

STEERING TRANSITIONS

2021 ANNUAL REPORT

TNO innovation
for life

TNO.NL

CONTENTS

- PROFILE AND MISSION** **3**
- REPORT OF THE EXECUTIVE BOARD** **5**
- STRATEGY** **10**
- REPORT OF THE COUNCIL FOR DEFENCE RESEARCH** **22**
- REPORT OF THE SUPERVISORY BOARD** **25**
- RISK MANAGEMENT AND CONTROL SYSTEM** **29**
- RESPONSIBLE OPERATIONS** **32**
- COMPOSITION OF THE EXECUTIVE BOARD** **37**
- COMPOSITION OF THE SUPERVISORY BOARD** **39**

- COMPOSITION OF THE COUNCIL FOR DEFENCE RESEARCH** **42**
- COMPOSITION OF THE STRATEGIC ADVISORY COUNCILS** **43**
- TNO ORGANISATION** **47**
- TNO: KEY FIGURES** **48**
- FINANCIAL INDICATORS** **50**
- FINANCES AT A GLANCE** **51**
- APPENDICES**
 - Risk management and control system **55**
 - Corporate Governance **60**
- PUBLICATION DETAILS** **62**

GAME CHANGERS IN 2021

The boxed sections throughout this report highlight the game changers in 2021 – that is, the technological innovations that TNO developed along with its partners during the reporting year. For more information about a game changer, just click each box below to find out more on the TNO website.



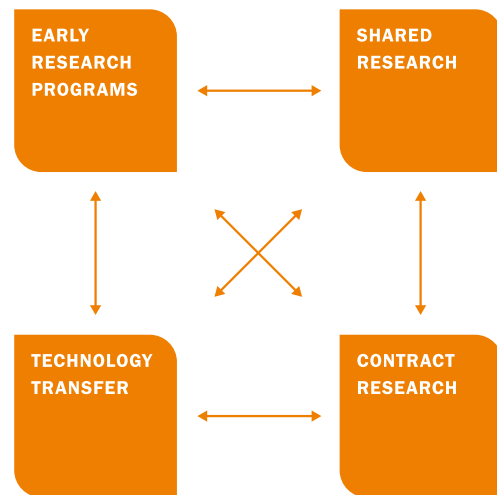
2021 Financial Statements

[2021 Financial Statements](#)

PROFILE AND MISSION

Arising from the vision of physicist and Nobel prize winner Hendrik Lorentz, TNO was tasked by law in 1932 to contribute to solving societal problems through applied scientific research.

Today, TNO connects people and knowledge to create innovations that sustainably boost companies' competitiveness and increase wellbeing across society.



This requires both in-depth expertise and the skill to connect and integrate the various knowledge domains, systems, and sectors of society. The power of innovation lies primarily in making smart connections across the boundaries between scientific domains and various sectors of society.

This is where TNO stands out: it is a multidisciplinary research organisation with dedicated people who work in dynamic partnerships, coalitions and alliances, offering the kinds of solutions that TNO's customers and partners are looking for. This is how TNO helps its customers and partners be successful, while also contributing to a safe, healthy, digital, and sustainable Netherlands.

APPROACH

The research TNO does can roughly be broken down into the development of knowledge on the one hand and, on the other, its application – two fields that differ from each other in terms of objectives, management, and financing. This will be detailed further below.

Developing knowledge

TNO knowledge development – Early Research Programmes (ERP) and Shared Research Programmes – concerns the development and refinement of knowledge to higher technology readiness (TRL) level. This state-funded, high-quality scientific research focuses, for a significant part, on research areas identified in the Mission-Driven Top Sectors and Innovation Policy. Where possible, TNO seeks to supplement knowledge development with contributions from third parties. This concerns pre-competitive and public-private knowledge development, in a phase where the risks are too high for industry and/or the public sector to bear on its own (the 'valley of death' phase). Knowledge acquired in this way is the basis that, at a later stage and through contract research in multiple areas, can be applied to solutions (competitive or otherwise) on an exclusive basis for customers.

