addressing social challenges and the role of research and innovation in doing so. AWTI believes that such a vision is necessary to make the Dutch economy and society more resilient and genuinely resolve these challenges. Current policy is often ad hoc, with large but temporary stimuli (which often fail to survive rounds of spending cuts), thus providing too little stability for those involved in research and innovation.

AWTI notes that the Netherlands has for years invested less in R&D than its neighbouring countries, causing it to fall further and further behind in this area. As a result, the Dutch economic structure and industry are becoming increasingly knowledge-extensive. This in turn leads to further reductions in investment in research and innovation. To reverse this trend, the government needs to ensure stability, in terms of both policy and financial resources; that will incentivise businesses, civil-society organisations and knowledge institutes to step up their own investments in R&D.

2.1 Research and innovation essential for a resilient society and economy

Our society and economy increasingly need to be future-proof so that we can deal with the social challenges we face. In Chapter 1 we made clear that the future resilience of the Dutch economy and society is under pressure. A country's resilience determines the extent to which it is affected by disruptive events. Investing in research and innovation is indispensable for strengthening the resilience of the Dutch economy and society, because research and innovation make a major contribution to creating a society in which well-being, justice and a sustainable, circular economy are central tenets; a society which respects the planet and safeguards our competitiveness and which is capable of dealing with the consequences of technological developments.

How does AWTI define resilience?

AWTI applies a broad definition of resilience which incorporates attention for welfare and prosperity whilst respecting the limits of the planet.[9] Resilience is the ability of a society and an economy to deal appropriately with disruptive and disturbing events (see Manca et al. 2017 and Hafele et al. 2022). Social challenges and changing geopolitical developments can be seen as disruptive and disturbing events. Challenges such as climate change and growing inequality of opportunity are permanent crises which can have serious consequences for the welfare and prosperity of a society. Addressing these

9. Resilience is about taking a stance and having the capacity to act. It is about shaping one's own future. These are essential characteristics for addressing social challenges and future-proofing the Netherlands. It is also a term that has increasingly come to be used in the public discourse.

challenges demands a proactive and strategic approach. Solutions demand radical changes at social, economic, ecological and technological level. Those solutions are moreover highly complex and characterised by uncertainty about what the world will look like after the transformation.

AWTI's breaks resilience down into four dimensions: social, economic, ecological and technological. These dimensions are not mutually exclusive, but are by contrast closely interrelated. No one dimension is more fundamental than the others. All four are important dimensions to some degree in addressing social challenges.

The four dimensions of resilience

To make the link between the four dimensions of resilience explicit, three examples are given below based on three themes: health care, social media and inequality of opportunity.

Health care

Health care can both contribute to a resilient society and be dependent on it. It is an important foundation for social resilience and cohesion. The four dimensions of resilience can reinforce each other. For example, trust in the healthcare system leads to greater acceptance of vaccines (= social); this limits the negative economic consequences of a lower vaccination rate (= economic); improvements in air quality (= ecological) reduce the pressure on the health care system; a healthy population and accessible health care contribute to economic stability (= economic); and technological and social innovations to make digital health care more accessible (= technological) can reduce social inequality (= social).

Social media

Social media connect the four dimensions and also offer both opportunities and challenges. Control of digital services and algorithms (= technological) results in greater social cohesion. This can help counteract the negative effects of social media on mental health, especially among young people (= social). Social media also stimulate the creation of new business models, such as e-commerce, media companies, etc., and promote diversity in business (= economic).

Inequality of opportunity

Inequality of opportunity can undermine the resilience of a society and economy. It weakens social cohesion and lowers trust in institutions (= social). It constrains economic growth and increases the vulnerability of certain groups to crises (=

economic). Moreover, inequality of opportunity means that certain groups are disproportionately vulnerable to changes in the climate, such as rising sea levels, because they have limited access to the resources needed to adapt to the changing conditions (= ecological). If certain population groups have limited access to digital skills and technology, the opportunity gap between them and other groups widens. This causes them to lag behind when it comes to economic opportunities and makes them more vulnerable to trends towards automation.

Taking a holistic approach to resilience can combat inequality of opportunity, for example by investing in inclusive systems in education, social security, green infrastructure and digital skills, and putting fair transitions at the heart of policy, such as climate measures which simultaneously combat (fuel) poverty.

Resilience is more than safety

In the present geopolitical context, resilience often equates to safety. However, that perspective takes too little account of a context in which there is also attention for well-being, sustainability, social justice, technological developments, prosperity and respect for the planet. For this reason, AWTI bases its conceptualisation of resilience on Manca et al. (2017) and Hafele et al. (2022) (see Appendix 3). Their approach to this concept places the social and economic system, respectively, at the heart. One key thing they have in common is that their analyses both devote explicit attention to the broader context and apply system thinking.[10] This approach views a crisis as an interconnected whole, rather than a series of individual events. AWTI adds two systems to this: the ecological system and the technological system.[11] The ecological system is included because of the serious impact of human actions on ecological systems and the ever more disruptive consequences this has for the economy and society. The technological system is included because of our growing dependence on technological systems and the need to find appropriate ways of dealing with this without harming social cohesion or the planet. These two systems therefore also need to be sufficiently resilient and future-proof.

10. A system is an interconnected set of elements which are organised in a coherent way to achieve something (Meadows 2009). A system is defined and analysed on the basis of a goal, the elements and how those elements are linked to each other.
11. Ecological resilience is about the functioning of an ecological system and the ability to absorb the effects of changes by that system. These changes may arise due to human activity or may have a natural cause. Technological resilience refers to the capacity of an organisation/business/society to ensure that technological infrastructure and services are resistant to disruptions and able to recover, adapt and/or transform in response.

Capacities and characteristics of resilience

There are four capacities which make a system resilient: absorptive capacity[12], recovery capacity,[13] adaptive capacity[14] and/or transformative capacity[15] (see e.g. Manca et al. 2017, Hafele et al. 2022). In addition to capacities, there are also characteristics that influence the resilience of a system (Hafele et al. 2022). Resilience characteristics at ecological, macroeconomic and/or technological level are (bio)diversity,[16] redundancy,[17] adaptability,[18] cohesion,[19] connectedness,[20] smart detection,[21] scalability,[22] reconfigurability[23] and omnipresence and accessibility.[24] Capacities and characteristics are interrelated (see Table 1 in Appendix 4).

The way a system responds to a disruptive event or disturbance is linked to two dimensions: the intensity of the disruption and the duration of the exposure to it. In a brief, mild disruption, the capacity to absorb and recover plays a key role. The more intensive the disruption, and the longer it lasts, the more important it becomes for a system to adapt or transform. This requires flexibility and incremental change, so that the components of the system (such as households, communities, businesses and government) can continue to function. The goal is to limit losses after a disruption as far as possible. A response may be a conscious – political – decision or a forced change, for example due to natural or socioeconomic circumstances (Manca et al. 2017).

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12. Absorptive capacity is the ability to recover quickly following a disruption to the performance level prior to the event, without any material harm to the system.
13. Recovery is the ability to repair system functions in the medium to long term which have been lost due to the disruptive event.
14. Adaptive capacity is the ability to change and improve the system after a disruptive event so that it is prepared for any future disruptive event.
15. Transformation is related to adaptation, but goes a step further, and concerns fundamental changes in the system.
16. Diversity refers to the presence of several forms and behaviours. In terms of the economy, diversification of trade partners is an example.
17. Redundancy refers to the holding back/reserving of sources/resources so that they can be used in the event of a disruption.
18. Adaptability refers to the flexibility to respond to present or future disruptions.
19. Cohesion refers to the existence of connections. These may be vertical or horizontal. Vertical connections are relationships where there is a power differential, e.g. between the government and citizens) and the deployment of efficient decision-making processes and legislation/regulations. Horizontal connections are social networks, both informal and formal.
20. Connectedness describes the degree to which the components of a system are connected to each other. A high degree of connectedness can be either positive or negative: it can ensure that the system recovers more quickly following a disruption, but can also accelerate the spread of the disruption.
21. Smart detection refers to the gathering and analysing of data in order to anticipate disruptions and therefore be resistant to them.
22. Scalability refers to the ability to use the power of digital platforms.
23. Reconfigurability Is the ability to exploit the modular nature of digital technologies and to combine them in new ways.
24. Omnipresence and accessibility relate to the speed with which a system reacts to a disruption.

A resilient society and economy develop activities which reinforce the capacities and characteristics of resilience. A resilient society and economy develop activities which offer continuity of welfare and prosperity for present and future generations, with respect for the planet (= liveability) and minimisation of negative social consequences which lead to a deterioration in welfare (= humanity). A resilient society and economy are able to effect the transformations and fundamental changes needed, with emphatic and continuous attention for liveability and humanity. The components of a resilient society and economy, such as businesses, communities, households and government, develop and possess resilience capacities and characteristics that contribute to the resilience of the social, economic, ecological and technological system.

Resilience requires collaboration

Creating a society and economy with strong resilience capacities and characteristics is not a simple or straightforward process. It requires the ability to cooperate and collaboration between countries and regions. [25] It requires joint action with reliable partners, such as the EU. It requires the sharing of knowledge, social values, technology and resources. Knowledge, resources, development and production by collaborating countries partially overlap and partially complement each other. This can lead to a wide distribution of these components (= diversity). Trust in the collaboration and in each other is important (= cohesion). Competitiveness must be focused principally on parties that are outside the collaboration. Strategic autonomy also plays a role. If we know the areas where strategic autonomy in the future will be important, we can focus on them (= adaptability). Under these conditions, research and innovation contribute to strengthening a resilient society and economy with liveability and humanity at his heart.

Research and innovation strengthen the resilience of society and the economy

Research and innovation play a crucial role in making the society and economy more resilient and more future-proof, because they contribute to strengthening and reinforcing resilience capacities and characteristics (see e.g. Mitra et al. 2024, Steedman et al. 2024).

Scientific knowledge is needed to understand the workings of social systems that we wish to change and to explore new paths for the society and economy. Applied research and innovation are necessary to provide technological and non-technological solutions for these changes. To achieve these transformations and fundamental changes, Steeman et al. (2024) point out the importance of looking beyond the traditional focus of science and

25. Ability to collaborate relates to other countries (e.g. the EU) sharing knowledge and ecosystems, so they align with the knowledge and ecosystems of those countries. The aim is to be stronger and more resilient together.

technology and also embracing disruptive, social and/or governance innovations. Research and innovation lead to greater autonomy and sovereignty in technologies and sectors which are of strategic importance, and ensure economic security in turbulent geopolitical times. In this way, research and innovation contribute to strengthening a resilient society and economy (Steeman et al. 2024). Research and innovation also help individual companies become more resilient, by enabling them to be competitive, penetrate new markets and improve their ability to absorb shocks through diversification. This became apparent during the COVID-19 pandemic, for example, when rapidly growing and innovative companies proved to be more resistant to the economic shock. These companies proved to have a substantially lower risk of going bankrupt than other businesses.

There are numerous examples of this. In the area of climate adaptation, research and innovation help mitigate the risks of systems and infrastructures. Solutions are also developed which help society deal more effectively and more quickly with vulnerabilities such as drought and flooding. Second, research and innovation in the health care and pharmaceutical sectors contribute to the development of new technologies and are essential for the transformation of the sector. Research and innovation improve diagnostics and treatment for patients, create scope for prevention and achieve new breakthroughs in therapies and medication. They can also greatly improve the quality and efficiency of care. Third, research and innovation are necessary for ensuring a fair and just society with economic and social security, welfare and a renewed social cohesion at its heart. Fourth, research and innovation drive (labour) productivity, economic growth and prosperity. Investments in research and innovation help make it possible to use existing resources and production factors more efficiently and to raise (labour) productivity. Research and innovation are also needed to develop new (earnings) models and solutions for the circular economy and to modernise and transform agriculture. Fifth, investments are essential for the development of new (social) innovations and technologies to achieve carbon-neutrality. Existing technologies will only enable partial achievement of the emission reduction targets for 2030 and 2050: 35% of the targets for 2050 cannot be achieved without new technologies. Moreover, continual innovation will contribute to lowering the costs of this transition (see e.g. Draghi 2024, Steeman et al. 2024).

Economic returns on investments in research and innovation

What returns do investments in research and innovation actually deliver? Such investments often only pay off in the longer term, and several factors play a role.[26]

The EU has attempted to map the economic benefits of the Horizon 2020 (2014-2020) and Horizon Europe (2021-2027) programmes. It has calculated that each euro invested in Horizon Europe will deliver 11 euros in economic growth over 25 years. A total of 80 billion euros was invested in the predecessor programme, Horizon 2020 (2014-2020). It has been calculated that this programme led to an increase in European GDP of 421 billion euros, to 798 billion euros, in the period 2014- 2040, or between 5 and 11 euros per EU resident.

Horizon 2020 also generated 20% more employment and 30% more turnover for participating companies compared with companies which received no funding from the programme (see e.g. Mitra et al. 2024 and Horizon Europe at MIDTERM).[27] Greater innovative capacity also correlates with much better living conditions, and research and development contribute to the ongoing training and reskilling of those members of the labour force who are affected by transitions and geopolitical developments.

2.2 The government is hesitant to invest in research and innovation for the longer term

AWTI observes that the Dutch government offers too little in the way of a long-term perspective for research and innovation and how they can contribute to the resilience of the Dutch economy and society. A substantial improvement is needed here in order to

26 The Netherlands Bureau for Economic Policy Analysis (CPB), for example, for a long time refused to incorporate the returns on investments in research and innovation in its extrapolations of political party programmes, instead treating those investments purely as cost items. The Royal Netherlands Academy of Arts and Sciences (KNAW) published a report in 2023 in which it called on government advisory agencies to develop a toolkit to enable the impact of investing in science to be measured. In the autumn of 2025, CPB did include investments in research and innovation in its extrapolations of party programmes.