Applying knowledge

From the knowledge base built during the knowledge development stage, customers' specific issues are subsequently solved through Contract Research or Technology Transfer.

Contract Research

When questions from customers and partners concern the specific and possibly competitive application of knowledge generated by TNO, and if there is a need for customisation, the research is usually done on a contractual basis and is paid for entirely by the customer. In this way TNO helps its customers bring products and services to market.

Technology Transfer

TNO also takes knowledge to market by licensing it to existing companies and setting up spin-offs. TNO holds approximately 900 active patent families that are used in different projects and that are also used by companies and public-sector organisations under licences. A number of these patents are used in spin-offs that are set up specifically for that purpose as part of the Technology Transfer programme. Through these four forms of research, i.e. Early Research Programmes, Shared Research, Contract Research, and Technology Transfer, TNO creates substantial value for Dutch society. For more details on how TNO works, please visit our website (www.tno.nl), which is also where you will find more information about the use of the portfolio of intellectual property rights and our research programmes.

Special-purpose funding

Under the header of 'special-purpose funding', TNO fulfils its role of innovation leader for the Ministry of Defence, Social Affairs and Employment, and the Ministry of Economic Affairs and Climate Policy in a unique way. Knowledge-intensive government duties (statutory duties) in the domains of defence, safety and security, labour force participation, and geological surveying have been delegated to TNO.

THE EXECUTIVE BOARD



THE EXECUTIVE BOARD

FROM LEFT TO RIGHT:

- › MAARTEN TOSSINGS, CHIEF OPERATING OFFICER (COO)
- › SUSAN SWARTE, CHIEF FINANCIAL OFFICER (CFO)
- › PAUL DE KROM, CHIEF EXECUTIVE OFFICER (CEO)
- › PETER WERKHOVEN, CHIEF SCIENTIFIC OFFICER (CSO)



REPORT OF THE EXECUTIVE BOARD

While the Covid-19 pandemic continued to have major impact on wellbeing across Dutch society in 2021, the Dutch economy outperformed all expectations, as shown by the economic growth rate and forecasts for 2022, among other things. However, geopolitical developments around the Russian invasion of Ukraine will continue to be an important factor that, while not having direct consequences for TNO's operations or balance sheet positions, may have indirect material consequences for TNO in 2022.

For TNO, too, 2021 was a good year, despite the Covid-19 challenges. For many TNO employees, it was an exceptionally complicated period due to the extensive homeworking and curtailed interactions with colleagues and stakeholders. Despite that, many TNO employees consistently showed great resilience and flexibility. The Executive Board is proud of all employees who were unrelenting in going the extra mile every day for our customers and partners, for TNO, and for each other. And while the pandemic is by no means behind us yet, what we have seen over the past year fills us with confidence that TNO employees will maintain their motivation and effectiveness going forward.

The upside to a highly impactful event such as the Covid-19 pandemic is that it also leads to new insights. We have seen, for example, that science has a capability to deliver solutions to complicated issues quickly and effectively. One fine example of that is the Covid-19 vaccine. Scientific breakthroughs, tech investments, and accelerated adoption of digital technologies during the pandemic are heralding a new era of progress driven by research and innovation. TNO welcomes the new Dutch government's acknowledgement of the necessity to invest in R&D for the current economic and social transitions. Besides the announced €5 billion investment in research and development, TNO hopes that the Netherlands will follow Germany's example and set course for R&D investment growth to 3.5% of GDP.

Over the coming years, inroads are needed especially in converting the knowledge we develop into value for society. When it comes to systems thinking, there are still major strides that the Netherlands can make over the coming years. By looking at the bigger picture of all the major transitions, instead of focusing on individual solutions, knowledge can be converted to value in an effective manner, both on a domestic and on an international level. By setting up the Growth Fund, the new government led by PM Mark Rutte gave an extra impulse for investment in several areas, including R&D. TNO welcomes this and plays an active role in many of these proposals. Additionally, TNO has concerns about the increasing complexity and fragmentation of governance and instrumentation in the innovation system.

STRATEGY AND EVALUATIONS

In the spring of 2021, TNO presented its strategy for the 2022-2025 period, entitled 'Connecting, changing, accelerating', to the Ministry of Economic Affairs and Climate Policy. In the new strategy period, TNO's promise to society will take priority. It is TNO's ambition to contribute to solutions for a safe, healthy, sustainable, and digital society.

TNO connects these four societal challenges to the strengthening of the Dutch economy's earning power by putting systems thinking and transdisciplinarity centre stage. This annual report includes a separate section devoted entirely to the completed 2018-2021 strategy, offering also a look ahead to the upcoming 2022-2025 strategy period.

ARI evaluation

Once every four years, the Ministry of Economic Affairs and Climate Policy has all applied research institutes (ARI) in the Netherlands evaluated by an external committee. The evaluation of TNO led by Amandus Lundqvist started in 2020. The resulting final report was presented in February 2021. The results were highly positive. TNO's scores were significantly up on 2017 across the board, i.e. on quality, impact, and vitality.

After all five applied research institutes (Deltares, Marin, NLR, Wageningen-Research, and TNO) had been evaluated, the ARI umbrella committee headed by Prof. Wim van Saarloos also published an overall report covering all five organisations. In it, the committee advises the Dutch government to reinforce applied research on a national scale. Obviously, TNO can only applaud this advice, as it would also bolster TNO's competitive position relative to universities and European research institutions. The 'Strategy' section will go into the evaluation results in greater detail.

IMPACT AND SOCIAL RELEVANCE

Creating impact is what drives TNO. TNO wants to put scientific ideas and concepts into practice, with real impact and for everyone to see. TNO wants to excel by offering effective solutions to societal challenges, while at the same time strengthening the earning power of the economy. In 2021, TNO's impact was tangible once again in numerous innovations. The ten most important game changers are presented and detailed throughout this annual report.

INNOVATIONS THAT TNO BELIEVES HAVE GREAT POTENTIAL SOCIAL IMPACT INCLUDE THE FOLLOWING:

- **ACCELERATOR MASS SPECTROMETRY** enables more efficient medicine development thanks to the use of microtracers.
- **POSHYDON** is a trial for the first offshore hydrogen plant and an initial step towards large-scale hydrogen production from offshore wind power.
- **SPOT THE ROBOT DOG** can autonomously look for survivors and casualties in places that are inaccessible to rescue crews.
- **TANDEM SOLAR ENERGY SYSTEMS** not only double the energy yield but also makes solar panels cheaper to manufacture.
- **BIO-BASED AROMATICS**, i.e. the production of aromatic compounds from residual biomass, will enable the chemical industry to make its operations significantly more sustainable.
- **ULTRAIR** is a TNO programme that experiments with laser communication for aircraft. Intended initially for military purposes, it will in the long term also give passengers on commercial aircraft access to secure and stable internet at high altitudes.

Thought leadership

Thanks to its expertise, independence, and multidisciplinary, TNO is ideally placed to develop a vision for the future with respect to societally relevant issues and thus feed the public debate. For that purpose, TNO develops white papers that revolve around innovative insights. The approach is to provoke, inspire, and mobilise, always based on facts and always properly substantiated. White papers that TNO published in 2021 addressed topics such as energy poverty, a skills-based labour market of the future, making buildings sustainable, new vehicle taxes, and circular business models where digitalisation plays a key role.

SMEs

Of all the companies in the Netherlands, a large number are small and medium-size enterprises (SMEs). It is important to TNO that these SMEs also benefit from innovations. In 2021, TNO launched the ambitious SME innovation square, an online platform that lets SMEs join projects and activities around new technologies. Small enterprises can, for example, learn what quantum technology, optic sensors, or robotics could do for their business. This low-threshold way of sharing knowledge with SMEs is offered alongside the existing field testing projects such as Robohouse, the Smart Connected Supplier Network, the Industrial Electrification Field Lab, and 5Groningen.