27. We would place the following caveat against these calculations. Measuring the (economic) impact of public investments in R&D is complicated according to Zúñiga-Vincente et al. (2015) and Becker (2016). Those two studies conclude that several factors can influence that impact, for example country-specific factors, the time period studied, the type of company and the economic structure. Van Elk et al. (2019) attempt to measure the economic impact of publicly funded R&D by using different economic models. They conclude that the outcomes depend on the model used. Soete et al. (2022) also look at the impact of publicly funded investments in R&D in different countries. They conclude that as long as public and private investments are complementary, there is a positive effect on productivity.

give direction to research and innovation, ensure attention is given to the entire knowledge and innovation system (mainly through application of knowledge and innovations in society and the economy), and to improving collaboration across the entire ecosystem.

At present, large-scale, long-term investments in research and innovation are often temporary in nature. They also frequently fall prey to political vagaries. This creates instability, in turn leading to uncertainty and unpredictability regarding the direction of development of research and innovation and regarding the availability of financial resources for research and innovation for industry, civil-society organisations, knowledge institutes and other stakeholders. The government can then be perceived as unreliable. A combination of unstable policy and unpredictable financial resources means stakeholders will be less inclined to invest in research and innovation themselves (Van Kempen et al. 2025a). The knowledge and innovation ecosystem thus benefits from stability in both policy and financial resources.

The importance of a broad, clear long-term vision for research and innovation

Creating that stability requires a long-term vision for how research and innovation can contribute to addressing social challenges. Translating this into practical tools offers certainty and thus predictability for industry, civil-society organisations, knowledge institutes and other stakeholders.

A long-term vision also encourages industry, civil-society organisations and knowledge institutes to invest in research and innovation (Van Kempen et al. 2025a). Creating stable policy based on a long-term vision give these stakeholders clarity regarding the fundamental principles, in turn fostering greater confidence. Building and developing a knowledge and innovation ecosystem also takes time. Giving ecosystems the space they need through a long-term vision also creates scope to invest in development opportunities for (research) talent. Coordinating and aligning technical, economic and institutional system factors is also time-intensive. These elements are necessary to achieve breakthroughs in research and innovation and resolve social challenges.

As noted earlier, the Dutch government lacks a clear vision for research and innovation for the long term and how they can contribute to addressing social challenges. If we wish to make the Netherlands more future-proof and deploy research and innovation to strengthen its resilience, three things are needed.

First, it is important to give direction to research and innovation. This creates the focus and critical mass needed to address social challenges and (further) develop (key) technologies. Second, it is important to give attention to translating knowledge into innovation. The innovation paradox is a major problem in the Netherlands: lots of new

knowledge is developed, but it often fails to lead to innovations and applications. Third, more attention is needed for transdisciplinary and multidisciplinary collaboration. Several obstacles mean that not all relevant parties are or can be involved, while each party has their own important role to play in the process: from development of knowledge, application of that knowledge and dissemination of the applications throughout society and the economy.

Giving direction to research and innovation

Escalating geopolitical tensions, complex transition challenges, lagging productivity and social unrest are combining to produce ever louder calls for targeted policy. Without targeted investment in new knowledge and innovation, the necessary change in the economy and society is unlikely to be fully achieved (Geurts et al. 2024). Draghi (2024) also recommends encouraging innovation in a limited number of specific (key) technologies. Increasing the resilience of the Dutch society and economy will require more targeted investments in specific themes. We cannot do everything, and choices need to be made to address urgent issues, (key) technologies and sectors where the Netherlands has an unassailable position or is explicitly vulnerable. We must also not lose sight of the European context.

Targeted investments are needed to be able to engage in the battle for technological development, where parties are able to secure a strategic position in the market ('control point' - Pisa et al. 2024) based on knowledge and innovation. With many key technologies, the parties which are the first to successfully penetrate the market ('first movers') will dominate that market, and become almost uncatchable. The 'winner takes all' effect occurs when these parties are able to encapsulate the knowledge and data in their core processes and applications, and when these are difficult to share (Barwise & Watkins 2018).

The present Dutch research and innovation policy is largely generic.[28] This means that all companies, technologies and scientific disciplines can make use of it, provided they meet the conditions. In 2023, roughly 68% of the government contribution to research and innovation was generic (see e.g. Velzing 2018, AWTI 2023a, De Heide 2025).[29] Although

28. There are of course also advantages to generic policy. The implementation costs are relatively lower. They more often have a greater reach, theoretically reducing the risk of missing new, emerging knowledge areas and technologies. Generic policy is also less susceptible to influence by parties which drive change incrementally rather than through radical or transformative change.
29. The biggest categories in generic policy in financial terms are the first flow of research funds to universities (direct funding) and tax support, especially the Tax Credit for Research and Development (WBSO). The 'Innovation Box' Is far and away the largest tax measure, amounting to 1.847 billion euros in 2021. The Innovation Box is not included in the calculations because of

this approach does allow scope for innovation, politicians often fail to make choices in favour of investments in specific social challenges, technologies or missions. The Dutch government is hesitant in giving direction to the research and innovation policy.[30] They prefer to leave it to knowledge institutes, industry and civil-society organisations to decide where to invest (AWTI 2020, WRR 2024).[31]

The advantage of targeted policy is that it can promote disruptive or groundbreaking social and other innovations to facilitate transitions or accelerate specific technology developments. Targeted investment in research and innovation can moreover bring greater focus and critical mass in specific domains and social challenges (Hasekamp 2023, AWTI 2020). But targeted policy also brings risks: focusing on a limited number of core themes can lead to new, upcoming knowledge areas being ignored; targeted policy also frequently reaches the familiar players, leaving 'unusual suspects' out of the picture.[32] Another risk of targeted policy is that making tough choices acknowledges the possibility of failure: not every choice will turn out well, and failure is a possible outcome. It is therefore wise to adopt a portfolio approach to targeted policy.

Attention for the entire ecosystem and countering the innovation paradox

Innovations are needed to make the society and economy more resilient, as is the application of new knowledge in new products, processes, services, methods, organisational forms, etc. Achieving this requires investment in all kinds of research, from fundamental to applied and experimental research. Resources are also needed for the development of innovations, knowledge and skills among staff, adaptation of organisations and processes within companies, new business models, new industrial activity and immaterial capital such as data and software, as well as for the development

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international agreements that measures of this type ('patent boxes') should not be included in the R&D statistics as reported by the Rathenau Instituut.

30. Instruments for targeted policy include the Mission Driven Top-Sector and Innovation Policy (MTIB), the National Growth Fund (NGF) and the National Technology Strategy (NTS), formulated in 2024.
31. This attitude of the Dutch government does mean that Dutch parties are accustomed to engaging in dialogue and arriving at compromises in a broad coalition (Goetheer et al. 2018). The government can then only react to initiatives and choices which emerge bottom-up in this process. It is unclear how and why the government subsequently makes choices. Does it mainly select the best-organised technologies? Does it select sectors and lobbyists with the best narrative? AWTI therefore advocates a transparent approach based on well-considered and supported choices. Making choices prevents dilution of resources and loss of striking power. Choosing also provides clarity to private players regarding future earning opportunities, enabling them to invest in key technologies, too (AWTI 2020 and Goetheer et al. 2018)
32. In the context of industrial policy, the term 'embedded autonomy' is used: the government has to learn what industry wants and what obstacles it encounters (the government itself does not after all have all the answers). At the same time, the government also has to maintain the necessary distance to be able to make choices and allow for the risk that some players will work with a short horizon or prioritise their own private interests rather than the sector, economy or society.

of knowledge and innovation ecosystems (see e.g. AWTI 2023a, 2024, Van Bree et al. 2025a). The Netherlands invests relatively large amounts in fundamental research and the development of new knowledge, and less in applied and experimental research, whereas it is precisely applied and experimental research that is needed for the development of new products and processes and for improving existing ones (Bollen et al. 2025, De Heide et al. 2024).

More focus is needed on translating knowledge into innovation, then. Like the rest of Europe, the Netherlands is confronted with an innovation paradox, whereby newly developed knowledge is insufficiently translated into practical applications and innovation – or, put differently, into economic and/or social value creation (see text box). Knowledge production and scientific publications have insufficient impact on areas such as industrial activity, employment and/or (labour) productivity. By contrast, large industrialised countries such as Japan, the US and South Korea focus heavily on experimental development.[33] This choice, combined with the high level of investment, has enabled the South Korean economy to develop strongly in a relatively short space of time (OECD Korea 2023). It is precisely the application of knowledge and innovation in society and the economy which enables social challenges to be addressed. If we are serious about wishing to strengthen the resilience of the Dutch society and economy, therefore, attention will need to be given to all forms of research as well as to translating that research and knowledge into innovation and valorisation.

What is the innovation paradox?

There are structural failings on several fronts in the innovation process. This leads to sub-optimal implementation of (new) knowledge in society and the economy (valorisation), even where there is sufficient funding and effort on the part of stakeholders. A lot of new knowledge is developed in the Netherlands; however, it does not always align with the needs of businesses and civil-society organisations. It is also sometimes unclear how newly developed knowledge can be applied. Culture and institutional setting also play a role: there is often insufficient scope for experimenting and failure. Sometimes the reason lies in strict legislation and regulations, though the culture within organisations can also limit this scope. Organisations, companies and governments do not always have a clear strategy and vision for innovation. These are all factors which can cause an innovation ecosystem to function less than optimally. Often the input of social and civic skills, such as entrepreneurship, marketing, financing, organisation skills and social embedding are

33. See e.g. TNO R&D Uitgaven Factsheet and OECD Data Explorer

enough to counter some of these obstacles in the innovation process (Van Bree 2025b).

According to Van Bree et al. (2025b), three types of failure play a role here: market failure, system failure and transformation failure. Market failure refers to situations where the market falls short and delivers insufficient private investments in R&D. System failure characterises situations where there is insufficient collaboration and coordination between actors, networks, infrastructures and institutions, caused by systemic shortcomings in the entire research and innovation ecosystem. The result is weak creation and dissemination of knowledge. Transformation failure arises in situations where a research and innovation ecosystem is unable to support necessary social changes. There is an overemphasis on technological innovation or economic benefits, whereas attention for social needs is what is required to ensure that changes and innovations are accepted. This may be due to various obstacles (in the system), or to a lack of a vision, common goals, governance and long-term engagement. As a result, the status quo remains unchanged and the essential change cannot take place (Van Bree 2025b).

The cause of the innovation paradox can be sought not only in limited funding or effort on the part of stakeholders, but also in the role of the government: by taking a different stance, the government can resolve these forms of failure, at least partially. Simply funding research and innovation is thus not enough: the government needs to develop appropriate policy which takes into account the dynamic of the research and innovation ecosystem and the broader social context in which innovation takes place. According to Van Bree et al. (2025b), the government could tackle the innovation paradox by developing a long-term vision for research and innovation, giving direction to research and innovation and playing a coordinating and connecting role. The government can encourage knowledge institutes, industry startups, scaleups and civil-society organisations with specific incentives to invest in R&D. By creating the right conditions, the government can strengthen ecosystems, for example by promoting collaboration across the entire ecosystem and improving networks and infrastructure. The innovation paradox can be tackled through a mix of targeted policy instruments (based on a long-term vision), thereby ensuring that necessary social and economic developments and changes actually happen (Van Bree 2025b).[34]

34. The text in this box is based on a study by TNO (Netherlands Organisation for Applied Scientific Research), carried out by Van Bree et al. (2025b). TNO was commissioned by the Ministry of Economic Affairs to formulate a critique of the Actieplan 3% R&D.

Promoting transdisciplinary and multidisciplinary collaboration

The present policy devotes too little attention to genuine transdisciplinary and multidisciplinary collaboration (see text box) in research and innovation, whereas this is crucial for strengthening the resilience of the Dutch society and economy. This collaboration combines theory and practice and extends across disciplinary and sectoral boundaries. Solutions to social challenges are not bound by traditional disciplines or actors. Promising innovations stem not just from technological developments, but also from the humanities and social sciences. Sociological, organisational, ethical, economic or institutional aspects (of innovation) are essential for the development, dissemination and acceptance of innovations (AWTI 2022a, AWTI 2024). A variety of perspectives is also needed to ensure the successful application, dissemination and acceptance of innovations in society.

Transdisciplinary and multidisciplinary collaboration demands considerable time and energy from those involved. But it also delivers many benefits for knowledge institutes, companies, civil-society organisations, entrepreneurs and government authorities. New combinations of knowledge lead to innovations and technological developments. These do not arise within the walls of a single organisation, but in collaboration between different actors. Not every actor is of equal importance in every phase of the research and innovation process. It is important to develop new types of organisations and consortia which operate at the interface of community, market and government (Nationaal Klimaat Platform 2023, Diercks & Avelino 2022, De Moor 2023). This creates a different potential for innovation: enrichment of existing knowledge and genuinely new, creative and workable solutions (Soete & Stierna 2023, Schwaag Serger et al. 2023). The process of joint learning, researching, innovating and experimenting also creates a stronger ability to solve problems; this too contributes to the resilience of society and the economy (AWTI 2022c, Den Boer et al. 2021).

The present policy on collaboration in research and innovation throws up a number of obstacles to a broad, inclusive and dynamic collaboration. (AWTI 2022b, 2022c, 2023, 2024, 2025, Schoenmaker et al. 2024). Funding conditions make it difficult for civil-society organisations, startups and collective initiatives to participate in consortia. They fall outside the framework of the traditional ‘triple helix’: the public-private partnership between governments, industry and knowledge institutes (AWTI 2022b, Diercks & Avelino 2022 and Transitiecoalitie Voedsel 2019).[35] Conditions for co-funding are a high fence for

35. Even within the triple helix, parties do not always connect with each other and the collaboration is not always smooth. It is important to examine the causes of this in order to improve the cooperation and trust and ensure that parties genuinely make use of each other’s knowledge, expertise and strengths.

these parties to climb, because they often lack sufficient resources (AWTI 2022a, Diercks & Avelino 2022, De Moor et al. 2020, Nationaal Klimaat Platform 2023). Finally, sufficient striking power is important, something that civil-society organisations, startups and collective initiatives do not automatically possess. There are also a number of additional obstacles faced specifically by collective initiatives: difficulty scaling up; lack of money; heavy dependence on volunteers; and lack of knowledge and skill to professionalise. They are also faced with discouraging regulations (AWTI 2022c, De Moor et al. 2020, Overlegorgaan Fysieke Leefomgeving 2022).[36].

The funding structure for collaboration, through calls for proposals, also poses an obstacle. There is a silo mentality which inhibits genuine transdisciplinary and multidisciplinary collaboration and sharing of knowledge, information and technology. Collaboration often focuses on only part of a challenge. Incentives to share results outside participants' own collaboration and/or field are often very limited. This leads to missed opportunities to apply innovations on a large scale in several domains (Schoenmaker et al. 2024). Participants also often pursue their own individual interests; they are held insufficiently accountable for achieving a common, overarching goal. Finally, funding conditions make it difficult to allow parties to join or leave the project at a later date, even though this may be desirable because different needs arise during different phases of the innovation process, which may require different parties

Different forms of collaboration

In 2022 AWTI published an advisory report on interdisciplinarity in research (2022a). Interdisciplinarity concerns research which crosses the boundaries between different scientific disciplines. It incorporates a number of related, sometimes overlapping terms. These are briefly described below.

Interdisciplinary research is the combination and integration of research methods, theories, epistemological schools, procedures and/or data from two or more scientific disciplines. It is related to multidisciplinary research, where two or more scientific disciplines are individually involved in a research project, without integration taking place. Another way of crossing boundaries between scientific disciplines is through research collaboration with non-scientific or social partners. The term transdisciplinary research is used for this; this involves using the knowledge, skills and experiences of parties outside the scientific field.

36. The co-funding requirement was dropped in the National Research Agenda programme Research on Routes by Consortia (ORC) in early 2023; see: https://www.nwo.nl/nieuws/nwo-brengt-focus-aan-nwa-programma

The importance of stable investment

An important condition for stability is stable government investment in research and innovation. This improves the predictability and thus the confidence of industry, civil-society organisations and knowledge institutes, which will therefore be more inclined to invest themselves in research and innovation. These private investments are essential in addressing social challenges.

The Netherlands often opts for temporary stimuli

The Dutch government has set up various large funds in the past; these were all temporary stimuli aimed at knowledge, technology and innovation, with the aim of encouraging economic development. The way they were deployed was heavily dependent on the political order of the day, which did little to enhance the consistency of policy choices. As both the Netherlands Scientific Council for Government Policy (WRR) and the Netherlands Court of Audit observed, financial stimuli as these readily fall prey to political whim and unpredictability (WRR 2024, Joziasse 2023).

In 2020 the then Minister of Finance, Wopke Hoekstra, and the Minister of Economic Affairs and Climate Policy, Eric Wiebes, established the National Growth Fund (NGF), an investment fund which the government planned to use to boost the earning capacity of the Netherlands. The NGF targeted two areas: knowledge development; and research, development and innovation. A third area, infrastructure, was abandoned in 2022. Originally the NGF was intended to run for five years, (2021-2025), with a total budget of 20 billion euros for projects to enable them to access the promised funding over a longer period. The low interest rates at that time were a key motivation for setting up the NGF. Since its inception, the NGF has come under increasing political pressure. On several occasions, funds from the NGF have been diverted to other purposes (see also WRR 2024).[37] The fall of the fourth government under prime minister Mark Rutte and the subsequent national elections and government formation process had direct consequences for the NGF. The outline coalition agreement and the government programme both stated that the NGF would be phased out and that rounds 4 and 5 would be scrapped.[38]

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37. In 2022, 600 million euros, followed by a further 381 million euros, were withdrawn from the NGF, among other things to reduce corporation tax, reduce tax on income from investments, fund the state retirement pension, for defence, for grants to SMEs, to increase the statutory minimum wage and to remove the toll charges from the Western Scheldt Tunnel. In 2023. Parliament used 1.2 billion euros from the NGF to avoid raising fuel duty. And in 2024 the Minister of Economic Affairs and Climate Policy used 1.28 billion euros from the Fund for education, knowledge-building and spatial infrastructure in the region around Eindhoven
38. Government programme, 13 September 2024

The Economic Structure Reinforcement Fund (FES) (1995-2011) is another example with a tumultuous history. It was financed using part of the proceeds from natural gas extraction, and was managed jointly by the Ministries of Economic Affairs and Finance. The initial purpose was to invest in infrastructure, to which investing in the Dutch knowledge economy was added in 2005. The fund invested in investment projects of national importance, which were expected to strengthen the economic structure of the Netherlands. A total of 3.8 billion euros was invested in research and innovation (Rathenau Instituut 2022). As with the NGF, FES funds were also used for other purposes, including a withdrawal of 1 billion euros in 2007 to reduce the tax burden. The first Rutte government scrapped FES in 2010.

These large, temporary stimuli do not make for stability of financial resources.[39] Other negative long-term effects also arise (Rathenau Instituut 2022). The extra funding often ends up in a complex mix of funds flows for research which influence each other in a variety of ways, for example by matching project funding conditions with resources from the first flow of funds (direct research funding) (Rathenau Instituut 2016). One effect of this is that the funds give rise to all kinds of new, short-lived intermediary organisations, which often work in their own way and exert increasing influence over the funding and programming of research, rather than this being left to knowledge institutes themselves. Another effect is that some research fields are in danger of becoming dependent on temporary stimuli and that new research groups founded using this short-term funding cannot be funded on a structural basis. Displacement effects can also arise, whereby researchers focus all their attention and efforts focused on new short-term funding at the expense of European funding or other national programmes. This undermines the very complementarity which is essential at European level.

R&D intensity in neighbouring countries – What creates stability?

Van Kempen et al. (2024, 2025a) analyse the R&D expenditure of three neighbouring countries, in which stability of policy and funding are a central tenet: Belgium, Denmark and Germany. They posit that the higher R&D intensity of these countries is due principally to four factors: 1) consistent policy; 2) long-term security of funding; 3) a focus on existing high-tech sectors; and 4) proactive Investment in future sectors. They also conclude that societal awareness of the importance of research and

39. Temporary stimuli can also include public investments to kickstart a project and/or break through an impasse, after which the project can continue without further substantial funding. An example is the National Growth Fund green power programme, GroenvermogenNL. The aim is to set up large-scale green hydrogen production facilities to drive the costs down and generate demand which can then lead to the creation of more hydrogen production capacity.

innovation, and collaboration between knowledge institutes and R&D-intensive companies, contribute to a successful R&D policy. Consistent policy means that industry, civil-society organisations and knowledge institutes are also willing to invest in R&D.

Belgium

Belgian policy is mainly generic, and based largely on tax breaks.[40] The pharmaceutical industry is the biggest driver of R&D growth. A high proportion of R&D investments in Belgium originate abroad. This policy enabled Belgium to meet the 3% Lisbon target in 2019. Along with the tax measures, a positive R&D ecosystem also contributed to the investment climate: in addition to the traditionally bottom-up approach by the Belgian public authorities with regard to promoting innovation, top-down platforms and policy instruments are also developed. These platforms focus more on promoting already strong sectors (see text box: Flemish Strategic Research Centres in Chapter 3). A large part of the economic growth and investments in R&D in Belgium is actually due to the worldwide growth in pharmaceutical R&D expenditure in the context of the COVID-19 pandemic.

Denmark

Danish R&D policy is highly consistent thanks to a combination of broad public support and a stable funding structure. Since 2010, 1% of GDP annually has been devoted to public funding of R&D, offering long-term certainty to stakeholders. An example of a sector that has secured a leading international position as a result of this policy is wind energy: more than 40 years of consistent policy have led to groundbreaking innovations. This approach has contributed to a stable and attractive ecosystem for R&D-intensive companies in the green energy sector, enabling Denmark to become the world leader in wind energy. Two of the five biggest wind turbine manufacturers in the world, the largest manufacturer of wind turbine blades and the largest developer of offshore wind farms are based in Denmark. The benefits find their way into Danish society, partly through energy cooperatives (Van Est 2022).

40. The two Biggest measures Carter tax cuts for R&D staff and a reduction in taxes on profits from innovation, are the driver behind the achievement of the 3% target. Evaluations suggest that the first measure, in particular, had a positive effect. Reducing tax on profits from innovation appears to make a limited contribution To raising R&D expenditure, with signs that it mainly benefits company switch would also carry out R&D activities without this support. For a while, Belgium had the most favourable tax climate for R&D- intensive companies. The success of these measures did come with a price tag, however: in 2019 the loss of tax revenues amounted to 0.58% of Belgian GDP, where is investments by private parties in 2019 I amounted to 2.08%. The three Biggest players in the Pharmaceutical industry received around 70% of the tax breaks on profits from patents.

Germany

Germany takes a different approach, but here too, consistency in policy and funding is important. Structural investments in R&D have been key factors in the strength of German industry and its historically leading role in several industries, including the automotive and mechanical engineering sectors. The federal government enters into long-term contracts with the federal states, containing agreements on targets and funding for public research institutes (GWK 2021). These contracts provide clarity regarding expectations, such as fostering knowledge transfer and strategic alliances, and offer financial security, making it easier for companies and research institutes to make long-term investments in R&D (TNO case study on Germany 2023). At the same time, a structurally high R&D intensity is not enough on its own: forward-looking governance and policy are also important in preventing lock-in (OECD Reviews of Innovation Policy: Germany 2022).

2.3 Investments are insufficient and attract too little private investment

For years, the Netherlands has underinvested in research and innovation, both the public and private sector investment. Internationally, the Netherlands scores only moderately (Rathenau Instituut 2025a). As a result, the 3% Lisbon target has never been achieved (see text box), causing the Netherlands to fall further and further behind its neighbouring countries.

AWTI also notes that private sector investments in R&D are vulnerable, because the Netherlands has a knowledge-extensive economic structure and relies heavily on investments by a limited number of knowledge-intensive companies. There is also a causal connection between public and private sector investments: more public investments lead to more private investments in R&D and innovation (see e.g. KNAW 2018, CPB 2024, De Heide 2024 and 2025, Van Kempen et al. 2025a). It is important not only that the government invests more in research and innovation, but also that it does so with a clear vision of their importance in addressing social challenges, and of the government's own role in that whole process. Only then can the Netherlands become sufficiently resilient to withstand the social challenge it faces.

The 3% target and the Ministry of Economic Affairs' 3% R&D action plan

In the Lisbon Strategy, agreed in March 2000, EU member states agreed to devote 3% of gross domestic product (GDP) to R&D. Two-thirds of this investment was to come from businesses, and a third from other investors, including governments.[41] In 2010 the Dutch government, referring to the structure of the economy, set the target at 2.5% of GDP. At the end of 2022, the Rutte IV government upgraded the target to 3% of GDP,[42] and the government programme under prime minister Schoof confirmed this ambition.

The Netherlands has never achieved the 3% target agreed in the Lisbon Strategy. For more than fifty years, the Netherlands has had an R&D intensity[43] within the range of 1.6% to 2.3% of GDP (Rathenau Instituut 2024c). In 2023 the Netherlands spent a total of 2.23% of GDP (23.8 billion euros) on R&D (Van Kempen et al. 2024a).[44] The investments via the National Growth Fund were taking the Netherlands towards attaining the 3% target, but spending cuts and lagging investments by industry have pushed the target beyond reach again (see e.g. Van Kempen et al. 2024a, Rathenau Instituut 2024a). To achieve this target in 2025 would require a total of 14.3 billion euros in additional investment, with the government contributing 4.2 billion euros (Rathenau Instituut 2025a).[45]

The former Minister of Economic Affairs, Dirk Beljaarts, accordingly commissioned the formulation of a '3% R&D Action Plan'. One key focus was to encourage private sector investments in R&D: the 2% target for private sector investments is currently not being achieved. His successor, the outgoing minister Vincent Karremans, published the Action Plan on 11 July 2025. It focuses on technological innovation and is not sector-specific. The minister proposes nine ways of raising public and private

41. Tax support measures are left out of consideration
42. See Letter to Parliament (Kamerbrief) from the Minister of Economic Affairs and Climate Policy and the Minister of Education, Culture and Science of 11 November 2022.
43. To compare the level of R&D expenditure over several years and between different countries, we express that expenditure as a percentage of gross domestic product (GDP). This is referred to as the R&D intensity.
44. CBS Statline, provisional figures.
45. If the current allocation is preserved (government 1.0, industry 2.0, other parties 0.4), this means that the government would need to invest an extra 4.2 billion euros in R&D activities carried out within the Netherlands). In 2025 the government budgeted 3.4 billion euros extra compared with 2022 (CBS, more provisional figures), a shortfall of 0.8 billion euros. Industry and other parties together would need to invest an extra 10.1 billion euros in 2025 compared to 2022 (Rathenau Instituut 2025a). These calculations by the Rathenau Instituut (2025a) also show that government investments in 2026 are forecast to be lower than in 2025, while GDP is projected to increase further. This means that the percentage of GDP spent by the government on R&D will fall.

sector investments, including continued development of the existing innovation and valorisation policy, as well as the development of new instruments such as an organisation akin to ARPA (see text box in Chapter 3) for innovative procurement and a national investment agency. The minister stressed that his Action Plan required further decision-making and detailing, but that a number of elements within the existing policy context could be implemented straight away, such as attracting R&D-intensive companies via an R&D launch platform. Currently, no additional financial resources have been made available for the Action Plan, begging the question of whether it can be fully implemented. If there are no extra investments in the nine actions set out in the Action Plan, how can the Netherlands achieve the 3% target?