Technology Transfer

The TNO Technology Transfer programme is intended to take TNO-developed innovations to market faster. Five new spin-offs were set up in 2021. Representing a total value of €161 million, these companies created 322 new jobs. In 2021, we reached the milestone of a total of €100 million in capital invested in spin-offs that were set up from 2016 onwards. Further details of the Tech Transfer spin-offs will be provided later in this annual report, in the 'Strategy' section.

TNO has also adopted a policy to participate in a number of early-stage investment funds. In 2021, TNO became a shareholder in the Eindhoven-based venture builder HighTechXL. Together with partners at this organisation, we were successful in raising seed capital under a scheme run by the Netherlands Enterprise Agency (*Rijksdienst voor Ondernemend Nederlands* [RVO]), which awarded €9 million for a seed fund totalling €20 million.

B4X challenges

TNO's innovative prowess was used strategically in 2020 to help combat the Covid-19 crisis with practical short-cycle solutions. Under the header of 'Brains4Corona', twenty projects were launched and executed, including the LAMP test for rapid and reliable Covid-19 infection detection. In 2021, TNO experts focused on the nitrogen problem through the 'Brains4Nitrogen' project. The idea was to find solutions that help push back nitrogen emissions. It produced four successful solutions, including 'Torwash', a manure processing machine that can potentially completely eliminate farms' nitrogen footprint.

COOPERATION & COLLABORATION

2021 was the year that the European research funding programme Horizon 2020 ended. Over a period of seven years, TNO was awarded €173.46 million in EU grants for over 350 projects. TNO's most recent successful participation was in the European Green Deal call, which resulted in six multidisciplinary, impactful projects for TNO around the 'twin transitions' (green and digital). TNO aims to be at least just as successful in the new Horizon Europe research programme, which started in 2021.

Through its National Growth Fund, the Dutch government makes ample funding (€1.3 billion) available for investments in R&D to ultimately increase the Netherlands' growth potential. In the first funding round, TNO has been closely involved in three of the accepted proposals (AINED, Quantum, Groenvermogen).

While the conditions for implementation and governance are not yet clear, it does offer major opportunities for TNO. Proposals for the second Growth Fund round were submitted in November 2021. TNO was involved, as an orchestrator in several cases, in no less than sixteen of the twenty-two proposals. The results will follow in April 2022.

The Dutch government also launched an R&D grant scheme for mobility-related industries (*Subsidieregeling R&D Mobiliteitssectoren [RDM]*). This scheme is intended for the automotive, aviation, and maritime industries, which are struggling to keep up their investments in R&D due to the Covid-19 crisis. TNO is part of the consortia behind six of the eight projects that have been awarded funding.

Cooperation and collaboration are becoming increasingly important on both a European and a domestic level. In 2021, international cooperation in particular saw slight delays due to the ongoing Covid-19 pandemic. Despite that, several key partnership agreements were sealed in 2021, including the following:

TNO and Fraunhofer

Alongside overall European cooperation, TNO again stepped up bilateral cooperation with several fellow institutions across Europe in 2021. Under the umbrella of the German-Dutch Innovation Pact signed in 2021, TNO signed a Memorandum of Understanding with Fraunhofer for cooperation in the area of intelligent energy networks and reliable artificial intelligence. In mid-2021, the topics of 'secure intelligent systems' and 'quantum internet' were added to the scope of this partnership.

Ministry of Justice and Security, Dutch National Police, and TNO

In 2021, the Dutch Ministry of Justice and Security, the Dutch National Police and TNO decided to intensify their collaboration to better interconnect existing technologies and new innovations,

thus shoring up cybersecurity, crisis management, and the fight against subversive crime. TNO's knowledge thus also contributes more directly to making the Netherlands safer.

TNO also further formalised collaborations with institutions such as the Johns Hopkins Applied Physics Laboratory (in the areas of space, AI, and cyber), the University of Twente (embedded AI), NEN (standardisation), and the Quantum Application Lab (quantum software).

PERSONNEL AND OPERATIONS

Hybrid working

Even before the Covid-19 outbreak, anywhere and anytime working was already an option for TNO employees. The outbreak of the pandemic, however, made it the standard way of working. It stayed that way throughout the first half of 2021, and returned from November after a hiatus over the summer. When, after the start of the vaccination programme, the government gradually eased the restrictions, TNO gradually switched to a hybrid way, which sees employees work partly from home and partly at their work location. Hybrid working has significant consequences for TNO's accommodation needs (bricks), the required IT support (bytes), and behaviour and working methods (behaviour). TNO's hybrid working practices will be further shaped in 2022. Other Covid-19-related schemes, such as special leave, remote working from abroad (for our international employees), and the interim travel allowance, were all continued in 2021. When schools and childcare facilities outside of school hours were closed in late 2021, TNO also set up a childcare scheme.

New research facilities

As already noted in the ARI evaluation, good research facilities are crucial for knowledge development at TNO. In 2021, five new labs were built, including a new Solar Lab in Petten and a Construction Innovation Lab in Delft, funded partly from the

Dutch government's 'Climate Envelope' funding pot. These new research facilities contribute to the acceleration of the energy transition and the knowledge position of Dutch industry.

Outstanding employment practices

In 2021, HR services provider Randstad named TNO the Netherlands' most attractive employer in the non-profit category. TNO had previously won this same Randstad Award in 2014 and 2016. LinkedIn put TNO in third place on the 'Top Companies in the Netherlands' list of 25 companies where employees have the best career opportunities.

Corporate Social Responsibility and Diversity & Inclusion

The Corporate Social Responsibility policy adopted in 2020 has laid the foundation for TNO's societal ambitions. In it, TNO commits to ten principles of the UN Global Compact regarding socially responsible business practices. In 2021, TNO explored ways to reach climate neutrality and further increased the sustainability of its buildings. A new, sustainable mobility policy was also adopted, which will partly take effect in 2022 and become fully effective in 2023. TNO also worked to increase diversity and inclusion in its employment practices: in 2021, a D&I Board was created and work went into a four-year plan that will take effect in 2022.

Composition of the Executive Board

There was a change on the Executive Board in 2021. After over seven years at TNO (since 2014), CFO Cis Marring announced her intention to move on in her career and look for a new challenge. On 1 May, Susan Swarte succeeded her as CFO. The Executive Board owes Cis Marring a great debt of gratitude for her unbridled effort, her expertise, and the pleasant collaboration. As the former CFO of Olympia, OctoPlus NV, and Van Hessen Groep, Susan Swarte boasts extensive experience to make a success of her new role at TNO.

In the autumn of 2021, CEO Paul de Krom decided in consultation with the Supervisory Board to leave TNO as of 1 February 2022. His fellow Executive Board member Peter Werkhoven will replace him on an interim basis until Tjark Tjin-A-Tsoi takes office as the new CEO on 1 June 2022. In many ways, TNO is in a good position right now: the organisation is financially healthy again, the Executive Board and management teams are functioning well, and the new strategy is ready to be implemented. After seven years as TNO's CEO, it was a good time to pass the baton to a successor with a fresh outlook on things. Looking back on his time as chairman, Paul de Krom said: 'I am proud that I have been able to contribute to the future of this tremendous organisation and, with that, to the Netherlands' innovation capacity. I would also like to take this opportunity to thank everyone for the pleasant working relationships and the trust you have placed in me.'

FINANCES

TNO is doing very well financially. Despite the uncertainties brought by the Covid-19 pandemic, it is safe to say that TNO's result for 2021 is good: €13.6 million above plan and €7.9 million up on 2020. We must note, however, that contributions and investments from the private sector in joint innovation projects are lagging behind, especially compared to the increased government spending on research and innovation. TNO has launched a Commercial Excellence project to address this situation.