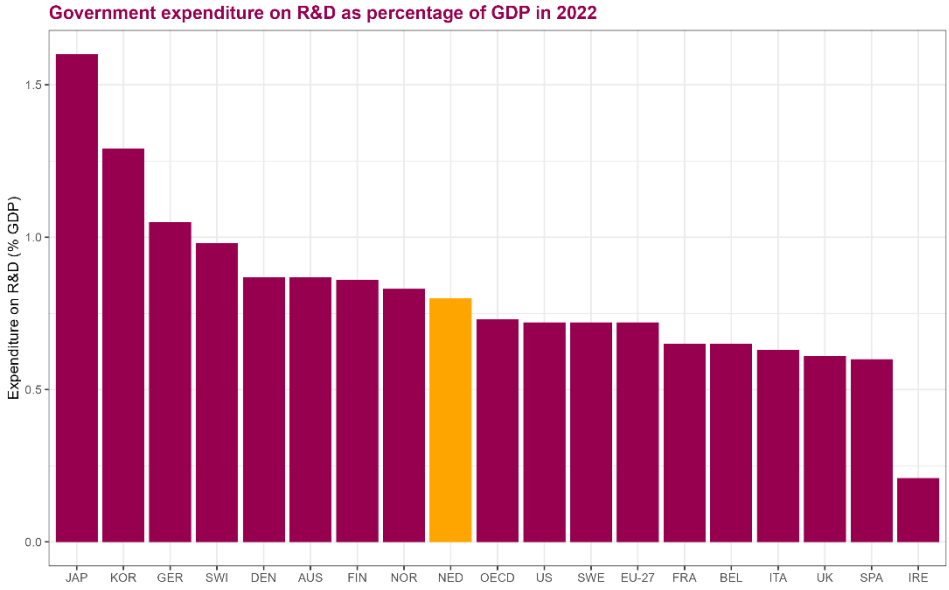
AWTI does not see the 3% target as an end in itself, but as a means to an end. Higher investments in R&D lead to an increase in (labour) productivity and economic growth, both of which are necessary if the Netherlands wishes to preserve welfare and prosperity at their present level into the long term. Higher investments in R&D also contribute to the development of the Netherlands as a fully fledged knowledge economy (Erken et al. 2021a). Another key reason for the government to invest in R&D and innovation is that public investments encourage private sector investment by industry and civil-society organisations, ultimately strengthening the resilience of the Dutch economy and society.

The Netherlands spends too little on R&D

Compared with other countries, in the period 2013-2023 the Netherlands occupied a middling position as regards *total R&D expenditure*, falling below the average for OECD countries and just above the average for the EU-27.[46] The same picture emerges if we subdivide expenditure into *public and private spending on R&D:* once again, the Netherlands occupies a fairly average position compared with other countries (Rathenau Instituut 2025a). However, *government expenditure on R&D* lags behind that of a number of neighbouring countries such as Belgium, Denmark, Germany, Finland, Austria, Sweden and Switzerland, all of which, unlike the Netherlands, have pursued an active policy to raise R&D expenditure. As a result, they achieved the 3% Lisbon target some

46. There are three recognised types of R&D expenditure: total expenditure, public expenditure and private expenditure. There is also a difference in expenditure on and funding of R&D. 'Expenditure in this context refers to the financial resources deployed by actors in the innovation system to carry out R&D in-house, using their own or drafted-in personnel' (Van Kempen et al. 2025b:5). 'Funding refers to the source of the financial resuorces for performing R&D. The sum of all funding flows is equal to the sum of all expenditure' (Van Kempen et al. 2025b:5). Policy often focuses on expenditure, partly because knowledge created remains within the organisation, which is not the case with funding

years ago.[47] Countries like the US, Japan and South Korea have also stepped up their investments (Van Kempen et al 2024a, 2024b, Rathenau Instituut 2025b).



Government R&D expenditure can be subdivided into two categories: direct expenditure (grants and basic funding) and indirect expenditure (in the form of tax measures).[48] Although direct government expenditure in R&D in the Netherlands has doubled since the signing of the Lisbon Strategy in 2000, government funding of R&D lags behind total government spending (Kempen 2024a, Rathenau Instituut 2025c). This contrasts with Belgium and Germany, where public funding of R&D has risen faster than total public expenditure.[49]

The substantial spending cuts made by the Schoof government in research and science will lead to a further fall in public expenditure on R&D and innovation in the coming years, including the scrapping of the fourth and fifth rounds of the National Growth Fund, cuts int the Fund for Research and Science, deep cuts in the startup grants, halving of the incentive grants and, from 2030, additional cuts in funding for the Dutch Research

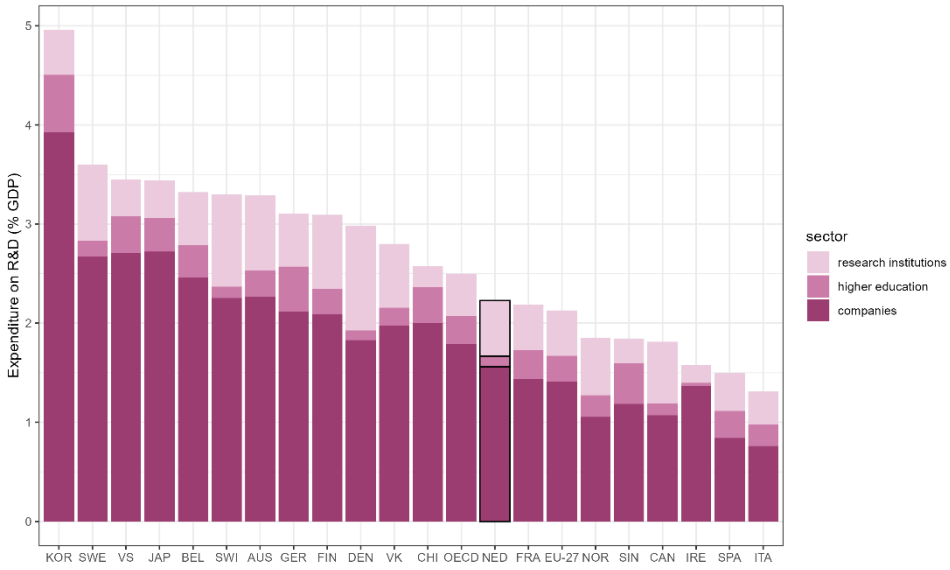
47. In 2022 the total percentages were 3.4% for Belgium, 3% for Denmark, 3.1% for Germany, 2.96% for Finland, 3.26% for Austria, 3.4% for Sweden and 3.4% for Switzerland.
48. In 2023, roughly 14% of total government expenditure on R&D was indirect.
49. There are wide differences between the countries in the extent of support from the tax system. In 2023 this support ranged from zero in Switzerland to 0.3% of GDP in the United Kingdom (2022). The figure in the Netherlands was 0.13%.

Council (NWO). There will be a reduction both in absolute terms and as a percentage of GDP. In absolute terms, spending will fall between 2024 and 2029 by 14% (from 9.7 billion to 8.4 billion euros, and in percentage terms by 0.19% of GDP (from 0.86% to 0.66% - Rathenau Instituut 2025c). The Rathenau Instituut (2025a) has calculated that an additional 14.3 billion euros would need to be invested in 2025 in order to achieve this target, 4.2 billion euros of which would need to come from the government.

Private investment in R&D lags behind and is not easy to increase

A major reason for the relatively lower total expenditure on R&D in the Netherlands is the relatively limited contribution from the private sector, which currently invests around 1.5% of GDP rather than the envisaged 2%.[50] Here too, the Netherlands lags behind other European countries such as Belgium, Denmark, Germany, Finland, Austria, Sweden and Switzerland (Rathenau Instituut 2025b, TNO 2024).

Government expenditure on R&D as percentage of GDP in 2022 per sector



50. In 2022 almost 15 billion euros of the total R&D expenditure in the Netherlands was funded by private companies. That is equivalent to 1.27% of GDP, less than their R&D expenditure. This was due in part to the tax breaks they received. The Netherlands is also a middling performer when it comes to R7D funding by companies, and scores lower than most of the reference countries. In Belgium, Denmark and Germany, for example, the private sector finances a significatntly higher proportion of total R&D investments (e.g. Rathenau Instituut 2025b, TNO 2024).

There are different explanations for the limited private sector expenditure on R&D. Two important factors are the economic structure of the Netherlands and the lack of diversification of R&D-intensive companies. As regards the former, the Netherlands has a relatively knowledge-extensive sector structure (see e.g. Erken et al. 2021a, Rathenau Instituut 2024c). This means that sectors where relatively little is invested in R&D, such as trade and business services, are relatively large, while knowledge-intensive sectors such as computer, electronics and automotive are relatively small in the Netherlands (Erken et al. 2021b). The OECD has calculated that the R&D intensity of the Netherlands would increase by more than half a percent if the sector structure was comparable to the average in other OECD countries.[51] The longer a country underinvests in knowledge and innovation, the more the sector structure adapts to this. The knowledge-extensive sector structure has caused the Netherlands to fall further and further behind over the last three decades. In the long term, the knowledge-intensity of the sector structure is not only a reflection of comparative strengths, such as geography, climate, culture and institutional factors, but also of technological innovative strength and policy choices (Erken et al. 2021a, Hollanders & Verspagen 1998).[52] A sector structure is not cast in stone, but can change over time due to policy choices. Structural investments in research and innovation, consistent policy and a long-term vision are crucial for this (Erken et al. 2021a, 2021b).

The second factor behind the limited private investment is a lack of diversification: in the Netherlands, private R&D expenditure is dependent on a small number of companies; that makes the country vulnerable. In 2023, the top five in the ‘R&D Top 30’ accounted for almost 30% of total R&D expenditure.[53] The figure in 2016 was 20%. What makes the Netherlands even more vulnerable is that the number one in that ranking, ASML, invested as much in 2023 as the next eleven companies on the list: 2.8 billion euros. Moreover, private investments in R&D are dominated by the engineering industry (which includes ASML) (De Heide et al. 2024). Other countries with substantially higher total and private R&D expenditure more often have at least two R&D-intensive sectors. Finally, there is little renewal at the top of the rankings; four of the ten companies have held their leading position for the last 25 years: Philips, ASML, Thales and Canon Production Printing

51. OECD; Science technology and Industry scoreboard 2017
52. The question here is of course what is cause and what is effect: the knowledge-extensive sector structure or a business community which invests less in R&D? The follow-up question is whether the answer to this question is relevant for the solution. We are dealing with a vicious circle here, and the government has an important role to play in breaking it. The solution is not just extra financial resources, but above all the formulation of a clear vision of where the Netherlands wants to get to and what kind of industry and economic structure is best suited to that.
53. A ranking of the most innovative companies in the Netherlands, compiled by Technisch Weekblad, VNO-NCW and TNO

(formerly Océ). The composition of the top ten in 2023 was almost identical to that in 2015, with Booking.com as the only newcomer (De Heide et al. 2024).

The spending cuts by the Schoof government also have consequences for public-private partnerships and the private investments in R&D they entail. This is because part of the government funding of R&D goes to public-private projects. To the extent that the announced austerity measures impinge on public-private projects, this puts private R&D investment under pressure. Offsetting the spending cuts, the government has made an extra 1 billion euros available for Invest-NL, but capital funding by Invest-NL leads to R&D investments that do not involve subsidies, whereas they are precisely what is needed to fund high-risk research (De Heide et al. 2024).

Increasing public investment leads to more private investment

There is thus a causal connection between public and private R&D investment: raising public expenditure encourages private investment. This public investment may be both direct and indirect. By and large, public funding of R&D strengthens and increases economic activities in general, and this effect appears to be permanent (Becker 2014, De Heide 2024, De Lipsiset et al. 2023, KNAW 2018, Soete et al 2022, Zúñiga-Vicente et al. 2012). This effect is particularly marked in the SME sector, because these companies often have more limited financial muscle. Private investment also increases when a long-term view of research and innovation is combined with stable policy and funding. If these factors are present, companies, knowledge institutes and civil-society organisations are also more inclined to invest in research and innovation. Calculations to measure the impact therefore need to include the expectations of private actors. Financing and implementing R&D activities inevitably entails uncertainty, because it is high-risk and capital-intensive. Private actors are hesitant to invest if there is uncertainty about the future contribution and focus of the government. Stable government policy and financial resources are therefore essential (Coccia 2011, De Lipsiset et al. 2023).[54] That stability feeds the multiplier that generates public funds with private funds.