First Dutch Innovations

In close consultation with other shareholders, TNO's remaining (minority) stake in First Dutch Innovations (FDI, formerly TNO Bedrijven) was valued with the help of external experts and subsequently sold to the other (majority) shareholder. VSL, however, was not included in the sale because of its statutory duties. Instead, VSL has been converted into a separate private

limited company, with TNO holding a 45% stake and a seat on the three-seat Supervisory Board. This shareholder agreement is based on previously made agreements with the Ministry of Economic Affairs and Climate Policy.

AND FINALLY...

The Executive Board would first of all like to express its gratitude to all customers and partners, both in the public and in the private sector, for placing their confidence in TNO in 2021. The Executive Board is also proud of the approximately 3,650 employees who work day in, day out with great passion, energy and dedication to fulfil TNO's mission and have continued to work hard for Dutch society and businesses in this second year marked by Covid-19. Needless to say, our gratitude also goes out to the Works Council and the Supervisory Board. It is with great confidence that we look forward to continuing and intensifying cooperation with all our stakeholders.

Paul de Krom, CEO until 1 February 2022

Peter Werkhoven, CSO and interim CEO from 1 February 2022

Susan Swarte, CFO

Maarten Tossings, COO

GAME CHANGER IN 2021

SPOT THE ROBOT DOG SAVES LIVES

How do you rescue people from buildings that are at risk of collapsing or filled with toxic fumes? If it is up to TNO, autonomously thinking machines will take over these kinds of hazardous jobs from emergency responders in the foreseeable future. The latest developments in artificial intelligence and robotic motion technology are paving the way for a robot as a life saver.

SPOT the robot dog was developed by US tech company Boston Dynamics. TNO added the SNOW technology, which increases the robot's autonomy and thus reduces the need for human intervention.

'We are teaching this robot to stand on its own feet,' says Joris Sijs, autonomous systems expert at TNO, 'literally and metaphorically speaking.' 'This is how we save lives in places that are inaccessible to humans.'

Partner: Boston Dynamics

[Read more: To be where no one can go](#)



DEFENCE, SAFETY AND SECURITY UNIT



STRATEGY

2021 was the fourth and final year of the 2018-2021 strategy period. The focus during the year was, therefore, a dual one. On the one hand, activities to meet the priorities from the current strategy plan continued, while on the other TNO formulated a new strategic plan for the 2022-2025 period.

Topics addressed in this section include the developments around customer contact and collaborations, the evaluation of TNO, and how TNO intends to strengthen its ties with SMEs. In addition, there will be a focus on commercial excellence and finances. The section will close with a brief look ahead to the coming years, contrasting in with the main features of the new strategic plan.

However, this section will first go into TNO's impact and its contribution to the United Nations' Sustainable Development Goals (SDGs). Achieving impact for society and the economy is, after all, the statutory duty that TNO employees worked on with heart and soul in 2021.

TNO'S IMPACT

The SDGs are a universal reflection of the social challenges facing the world. TNO's research helps meet the SDGs. TNO focuses primarily on seven SDGs: see the goals that are enlarged in the figure below. These are subjects where TNO can achieve the greatest social impact, thanks to its knowledge and position. TNO thus commits to the global agenda for sustainable development.



TNO has an impact when it contributes to solutions to major societal challenges and if its innovations can strengthen the economy. TNO measures its impact on the basis of five categories, each of which has various indicators:

- **Cooperation & collaboration**

Today's major societal challenges call for innovations that can only come about through cooperation and collaboration. Indicators for this category include customers' and partners' satisfaction with TNO's work and the number of public-private partnerships.

- **Entrepreneurship and the economy**

TNO's mission includes increasing the competitiveness of Dutch business and industry. Through licence agreements and spin-offs, TNO ensures that knowledge developed actually makes its way to society. This is how TNO creates economic impact.

- **Science**

In order to be able to realise impact, TNO needs high-quality knowledge. A key indicator for this impact is the number of publications in scientific journals and the number of citations of TNO publications by other researchers.

- **Policy and politics**

One part of TNO's task is to support government bodies in developing and realising ambitions, policy, and standards. An indicator for impact in this category is the number of mentions of TNO and TNO research in policy documents on a regional, national, and European level.

- **Communication**

The more broadly it is known what TNO has to offer, the greater TNO's contribution to Dutch society and the Dutch economy will be. This is why TNO monitors its presence in various media.

KPIs have been defined for the above categories. To what extent TNO has succeeded in achieving these goals has been detailed in an impact analysis that is available on [TNO.nl](https://www.tno.nl).

The main key figures are shown in the figure below.

Category	Indicator	2021	2020
Cooperation	Number of public-private partnership projects	1,022	1,006
Cooperation	Customer satisfaction ¹	4.4	4.4
Entrepreneurship	Current licences	280	275
Entrepreneurship	Spin-offs	5	9
Science	Publications (scientific) ²	N/A	482
Communication	Mentions on Radio & TV	N/A	140

¹ On a scale of 1 to 5 ² Peer-reviewed articles and dissertations

CUSTOMERS, PARTNERS AND COOPERATION

Closer cooperation

The major social and economic challenges we are facing increasingly demand that parties form alliances and work together. In 2021, positive steps were taken in strengthening cooperation with a number of Dutch universities and international partners. Examples include the decision to intensify our cooperation with the Ministry of Justice and Security and the Dutch National Police to make the Netherlands safer, the Memorandum of Understanding with Fraunhofer for collaboration in the area of smart energy networks and reliable AI, and formal partnership agreements with universities in the Netherlands and abroad (see the Report of the Executive Board for details).

Strengthening customer focus and account management

TNO assesses the quality of its customer relationships through customer satisfaction audits. The average score customers gave TNO in 2021 was 4.4 out of 5, thus continuing the high scores of recent years. TNO is proud of the high regard our customers hold us in.

TNO wants to invest in its relationships with customers to further increase its impact on Dutch business and industry. Through a new initiative called Commercial Excellence, TNO intends to focus even more strongly on operational and strategic developments at customers. In mid-2022, decisions will be made as to which pilots to run to ultimately be able to roll this out across the whole of TNO.

Roadmaps

Roadmaps capture the needs of the outside world in product/market combinations (PMCs) and link these to TNO's projects, thus differentiating the TNO strategy to specific domains. These roadmaps are the primary tools guiding TNO's activities. A roadmap sets out the social and economic impact of the intended product/market combinations and the required investments.

One of the outcomes of the new TNO strategy for the 2022-2025 period is the intensification of the research into 'growth roadmaps.' Research resources for three of the roadmaps will be increased substantially: the existing Circular Economy roadmap and the two new roadmaps, Digital Manufacturing and Transitions & Transformations. The latter roadmap sees TNO conduct research aimed at accelerating and scaling up multiple transitions and transformations (social and otherwise). After the Maritime & Offshore roadmap was split up and its activities

were moved to various other roadmaps, it ceased to exist as a stand-alone roadmap. As a result, TNO had a total of 24 roadmaps at the end of 2021.

Involving SMEs

Additional investments in research and innovation must be made jointly by the public and private sectors. Research by TNO into boosting R&D in the private sector (carried out in 2019) shows that the required further growth in private investment in the Netherlands must come from the 'robust middle segment' of SMEs or from new activities and new sectors.

This research shows that applied research institutes such as TNO can play an important role in innovation on the part of SMEs, given how difficult it is for small or start-up companies to build and maintain R&D knowledge and capacity for incidental innovation processes. Joint projects with such partners such as TNO allow SMEs to make use of the organisation's existing research infrastructure, which can substantially reduce the costs of innovation for these SMEs. The likelihood that research projects will succeed also rises, thanks to the specific knowledge and experience that researchers at applied research institutions have.

TNO has taken steps in 2021 to intensify cooperation and improve the visibility and findability of TNO's offering for SMEs. TNO's offering and demand from the SME domain are brought together in a highly accessible manner on the TNO innovation square platform.

Position

For TNO, like for many other organisations, 2021 was dominated by Covid-19. On a positive note, the expectation that the Covid-19 pandemic would lead to a drop in funding for research, development and innovation (RD&I) did not materialise. Public and private funding was largely continued.