Public investment in research and innovation thus acts as a catalyst for private investments. Private actors see public investment as a mark of quality, sending a signal to the market that certain sectors and technologies are promising. It also fuels knowledge dissemination (spillover effect), as publicly generated knowledge is often not protected by

54. It is important take country-specific factors into account. Countries differ in their research investments, for example in their relative and absolute size, the nature of the investments, the institutional embedding, the presence and funding structure of large knowledge institutes, the dominance in R&D activity within large multinational companies versus the importance of rapidly growing, R&D-intensive companies, the international openness of a country with lots of foreign R&D talent (Becker 2014, KNAW 2018, Zúñiga-Vicente et al. 2012). This means it is not always possible to simply copy efficient and effective policy on a one-to-one basis.

patent or rendered exclusive. This enables industry and civil society to use and build on this knowledge. It gives rise to knowledge and/or innovation clusters and fosters public-private partnerships, making it attractive for companies, entrepreneurs and civil-society organisations to cluster together. It not only ensures access to knowledge, but also to talent, something that is essential for knowledge-intensive private actors. When deployed in the right way, public investment in research and innovation can correct for market failure. When addressing social challenges, the public benefits generally outweigh the private benefits. The outcomes are moreover sometimes difficult for private parties to internalise. All this makes it hard to get such projects off the ground. Public investment can reduce the risks for private actors, making them more inclined to invest (Becker 2014, Coccia 2011, CPB 2024, De Lipsiset et al. 2023, KNAW 2018, Soete et al 2022, Zúñiga-Vicente et al. 2012). The government can also foster the interplay between knowledge institutes, civil-society organisations and companies to work on social challenges. All these factors encourage private investment in research and innovation.

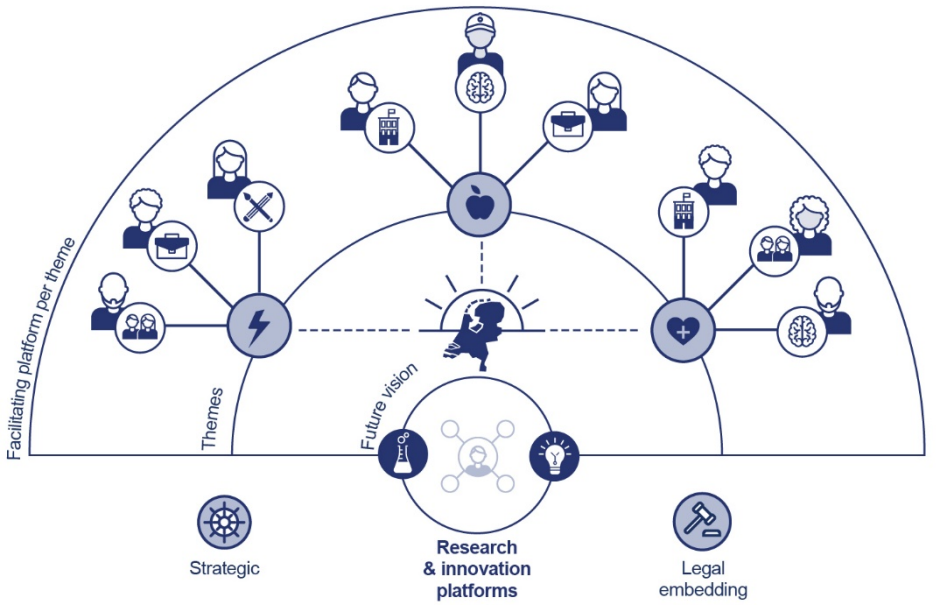
In 2018, a commission set up by the Royal Netherlands Academy of Arts and Sciences (KNAW) at the request of Parliament, chaired by Luc Soete, examined the Dutch situation. The commission investigated how big a factor substitution (crowding out) would be if the Dutch government invested in research and innovation. The commission found that this did not occur at all; on the contrary, extra investments by the government generated more private investment. In other words, the Netherlands is characterised by complementarity (crowding-in), and public investment does not displace private investment.

3

Recommendation: Develop strategic, collaborative research and innovation platforms

AWTI advises the government and Parliament to develop an instrument that provides for large-scale, long-term, structural funding of research and innovation. We refer to this instrument in the rest of this report as GLOOI (*G*rootschalig en *L*angjarig *O*nderzoek en *I*nnovatie) – Large-scale, Long-term Research and Innovation). The main purpose of GLOOI is to strengthen the resilience of the Dutch economy and society. AWTI recommends that 0.5% of GDP be reserved for this annually on a structural basis. This is on top of the existing resources devoted to research and innovation. GLOOI would entail the government investing in a number of platforms, each focusing on a specific social challenge which has a major influence on how resilient and future-proof the Netherlands is. Each platform would be given the wherewithal to invest in research and innovation projects with a long time horizon, and would be based on broad collaboration between all relevant Dutch stakeholders. These platforms would make it possible to strengthen or create a knowledge and innovation ecosystem which contributes to the resilience of the Dutch economy and society; an ecosystem which is capable of genuinely solving social challenges.

Recommendation: Develop strategic, collaborative research and innovation platforms.



GLOOI will only work if other research and innovation structures and funding continue to generate a generally high-quality knowledge and innovation ecosystem. GLOOI focuses principally on a specific challenge and on creating a high-quality system within it. That is only possible if GLOOI is able to build on a generally well-functioning ecosystem, to facilitate sharing of partners, knowledge, skills and experience and building mutual trust. To be able to continue developing high-grade knowledge and technology in the future, maintaining and funding of the existing system and instruments is important, because the problems or technologies which are the focus today may not necessarily be the challenges of the future.

The added value of GLOOI compared to existing instruments is its size. It incorporates large-scale investment (0.5% of GDP), broad transdisciplinary and multidisciplinary collaboration (between knowledge institutes, companies, civil-society organisations, government bodies and entrepreneurs) and funding of the whole research and innovation ecosystem. The purpose of GLOOI is also important, namely strengthening the resilience of the Dutch economy and society by addressing social challenges. The additional money made available for GLOOI is intended to ensure a long-term, stable approach to large-scale problems, which is also able to flex with future developments. Much of the existing

policy apparatus focuses on specific elements (in the ecosystem, of a social challenge) and on the shorter term.

3.1 Select themes based on a vision for the future

Not everything is possible, and certainly not all at the same time, and that absolutely holds true for GLOOI as well. It is important when configuring GLOOI to select specific themes. It is also key to extend GLOOI gradually to four or five strategic themes in which the Netherlands wants to increase its resilience. That means choosing themes where the Netherlands is either very strong or clearly vulnerable, based on a clear vision for the future. In this chapter AWTI presents an assessment framework in which it proposes a number of strategic themes for GLOOI. The ultimate choice will be a political one: after all, GLOOI involves investing taxpayers' money. The government and Parliament can seek advice from an independent strategic advisory team, comprising representatives from knowledge institutes, industry, civil society, entrepreneurs and government, all with wide-ranging expertise in research and innovation.

Within a GLOOI theme, research and innovation can be mobilised to address large, complex social challenges, such as energy security, a healthy living environment, well-being, climate adaptation, equality of opportunity and cybersecurity. A theme offers scope for both technological and non-technological innovation, as well as hybrid forms of innovation which combine the two. The central tenet of GLOOI is that research and innovation contribute to strengthening the resilience of society and the economy, with practicability and embedding in society and the economy as key elements. Technologies or research fields are not independent, stand-alone themes.

A theme works towards boosting the resilience of the Netherlands

What will the Netherlands look like in the future? What is our point on the horizon? That is the starting point for the assessment framework on which political choices for themes will be based. A core component of the vision for the future which is the focus of this advisory report is strengthening the resilience of the Dutch economy and society, taking into account the planetary boundaries and social justice. As stated in Chapter 1, the Netherlands faces a number of major social challenges; research and innovation can make an important contribution to addressing them. AWTI argues that this can be achieved by focusing on themes that contribute to resolving social challenges or to the implementation of key technology in society and the economy. These challenges can also be focused on the future 'growth agenda' of the Netherlands.

Build on Dutch strengths in a European context

The Netherlands is an innovative country; however, it does not stand in isolation: it is part of the European Union. The importance of an autonomous Europe is growing in the current geopolitical context. To determine the themes in which the Netherlands should invest, therefore, it is important to look at its strengths and at the opportunities for building on them. This must be viewed in relation to the elements that are present or absent in Europe, and to the areas where Europe wishes to be autonomous. In which disciplines, sectors, technologies and ecosystems should we invest? What can the Netherlands entrust to other EU member states? Where should the Netherlands play a (major) role itself? And where can the Netherlands be a follower within the European context? In this respect, the principal focus of GLOOI must be on collaboration between the Netherlands and Europe; it is explicitly not the intention that GLOOI should give rise to competition in the Netherlands or in the EU. When it comes to competition, given the size of the GLOOI programme, the perspective of the EU must be viewed mainly in relation to other superpowers like the US and China.

Take scarcities and vulnerabilities into account

The Netherlands faces a number of scarcities, such as physical space, sustainable energy resources, nitrogen space and, increasingly, labour. To some extent these scarcities form part of the social challenges we face as a country. The relative scarcities (i.e. relative to other European countries) should help determine what the Netherlands does and does not wish to do. This relates not just to the themes in which we choose to invest, but also to the specific contributions that the Netherlands wishes to make to a theme at European level. Areas where the Netherlands has explicit vulnerabilities must also be taken into account. Nitrogen, for example, is a Dutch problem, which is less relevant in other (European) countries.

Set strategic priorities

Based on the above criteria, it is still possible to identify a large variety of themes, and it is therefore important that politicians make strategic choices for themes targeted by GLOOI. AWTI sees a number of strategic considerations which will aid that prioritisation:

- Which social challenges require major strides in research and innovation?
- Within which themes could key technologies and social developments be essential? Are breakthroughs needed here?
- Given an investment horizon of at least 10-15 years, which social challenges match that horizon?
- Which themes offer opportunities to link up with European or regional policy, and where are there opportunities for cooperation?

The development of ecosystems can also be a key driver for including a theme within GLOOI, assuming those ecosystems can genuinely address and resolve a given social challenge. The following considerations are also relevant in this light:

- Which ecosystems need to be developed? Which ecosystems need to be strengthened?
- Is there a societal driver (for example stemming from civic initiatives), or is there public support, or can that be created?
- Which areas offer high potential for creating new industrial activity or for attracting large companies by investing in an innovative ecosystem?

AWTI's proposed themes

AWTI offers the government a number of themes for consideration. Based on the above assessment framework, these can provide inspiration for the ultimate choice of themes. They relate to a number of social challenges currently facing the Netherlands. At first sight, they may seem to be somewhat unrelated; however, if they are addressed from a holistic perspective (economic, social, technological, ecological), they can combine to help strengthen the resilience of the Netherlands.

► Nature as a driver of ecological and climate resilience

Nature offers us important ways to solve the problem of climate change. Research has shown that these solutions offer a relatively cheap way to achieve more than a third of the targeted reduction in global warming by 2030 as set out in the Paris Climate Agreement. Natural solutions to climate change also contribute to cleaner air and water, better soil health, water security and management, and preservation of biodiversity. The Scientific Climate Council recently published a warning on the declining quality of forest and soil quality worldwide, leading to a reduction in the ability to absorb CO_2 and making the climate challenge harder.

Making optimum use of nature as a solution to the climate challenge requires investment in research to fill gaps in knowledge. Testing and upscaling concepts based on nature requires investments in innovation. These are often large-scale solutions, such as the Sand Motor or the Dutch dune landscape as a protection against the sea and as a source of recreation, biodiversity and drinking water. It is therefore important to invest for the long term and at sufficient scale in collaboration between public, private and civil stakeholders. The Netherlands has a good deal of knowledge and experience on this theme. Moreover, as a country situated largely below sea level and facing major challenges around nitrogen, the Netherlands has a major stake in this theme. As investing in natural solutions to the climate challenge also delivers major public benefits, such as preventing climate damage, improving public health and strengthening biodiversity, government investment is justified.

► Digital resilience

Having an adequate grip on the digital world is vital for the security and resilience of the Dutch economy and society. Currently, the Netherlands and Europe are too dependent on monopolists from other parts of the world, though the Netherlands does have a good starting position in certain areas, which could be developed further. Other European countries are also investing heavily in solutions to make the EU more resilient and more strategically independent. The strong technological component requires the development of a lot of industrial activity. Research and innovation are needed to ensure that digital systems align with European norms and values and to reduce the dependence on the US and China.

► Energy security and energy transition

Research and innovation will enable Dutch businesses and households to gain and maintain access to the energy they need. That energy will be affordable and less and less polluting. Our dependence on other countries for energy will steadily reduce, giving the Netherlands greater strategic autonomy. Speeding up the energy transition will require more breakthrough innovations. The government needs to focus more prominently on this. At the same time, there is ample scope for embracing civic initiatives. AWTI explores this in more depth in its advisory report *Breakthroughs to the future. Towards system innovation in the energy transition* (2025). The Dutch government can seek inspiration here from ARPA-E, ARIA and SPRIND (see text box).

► Sociale cohesion and societal resilience

Societies worldwide today are strongly polarised. There are many reasons for this. For example, we live in a society with a powerful digital infrastructure which is focused on strengthening and amplifying more extreme views. Communication travels at lightning speed along large digital channels. Inequality of opportunity in the Netherlands also helps exacerbate the polarisation. Combating this requires the development of an infrastructure which is not focused (deliberately or otherwise) on reinforcing the polarisation. At the same time, we need to innovate more broadly and develop our society in a way that builds resilience against polarising forces.

► A liveable countryside

The liveability of the rural regions in the Netherlands (and Europe) is under pressure. Small population centres are shrinking and facilities are disappearing. Large-scale agriculture and other industrial infrastructure are threatening the health of the population. Landscape quality is under pressure from the building of large industrial complexes, tall wind turbines and large solar farms. Regional governments are working hard on concepts intended to keep the countryside liveable and attractive. They focus on innovative service delivery, preservation of local cultural and historical values and strengthening the rural ecology by bringing back specific historical elements and combining them with the

generation of sustainable energy. Regional governments are looking for new earnings models for farms and for associational life, to boost their chances of survival. This is a theme that is echoed throughout Europe, but the far-reaching digitalisation of services in the Netherlands means it feels more urgent here. At the same time, there is a shortage of space in the Netherlands: every square metre of the country is in use in one way or another. This offers ample opportunities for linking long-term investments in innovation to address these issues with the major spatial planning challenges facing the country. This theme can moreover make a major contribution to strengthening the regional economy.

3.2 Establish a facilitating platform for each theme

To be able to develop a cohesive amalgamation of research and innovation with high potential, it is important to create structure and direction within a theme. Each theme offers many possible ways of working on strengthening the resilience of society and the economy, and a degree of focus and structure is needed to increase the effectiveness of these efforts. The platforms proposed by AWTI are small, specific, facilitating and coordinating organisations. As far as possible, decisions on what the core focus areas within a theme are should be taken bottom-up, drawing on the available expertise to consider which solutions should be pursued. Creating a platform for each theme, with a broad and systemic modus operandi, means that GLOOI will prevent innovation becoming bogged down in (technological) solutions which are not embedded in society or the economy. Each platform brings together different disciplines, fosters collaboration between political, private and civil stakeholders, facilitates application and upscaling and maintains a focus on implementation, acceptance and governance. Finally, platforms play a facilitating role in building mutual trust through transparency, participation and long-term engagement. Examples, in terms of the way they function, include the Dutch Climate Research Initiative (Klimaatinitiatief Nederland – KIN) and the Top Knowledge and Innovation Consortia (Topconsortia voor Kennis en Innovatie – TKI).

The platforms act as coordinators and facilitators for ‘their’ themes. They serve as a linchpin connecting the actors from the ecosystem and maintain a stakeholder network. They also serve as centres of expertise in areas such as upscaling and commercialising solutions. They have an overarching view of ongoing activities and projects and can provide financial support. The platforms also play a vital role in strengthening the ecosystem and building trust between affiliated stakeholders. They also have a responsibility in facilitating interplay between different solution pathways. The platforms also have a task in strengthening the skills and development of the people in the ecosystem. It is therefore important that platforms learn from each other and share expertise.

Themes also need to be dynamic. Among other things, this means that solution pathways should not be cast in stone, creating scope for flexibility so that, depending on the success of a solution pathway, a decision can be taken to continue, to stop and grasp new opportunities, or to adjust the direction, slightly or significantly. New solution pathways may also present themselves en route, and flexibility allows these to be explored. This dynamic can have consequences for the mix of partners during the course of a GLOOI project; the composition can be adjusted where necessary, with new partners joining while affiliated partners may take a different path. In other words, at the overarching theme level there is stability and continuity, with scope for flexibility and dynamic at solution and ecosystem level. The platforms play a facilitating role here (see also Recommendation 3).

In 2023, AWTI advised that regional Dutch and EU policy should be designed in such a way that they complement or reinforce each other (AWTI 2023b). That same advice also holds for the GLOOI platforms. A European project that fits within a theme can be strengthened in the Netherlands. It can also mean that the Netherlands is able to shape a specific development in Europe. Relevant EU-coordinated policy instruments that need to be taken into account in this regard are Horizon Europe and its successors, the Competition Fund that is currently being established, and IPCEIs. The contribution from GLOOI can be used as co-funding or can make it easier to finance projects in the context of the rules on state aid. The platforms have a role in seeking out opportunities and building expertise.

AWTI advises learning from past experiences when setting up platforms. A good deal of experience has been gained in the past and in other countries in setting up platforms similar to those proposed here, although there are different emphases to take into account. The Dutch Climate Research Initiative (KIN) is an example, in which a diverse range of partners are working on one social challenge. Like the Biotech Booster and the TKIs, KIN can also serve as a model for collaboration between different kinds of partners, knowledge-sharing and network-building. The role played by implementing agencies such as the Dutch Research Council (NWO), the Netherlands Enterprise Agency (RVO) and the Regional Development Agencies (ROMs) in the Dutch research and innovation landscape, and the National Growth Fund as a whole, are important for the development of an assessment system and for monitoring and evaluating the platforms and the projects carried out within them.

In preparing GLOOI, it is vital to look carefully at the rules around state aid and to anticipate them as far as possible. This can be done in advance by creating sound frameworks and embedding experience from earlier processes in the platforms. These rules also apply for other investments, and experience has already been gained in how to

accommodate them, for example in projects funded by the National Growth Fund (NGF) or the National Research Agenda (NWA).

3.3 Encourage dynamic transdisciplinary and multidisciplinary collaboration

The GLOOI programme invests in all activities that are necessary to develop new, applicable knowledge, to apply it in new solutions, and to implement innovations and ensure their wide dissemination. This requires broad collaboration across boundaries between disciplines, sectors and stakeholder types. For this reason, AWTI advises encouraging collaboration and avoiding competition. This collaboration will take place in the 'quadruple helix' of collaboration between businesses and entrepreneurs, government, knowledge and research institutes, and actors in society such as civil-society organisations, associations and citizen collectives. In general, public, private and civil actors will need to work together for the development, application and upscaling of technology and the associated infrastructure, legislation and regulations, behavioural nudging and (simultaneously) the phasing out and discouragement of old technologies and structures.

Transdisciplinary and multidisciplinary collaboration are of great importance in this context. That collaboration can generate innovative solutions which would otherwise not be possible. AWTI has previously advised (AWTI 2022a) on how the government can stimulate this collaboration, and several other organisations are focusing on further improving the quality of transdisciplinary and multidisciplinary collaboration. An example of a platform that focuses on organising transdisciplinary and multidisciplinary collaboration in scientific research is the Dutch Climate Initiative (KIN) (see text box). This initiative is smaller in financial terms than what AWTI is proposing for GLOOI.

A programme which is closer to GLOOI in terms of financial resources is Biotech Booster (see text box), a technology-based platform which promotes innovation and focuses on ecosystem development. Where the Dutch Climate initiative lacks the element of collaboration with industry, the design of Biotech Booster has no place for the collaboration with societal actors as proposed by AWTI for GLOOI.

The drive for innovations within GLOOI is based mainly on collaboration between a variety of stakeholders. However, not all stakeholders warrant an obvious place in all phases of the process. GLOOI therefore needs to focus on dynamic collaboration with stakeholders that are appropriate for each specific phase in the process of addressing social challenges and developing innovations. Where a development is still in its infancy or where there is still a lack of clarity regarding solutions, it is logical to devote more attention to fundamental and primary knowledge production and on setting up field labs

with stakeholders that excel in that area. On the other hand, where there is a better idea of where potential solutions lie, expertise is needed in applied or experimental research. Where several solution pathways have already been identified for a particular social challenge, and the main challenge lies in upscaling and implementation, this requires different stakeholders, and knowledge production and innovation come into the picture.

Since GLOOI is intended as a multi-year programme, the form of the collaboration and the involvement of stakeholders can change during the course of the programme. AWTI believes it is important to ensure that the right expertise is present in the ecosystem, appropriate for the phase of development of solutions from the themes. This enables work to continue (simultaneously) on all the research and innovation that is needed: business models, ethical and tax aspects, infrastructure, legal, technological aspects, etc..

Examples in the Netherlands

Klimaatinitiatief Nederland (KIN)
The Dutch Climate Research Initiative (KIN) is an agency of the Dutch Research Council (NWO), established in partnership with the Royal Netherlands Academy of Arts and Sciences (KNAW). It arose from a commission given by KNAW and NWO to a Climate Research task force to examine how climate researchers from all disciplines could pool their strengths in a joint agenda for collective climate research, and how existing knowledge and skills could be streamlined more effectively. The task force advised setting up a network institute for discipline-wide climate research.

KIN has a budget of 20 million euros for four years. Its brief is to support climate research focused on transition. It plays a facilitating role in bringing together different stakeholders, identifying and prioritising gaps in knowledge and making knowledge accessible, all with a view to accelerating system transitions.

KIN fulfils three roles: as director, network organiser and financier. As director, KIN is responsible for stimulating climate research in the Netherlands, promoting collaboration and cohesion and overseeing a process focused on transition. As a network organiser, KIN promotes different types of transdisciplinary and action-focused networks, in which civil-society organisations, public authorities, NGOs, companies and scientists work together intensively. As a financier, KIN targets processes and projects that are working on transition. It also seeks to develop new methods and funding instruments with a view to using financial resources strategically, for example enabling funding of the demand articulation phase or

preliminary studies funded. Depending on the outcome, a call for proposals may be developed and published. This creates scope to fund the time, energy and efforts involved in the development phase, but also to discontinue activities if it transpires that they are not working or are insufficiently relevant.

KIN's work programmes emerge from bottom-up creation sessions between scientists, policymakers and civil-society stakeholders. The goal is cooperation and cohesion, rather than competition for funding. KIN primarily aims for combined social and scientific impact. To achieve this, KIN has entered into partnership with THRIVE, including training PhD's in knowledge brokering between climate science and social questions, and in valorisation of climate knowledge.

Biotech Booster

In one way or another, many National Growth Fund projects create a platform with a network function. One project focusing mainly on collaboration between businesses, entrepreneurs and knowledge institutes is Biotech Booster. This project, which has a budget of 246 million euros, aims to accelerate commercial applications of biotechnology in the Netherlands. It also offers a network and mentoring, thereby supporting researchers and entrepreneurs from the initial idea to a marketable product. Projects that are not eligible for financial support can sometimes receive other forms of support.

The programme is divided into five clusters of biotechnology applications in industry, agriculture and medicine. Projects in the proof-of-principle phase are led by knowledge institutes and can receive funding of up to 200,000 euros from Biotech Booster. Projects concerned with proof-of-concept can also be led by entrepreneurs and may receive up to 1.9 million euros in funding for projects lasting up to two years.

The ultimate goal is for Biotech Booster to become a revolving funding instrument, with the proceeds from earlier investments being used to fund new projects.

International examples

A common feature of the three international examples below is that they are all resilient and flexible: they have the ability and the freedom to stop, adapt or intensify projects at any time. They also allow scope for failure: the ability to fail is thus 'not a bug, but a feature'.

Advanced research projects agency-energy (ARPA-E) – United States

Inspired by DARPA, ARPA-E finances research and development of advanced energy technologies. It bridges the gap between radical energy innovations and their adoption in the mass market by guiding technologies to the market from concept to prototype. ARPA-E employs numerous programme directors and managers, each with a team responsible for specific technology themes, such as energy storage, smart grids and sustainable production. These teams consist of experts who are able to evaluate and drive both the technical aspects of new technologies and their potential.

ARPA-E regularly publishes open calls in which it invites research groups, companies and universities to submit innovative proposals. These invitations may relate to specific, complex challenges or be open to groundbreaking ideas in relation to energy. Proposals are assessed on the basis of technological sustainability, innovation potential and probability of transformational impact. Unlike traditional funding programmes, ARPA-E focuses specifically on projects that are higher risk but have the potential to deliver significant technological breakthroughs.

ARPA-E often finances projects in two phases:

- Phase I: Investment to enable the basic feasibility of a concept to be tested.
- Phase II: If the planned milestones and objectives appear achievable, the project proceeds to the next phase with additional funding.

This phased model minimises the risks while ensuring efficient use of resources.

Funding is measured against clear, predetermined milestones. This means that follow-on funding depends on tangible results and progress in development. If a project fails to achieve the envisaged results, the funding is phased out in stages.

Key figures in the organisation are the Technology-to-Market advisors, whose task is to help with the commercialisation of a technology.

Advanced research + invention agency (ARIA) – United Kingdom

ARIA is a UK agency which funds breakthroughs in research and innovation in neglected fields. It focuses on high-risk/high-reward research, for example in the fields of bio-engineering, AI and climate science. ARIA operates with maximum autonomy and flexibility. For example, the UK Parliament passed the Advanced Research and Invention Agency Act 2022, exempting ARIA from public tendering rules. ARIA has also been granted exemption from Freedom of Information requests, in order to reduce the administrative burden.

ARIA works with programme directors (PDs), who identify promising areas that are relatively neglected and where there is a shortage of talent and resources, and design their programmes within those areas. They have creative control over the direction of their projects and programmes and have the flexibility to decide how, who and what they finance. This results in a diverse portfolio of projects spanning several domains.

The ARIA research model consists of two primary pathways:

- ARIA develops multi-year R&D programmes within research domains, providing funding on a large scale: programmes have a budget of 50-80 million pounds.
- There are also 'opportunity seeds', with a budget of 500,000 pounds. As well as a smaller budget, these projects are also less structured than programmes. They are intended to enable individual research teams to discover new research pathways which can inspire future programmes or develop into stand-alone programmes themselves.

Bundesagentur für sprunginnovationen SPRIN-D – Duitsland

The German Federal government launched the Federal Agency for Breakthrough Innovations (SPRIN-D) in 2019. The Agency funds research that has the potential to lead to radical or breakthrough innovations and to accelerate the commercialisation and dissemination of highly innovative ideas. The Agency is based on the US DARPA. It organises innovation challenges and competitions around specific themes, ranging from combating virus infections to decarbonising the economy. SPRIN-D finances only a very limited number of projects (just four in 2021, out of 440 proposals). Its approach is lean, risk-tolerant and focused on breakthroughs.

SPRIN-D focuses on projects which create a completely new market, fundamentally change an existing market or solve a large-scale technological, social or environmental problem. This means that all topics are relevant for SPRIN-D, as long as they are based on European values and are non-military (though dual-use projects are supported). Unlike pure research funding, SPRIN-D aims to support new marketable products, technologies, business models and/or services which sustainably improve the lives of as many people as possible. The focus is accordingly on both social and economic added value.

New legislation, the SPRIN-D Freedom Act, enables SPRIN-D to employ various types of funding, such as validation contracts, equity investments and grants. Having access to these different types of finance enables SPRIN-D to operate in a targeted, precise, flexible and non-bureaucratic way.

3.4 Ensure stability and reliability and maintain democratic legitimacy

AWTI believes that government and Parliament have a shared responsibility for the choice of strategic themes, but that being at arm's length from the day-to-day political debate promotes the stability and reliability of GLOOI. As mentioned in Chapter 2, that stability and reliability is essential for facilitating investments by knowledge institutes, industry, civil society and other relevant actors. Where research and innovation are funded for the longer term, this often gives rise to discussion about the influence of political decision-making on the stability and reliability of government investment. One solution often suggested is to place government investment – often amounting to billions of euros – completely outside the sphere of political influence. This in turn invites criticism that placing investments too far outside parliamentary control erodes the budgetary powers of parliament. This Recommendation discusses the evaluation system and political influence proposed by AWTI to create a suitable balance between political responsibility and stability of the investments, based on a number of examples from home and abroad.

Ensure democratic legitimacy

If GLOOI is to work as envisaged, proper anchoring in legislation and regulations is essential. A good balance needs to be struck between the democratic legitimacy of spending taxpayers' money and securing the investments over the longer term. Experiences from the past have shown that these two interests can be diametrically opposed, as with the National Growth Fund and the Economic Structure Reinforcement Fund. AWTI suggests a number of directions and examples below which can help in finding the right balance between democratic control and stability in the multi-year lifespan of GLOOI.

Government and parliament set the frameworks in clear legislation

The government and Parliament play a crucial role in setting the frameworks for the GLOOI programme. Those frameworks must be laid down in clear legislation, with the government and Parliament being responsible for establishing the parameters, mission and vision for GLOOI. Two of the most important aspects to be enshrined in legislation are the financial size of GLOOI and its goals: investing in research and innovation to strengthen the resilience of the Dutch economy and society. Lessons can be drawn here from experiences with earlier large instruments aimed at innovation and investment, such as the National Growth Fund. One frequently mentioned weakness of earlier instruments is that, with Parliamentary approval, the resources were used for purposes other than

those for which the programme was set up. That did little to foster either confidence in the instruments or their stability.

To test which design works best, AWTI advises starting with one or two pilot platforms. These pilots will be designed based on earlier Dutch and international experiences, enabling lessons to be learned about what works and what does not. The pilots can subsequently be used to refine the instrument.

Coordination and engagement of ministries

AWTI proposes that the Minister of Economic Affairs act as overall coordinator of GLOOI. He or she will be responsible for organising GLOOI programme across sectors and ensuring that strengthening the resilience of the Dutch economy and society continues to be the main purpose of investments made via GLOOI. This is extremely important, because it will ensure that GLOOI remains focused on its objectives and prevents it from being diverted to different goals or metamorphosing into an instrument focusing solely on economic growth or technological or scientific excellence.

Other government ministers also have role to play in GLOOI, depending on the theme. They are responsible for the content of each theme falling under their aegis, thereby creating broad engagement and support within the government. This is essential if GLOOI is to be a success. This requires coordinated policy, creating cohesion and avoiding contradictory goals (of different ministries). This approach can give rise to an effective and efficient policy instrument which stimulates research and innovation and strengthens the resilience of the Dutch economy and society, whilst taking into account social justice and the limits of the planet. That will enable social challenges to be genuinely addressed.

Place GLOOI at arm's length from politics

GLOOI is situated at arm's length from politics. That said, there is accountability via the Minister of Economic Affairs in an evaluation cycle, thereby ensuring its democratic legitimacy. The coordinator of each theme decides – independently of the minister and politicians – on the working methods and specific (innovation) agenda, within the legal frameworks and in line with the direction set by political decision-makers. This ensures that the programme is deployed in the most effective way. A combination of bottom-up project formulation and top-down control can be used to arrive at the most suitable choices and combinations. As one of the actors in the ecosystem, the government can also contribute to this.

The Strategic Research Centres in Flanders and a national investment institute (see text boxes) are examples of how a degree of separation can be created between short-term

interventions and long-term investment.[55] Funding structures which are properly anchored in legislation can also suffice. However, AWTI believes that a national investment institute as described in the text box is unsuitable for the purposes of GLOOI, because it would focus mainly on investments that ultimately generate a financial return. Whilst not ruling out this type of funding, GLOOI is emphatically intended to stimulate research and innovation which, in addition to a financial return, will above all deliver social benefits and contribute to the resilience of the economy and society.

Strategic Research Centres Flanders (SOCs)

Flanders has four Strategic Research Centres (SOCs). They bring together fundamental and applied research. SOCs work with universities to valorise scientific research, as well as carrying out their own strategic research. They play a key role in the transformation of the Flemish economy, among other things by setting up spin-offs and developing a knowledge structure that attracts foreign investment. SOCs aim to keep Flanders at the forefront in the European knowledge society and in economic development. Evaluations show that the SOCs perform very strongly in terms of both scientific research and research valorisation.

The Flemish government provides much of the funding for the SOCs. The funding is based on a covenant between the government and each SOC, based on a number of defined KPIs, with the funding directly linked to the extent to which the KPIs are achieved. Each SOC is evaluated every five years, and a new covenant is signed. The term of the covenants is deliberately longer than a government term, ensuring that the continued existence of SOCs is not prey to short-term political interventions.

National investment institute

Several Dutch government advisory bodies, including the Council for the Environment and Infrastructure (Rli) and the Netherlands Scientific Council for Government Policy (WRR), have in recent years recommended setting up a national investment institute (Rli 2022, WRR 2023). It would bring together and strengthen existing institutes and instruments, such as Invest-NL, National Growth Fund and the Climate Fund. A

55. AWTI is aware of the difference in accountability to Parliament between an investment institute and the Strategic Research Centres in Flanders. The former are widely separated from Parliament and have limited accountability (for example Invest-NL). The Flemish Strategic Research Centres are also separate from parliament, but are subject to a five-year evaluation cycle, after which a new covenant must be agreed. Parliament has a regular say in this process.

national investment institute would be given a solid capital foundation and a broad mandate to generate more public-private investments for high-risk projects and long-term programmes. It would also have to be able to actively engage with the capital market as a bank.

The RIi (2022) and WRR (2023) argue that a solid, central, national investment institute – provided it operates at arm's length from politics – would make large-scale investment in transitions easier to achieve. It would also ensure more effective use of public resources, because:

- Unlike a funding and development institute like Invest-NL, a national investment institute can raise money itself by leveraging its equity, enabling it to grant much larger amounts in loans to companies and projects while contributing relatively little of its own capital;
- Unlike a fund, such as the National Growth Fund, which issued grants, a national investment institute receives its money back if the projects it finances are successful (sometimes even generating a positive financial return).

In its 2023 report Goede zaken ('Good business'), the WRR describes the importance of a public-private investment bank as follows: 'A well-designed public-private investment bank contributes to a more future-proof society. It brings together the knowledge and money needed for transitions. It could absorb instruments such as Invest-NL and the National Growth Fund and be given a clear mission. It would be a construction that incentivises the government to stick to its set course and reduce the uncertainties that currently plague the financial market. Deviating from that course would directly undermine the bank's portfolio. The amount of capital available for expenditure on long-term projects would increase as private actors would be co-financing them. For institutional investors, such as pension funds, a public-private investment bank would offer an ideal opportunity to focus their portfolio more on the long term. But other private financiers should also be involved to prevent a small number of stakeholders exerting undue influence over the bank's mission. Ultimately a public-private bank offers a way of providing stability to volatile financial markets and inconstant government policy.'

The economists Roel Beetsma, Arnoud Boot (member of the WRR) and Coen Teulings made the same argument in the FD newspaper (Beetsma et al. 2021). An investment bank, they argue, would discipline the government to make more consistent, less changeable policy. Moreover, it would make it easier for private financiers to assess the risk/return profile. An investment bank should contribute to stable policy over multiple years, and in that light should also attract suitable private shareholders. Pension funds would be an obvious choice, given the long time horizon

of their obligations. But other private finance providers would also be needed, partly to further underpin the commercial functioning of the institute.

Build in evaluations for the further development of GLOOI

GLOOI's watchwords are multi-year funding, stability and predictability. It is important to attach clear conditions to its investments, which offer clarity regarding the expected funding and how long it is provided for. Those conditions must also make clear what requirements applicants have to meet to be eligible for continued funding. A system of periodic evaluations could provide clarity on this, as happens for example with the Strategic Research Centres in Flanders.

Periodic evaluation has a dual purpose. On the one hand, it provides a fixed moment for government and Parliament to improve the functioning of GLOOI. On the other hand, it is a moment to reflect on the relationship between the chosen themes and developments in science, society and the economy. The outcomes of these evaluations can lead to adjustments within collaborative partnerships and objectives in relation to the various themes. An evaluation also creates an opportunity to decide to discontinue a platform for a given theme, for example if it is not proving successful enough, if the ecosystem that has arisen can function independently or if challenges have been largely resolved. The broad welfare indicators used by Statistics Netherlands can support these judgements.

AWTI recommends creating an evaluation mechanism with clear and appropriate conditions for the ecosystem concerned for a new funding period. Where only a limited ecosystem exists for a given challenge, or where relatively little is known about what the solution pathways might be, it is more logical to focus on indicators for ecosystem excellence. For themes where the Netherlands already has top-class stakeholders and a strong ecosystem, the evaluation mechanism can focus much more on output and impact – though it is important to ensure that the chosen indicators and conditions are appropriate for the stakeholders concerned. The indicators and conditions can if necessary be formulated in consultation with stakeholders in the platform, as also happens with the Flemish Strategic Research Centres (see text box).

3.5 Fund the platforms with a total of 0.5% of GDP

GLOOI entails additional investments for research and innovation, with a focus on large scale and the long term. AWTI therefore recommends that 0.5% of GDP be invested via the platforms annually. The government could create a fund for this, with a clearly defined purpose, to spend the resources with a view to maximising continued availability. It is important to draw lessons here from past investment funds, such as the National Growth Fund and the Economic Structure Reinforcement Fund. Various organisations, including

the responsible government ministries, have carried out evaluations which offer a good starting point (see e.g. AEF 2023, Decisio 2023, WRR 2024, Dialogic 2025). A number of evaluations are also planned for the National Growth Fund.

AWTI argued in Chapter 2 that additional resources need to be invested in research and innovation. In this recommendation, AWTI repeats its call to take 0.5% of GDP as a yardstick. That is equivalent to the extra annual investment the government needs to make in order to achieve the 3% Lisbon target, as calculated by the Rathenau Instituut (2025a).

Providing finance from a fund is important in creating the desired stability. A budget fund requires an implementing act, which should preferably set out what the purpose of the fund is, where its revenue will come from, how much money is involved and what that money is spent on. Enshrining all this in law generally makes a fund more stable.

There are pros and cons to opting for a fund structure rather than a regular budget line item. Whereas in the latter case, unused financial resources flow back to the Treasury, with a fund the money allocated to the fund is in principle spent entirely on a predetermined purpose. This enables certain types of expenditure, such as investments, to be safeguarded. Moreover, monies not spent can be carried over to a following year. With a regular budget item, pressure can arise to use resources not spent during the year due to a shortage of suitable projects, to finance less effective goals.

AWTI makes no recommendations in this advisory report on the most effective form in which to distribute financial resources, for example grants, loans or investments. It is up to the platforms – in liaison with the responsible government minister – to decide on the most effective option and structure. The fund could also become a partly revolving fund, meaning that part of the return on the investments or repaid loans can be invested back into the fund. Allowance does need to be made here for the long investment horizon needed in order to achieve a return.

Appendices

Appendix 1. Interviewees and roundtable

Numerous interviews were conducting in preparing this advisory report, and a roundtable meeting was also organised. This Appendix presents a list of the interviewees. We would like to thank all interviewees and participants for their time, openness and insights.

Interviewees

Barbara Baarsma	PWC/University of Amsterdam
Niels Bak	FME
Simon Bleijenberg	Ministry of Economic Affairs
Nettie Buitelaar	Biotech Booster
Michel van Duijnen	Netherlands Scientific Council for Government Policy
Hugo Erken	Rabobank
Frank van Es	Rabobank
Ymke Fokkema	Ministry of Education, Culture and Science
Amber Geurts	TNO Vector
Marcel de Heide	TNO
Michiel van den Hout	Dutch Climate Research Initiative (KIN)
Sander Koopman	Ministry of Economic Affairs
Bas Leenheer	Netherlands Court of Audit
Paul Schenderling	
Paul Thewissen	Ministry of Education, Culture and Science
Bert Tieben	Council for the Environment and Infrastructure (Rli)
Tanneke Vandersmissen	Netherlands Court of Audit
Erwin Vermeulen	Ministry of Economic Affairs
Jakob van der Waarden	Ministry of Economic Affairs

Roundtable meeting

Marije Dijksma	Techleap
Lukas Held	CollectieveKracht/Erasmus University Rotterdam
Michiel van den Hout	Dutch Climate Research Initiative (KIN)
Remco van Montfoort	Invest-NL
Sara Murawski	Sustainable Finance Lab
Frederike Praasterink	HAS green academy
Maya Rispens	NWO
Jorick Scheerens	Stichting Practoraten.nl
Reineke Timmermans	VNO-NCW
Paul Thewissen	Ministry of Education, Culture and Science
Erwin Vermeulen	Ministry of Economic Affairs

Appendix 2. Reviewers

In the final phase of compiling this advisory report, a draft version was submitted to two external reviewers:

- Janet Nieboer – Director, ROM InWest
- Dr Matthijs Janssen – Lecturer in Innovation Policy and Strategy, Utrecht University

The reviewers reflected on the consistency of the draft report. Where gaps were identified, the reviewers' comments were incorporated under the responsibility of the Council.

Appendix 3. Conceptualisation of resilience

Resilience of society and the economic system

To be able to meet today's social challenges, such as climate change, shifts in demographic growth and migratory pressure, Manca et al. (2017) developed a framework for policy conceptualisation and development. The central thrust is achieving resilience at societal and individual level; the focus is on the role of public institutions and government authorities in strengthening that resilience. The policy framework includes attention for sustainable growth and a social development pathway. Manca et al. (2017) argue that resilience of the whole system depends on the resilience of the component parts of that system: the resources (also called 'capitals', including economic, natural, human and social capital); the results of the use of those resources, such as welfare, employment, consumption, waste and investments; and the 'engine' of the whole system which converts the resources into results and consists of institutions (market, infrastructure, industry, research institutes, communities and government).

Hafele et al. (2022) start from an economic perspective. They conceptualise the notion of 'economic resilience' and view the economic system from a broader context, in which systems such as society and the planet also play a role. The economic system is a subsystem of the societal system and the Earth system.[56] These systems are interdependent and influence each other. Figure 1 illustrates this interrelationship.

Hafele et al. define the overarching purpose of the whole system as 'offering welfare for present and future generations within the planetary boundaries'. This overarching purpose has two limitations: the need to minimise negative societal consequences which diminish welfare; and the need to respect the hard planetary boundaries with regard to economic activities.

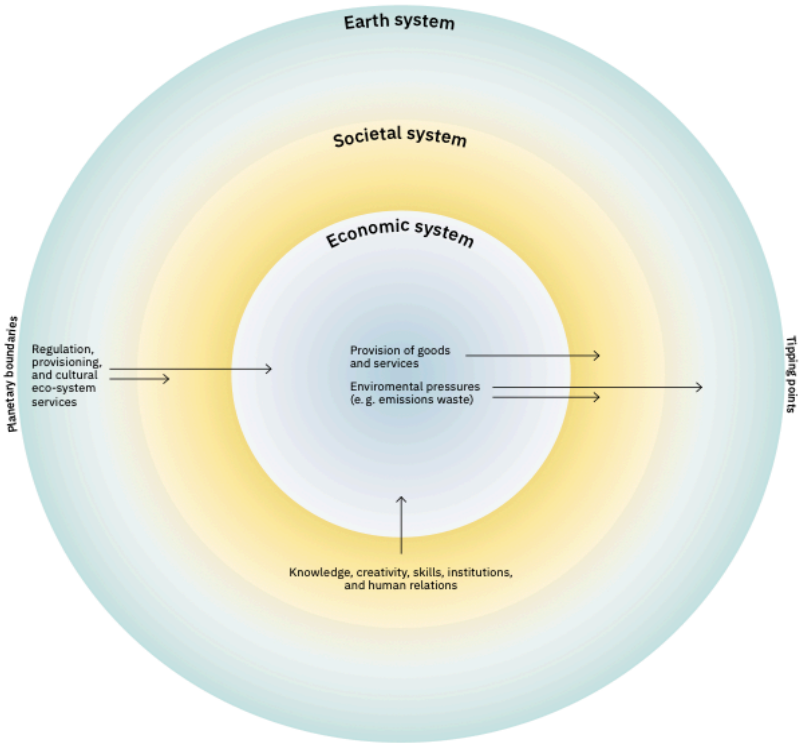
The purpose of the economic system is 'to provide goods and services in the right quantities and of the right quality for society'. The elements of the system are: households, communities, businesses and government. These elements act as intermediaries between the economy 'need satisfiers'. They play a mutually connected role in the supply of goods and services. Interactions between elements may be monetary or non-monetary, two-way or one-way. These interactions are also referred to as 'flows'.

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56. The Earth system is a concept from the earth sciences, and in particular geochemistry and ecology. It means that all components of the Earth together form one great, dynamic system, in which the individual components are in constant interaction with each other. The Earth system determines the planetary boundaries.

They contain the skills needed to deploy resources, such as the skill to develop and use technology, to use financial or natural resources and to develop and use new knowledge.

Figure 1: ***The economic system as part of the societal system and the Earth system***



Capacities and characteristics of resilience

The literature identifies four capacities that make a system resilient: absorptive capacity, recovery capacity, adaptive capacity and/or transformative capacity (see e.g. Manca et al., Hafele et al.).

The way a system responds to a disruptive event or disturbance is connected with two dimensions: the intensity of the disruption and the duration of the exposure to it. In a brief, mild disruption, the capacity to absorb and recover plays a key role. The more intensive the disruption, and the longer it lasts, the more important it becomes for a system to adapt or transform. This requires flexibility and incremental change, so that the components of a system (such as households, communities, businesses and government) can continue to function. The goal is to limit losses after a disruption as far as possible. A response maybe a conscious – political – decision or a forced change, for example due to natural or socioeconomic circumstances) (see Manca et al.).

As well as capacities, there are also characteristics that make a system resilient (Hafene et al.). Macroeconomic characteristics of resilience are diversity, redundancy, adaptability and cohesion. Capacities and characteristics are interrelated (see Table 1).

Policy interventions

Manca et al. developed a policy framework to help policymakers decide which policy instruments can strengthen the resilience capacity of a society.[57] They argue that the ability to 'bounce forward' is important in ensuring that future generations can also enjoy high standards of welfare. Bouncing forward means that a society is able to learn from earlier disruptions, see them as opportunities to do better in the future and then adapt accordingly. They list a number of policy interventions which can strengthen the resilience capacity of a society, such as:

1. Prevention → measures which reduce the number and extent of disruptions.
2. Preparation → measures which strengthen resilience capacity if a disruption occurs.
3. Protection → measures which limit the impact of a disruption to prevent loss of living standards.
4. Promotion → measures which make it possible to deal with long-term and/or severe disruptions.
5. Transformation → measures which facilitate processes of change and avoid unnecessary changes if the existing system can no longer be maintained.

Hafele et al. also devote attention to the role of policymakers and politicians in strengthening resilience capacity. They discuss four points on which (political) judgements can be made and around which tensions can arise.

First, in addition to the *what* of resilience capacity, it is also important to be clear about *who* the resilience capacity relates to. There are structural inequalities in the socioeconomic system, and those inequalities are often exacerbated during a disruptive event. There are several aspects to the *who*: international, national, local, formal and informal. Reflecting on the *who* of resilience capacity means that consideration needs to be given to the balance between stakeholders. It is therefore important when developing policy to consider *who* benefits and *who* is vulnerable.

Second, there is a tension between risk and resilience capacity. For example, if a country has several trading partners, there may be a greater risk that the system will be exposed to the consequences of a disruption affecting one of those partners. On the other hand,

57. The policy framework is operationalised in the Resilience Dashboard. This was developed in 2021 and aims to provide a holistic assessment of the resilience capacity of the EU and its member states. The Dashboard is updated annually.

network diversity increases a country's ability to recover from a disruption because trade flows are more easily replaced.

Third, there is a tension between characteristics of resilience capacity and the goal of the economic system. For example, flexibility in the market contributes to adaptive capacity. But that flexibility can also result in a 'gig economy' and a more flexible labour market, putting pressure on social security and worker protection.[58] This in turn can have a negative impact on (labour) productivity. It is moreover at odds with the aim of limiting negative consequences for society.

Finally, there is a tension between the different capacities; for example, absorbing and recovery require less energy and resources in the short term than the capacity to adapt (= change). However, for the long term, the capacity to adapt can be better for (economic) resilience capacity. The pros and cons of these capacities therefore need to be mapped for both the short and long term in order to be able to make a proper judgement.

58. A gig economy is one where temporary work is very common and where self-employed workers are hired on a temporary basis.

Appendix 4. Capacities and characteristics of resilience in relation to research and innovation

Research and innovation contribute to the development of resilience capacities (absorb, recover, adapt, transform) and to strengthening resilience characteristics (diversity, redundancy, adaptability, cohesion). How do these capacities and characteristics relate to each other? And how can they be connected to (the financing of) research and innovation?

The characteristic 'redundancy' is important for the capacity to absorb; diversity and cohesion are important for the capacity to recover; and diversity, adaptability and cohesion are important characteristics for the capacity to adapt and transform (Hafele et al. 2022). Table 1 summarises the relationships between resilience capacities and characteristics. A resilient society and economy can be strengthened and reinforced by targeting research and innovation funding at these capacities and characteristics.

Achieving a resilient society and economy requires the ability to collaborate. Acting in partnership with reliable partners (such as the EU) and sharing resources, knowledge, technology and social values strengthens the resilience of all partners. Knowledge, development and production in collaborating countries partially overlap and are partly complementary. This makes wide dissemination of these elements possible (= diversity). Collaboration requires trust in the partnership and in each other (= cohesion). It is important to focus competitiveness mainly on actors that are not party to the collaboration, such as China and the US. Aiming to strengthen resilience is also important for strategic autonomy. If we know the areas where strategic autonomy will be important in the future, attention can be focused on those areas (= adaptability).

Although all four capacities are important for making a system resilient, in this advisory report we concentrate on the capacities 'absorb' and 'transform'. Funding research and innovation as proposed in this report focuses on the major social challenges we face and the transitions need to overcome them. Making society and the economy resilient to these challenges therefore requires development and strengthening of the 'adapt' and 'transform' capacities.

For strengthening the 'absorb' and 'recover' capacities, we refer to the report by the Netherlands Scientific Council for Government Policy (WRR) *Coronascenario's doordacht: Handreiking voor noodzakelijk keuzes* ('A reflection on Covid strategies. Guide to necessary choices')(2022). In that report several advisory councils, led by the WRR, analyse the impact of the COVID-19 pandemic on the domain that falls under the aegis of

each advisory council and how a domain can anticipate and prepare for that impact. AWTI also contributed to that report. There is a relationship between strengthening and developing the resilience characteristics adaptability, cohesion and diversity and the GLOOI assessment framework.

	Absorb *Redundancy*	**Recover** *Diversity* *Cohesion*	**Adapt** *Adaptability* *Cohesion* *Diversity*	**Transform** *Adaptability* *Cohesion* *Diversity*
Education and skills	Presence of labour potential with the skills needed to accommodate disruptions.	People possess a wide skill set. Rapid, flexible opportunities for further training and retraining. flexible labour market. Cohesion: regaining pleasure in work.	All characteristics under 'Recover'. Adaptability: knowing which skills will be needed in the future and which skills will be less important.	
Technology	Presence of reserve technologies that can replace technologies affected by disruption. Presence of reserve capacities to develop/produce new technologies. [59]	Flexibility in changing what technologies can produce. Diversity: diversification of suppliers and supply chains Cohesion: sharing (benefits of) technologies.	All characteristics under 'Recover'. Adaptability: knowledge of how technologies can create disruptions. Replacing technologies where necessary. Using technologies that are less sensitive to disruptions (these may have to be developed = innovation). Cohesion: benefits of technologies are widely shared.	
Knowledge creation	Infrastructure, data storage capacity and providers of critical data, independence from global internet structure.	Diversity: several knowledge providers, access to different types of knowledge, multidisciplinary teams.	Adaptability: anticipating impact of applying certain knowledge to the system, the elements in the system (households, communities, businesses and government), society and the environment.	

59. Reserve capacity can relate to raw materials, financial resources, human capital and skills.

		Cohesion: co-creative ecosystems.	Creating and sharing knowledge that is needed to transform societal systems: understanding how the old system works and the problems associated with it; exploring new directions for the system; understanding obstacles to transformation; penetrating new sources and knowledge; abandoning knowledge that is no longer relevant for new systems.
Innovation	Emergency plans that are embedded in the system.	Diversity: diversity of innovation clusters, both regional and thematic. Cohesion: ecosystems, trust in science.	Adaptability: promoting innovative and enterprising thought and action, creating new sectors in the economy. Diversity and composition of consortium/ecosystem; diversity of knowledge and backgrounds of people, organisations and businesses involved. Creating, upscaling and implementing innovations needed to transform societal systems: new solutions for new needs; sustainable solutions; penetrating new 'sources' of innovation; technological and non-technological innovations; conditions for upscaling; organising implementation and dissemination; abandoning unsustainable solutions.
Economic activities	Presence of reserve capacities to continue economic activities and production processes after disruption.	Flexibility and diversification in access to suppliers and cooperation partners (import and export), resources (economic, natural, human and	All characteristics under 'Recover'. Adaptability: developing new economic activities that are sustainable (= taking into account the planetary boundaries and limiting the negative social consequences which lead to a deterioration in welfare). That

		social capital and customers. Flexibility and diversification in producing other goods and services (for different markets). Cohesion: using and trusting institutions (incl. science), ecosystem development. Higher productivity of resources leads to higher value creation from raw materials (even if supply is limited).	means focusing on sectors that are highly productive, have a limited spatial and ecological footprint and are not dependent on low-paid labour. Developing new business models, new business types (cooperatives, commons).

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