Compared to previous years, 2021 saw the Dutch government submit more specific research requests to TNO, which led to growth in programme funding. Among these research requests were requests for Covid-19-related research, which led to TNO's involvement in the study into the feasibility of mass events in times of Covid-19 (*Fieldlab Eventementen*).

National Growth Fund

In 2020, the Dutch government created the National Growth Fund (*Nationaal Groeifonds*). The Growth Fund is intended for targeted investments in three domains with the most opportunities for structural and sustainable economic growth: knowledge development; research, development, and innovation; and infrastructure.

In the first funding round, five proposals were approved. TNO is closely involved in three of these proposals, namely ones centred on artificial intelligence (AI), quantum technology, and hydrogen. The government is currently working on concrete funding decisions for the approved proposals. Additionally, TNO is pushing for existing knowledge infrastructure and tools to be used as much as possible.

In the second funding round of the National Growth Fund, TNO is involved in 16 of the 21 proposals submitted in the domain of research, development, and innovation. In April 2022, the assessment committee will announce the results for this round.

GOOD FINANCIAL HEALTH

Healthy finances are essential to guaranteeing TNO's continuity. A positive financial result is needed as a buffer to absorb setbacks, to ensure operational continuity, and to be able to keep investing in the organisation's knowledge base and portfolio. In 2018, a programme was launched to strengthen financial performance during the 2018-2021 strategy period. Over the past years, TNO has been able to post a healthy, sustainable net profit (this aside from profits from participating interests). The biggest hurdle is still the limited return on investment that research facilities offer. The lack of a level playing field at both the national and international levels and the decline in private-sector investments in R&D are additional challenges.



RESEARCH

Early Research Programmes

The Early Research Programmes (ERPs) are the first stage of knowledge development at TNO. These programmes are of a multidisciplinary nature. They are set on the crossroads of key technological and methodological innovations and socioeconomic challenges. The ERPs lay the foundation for new Demand-Driven Programmes (DDPs) and for significant innovation in existing DDPs.

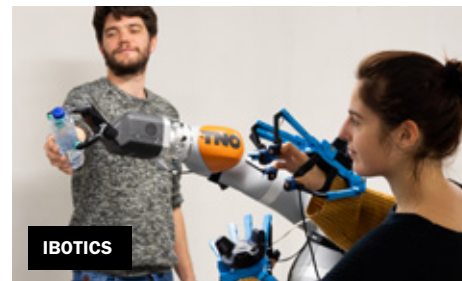
In 2021, TNO had nineteen active ERPs, most of which have a duration of four years. The portfolio has now been organised in such a way that around five new ERPs can be launched every year, allowing TNO to rapidly respond to new needs and seize new opportunities.

IN 2021, THE FOLLOWING SUBJECTS WERE SELECTED FOR NEW ERPs:

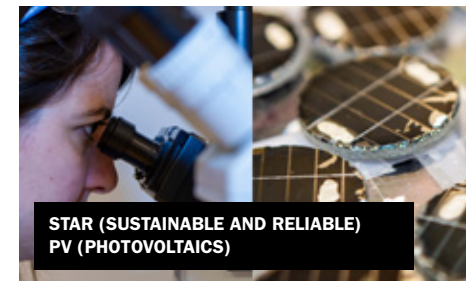
- **Subsidence and Building Damage** (predicting damage to buildings caused by subsidence)
- **Auto-ADAPT** (autonomous systems that adapt to changing conditions)
- **Digital Health Measures** (early diagnosis using smart sensors)
- **Optoacoustics** (optoacoustic sensors that can be used in many different domains)
- **Pandemic Preparedness** (fighting new epidemics with better molecular diagnostics)
- **Microplastics** (better insight into how microplastics are created for greater effectiveness in dealing with this problem).

In addition, a decision was made to extend the Quantum Technology for Computing and Communication ERP for a second four-year programme period, linked to the successful QuTech joint venture of Delft University of Technology and TNO.

The following examples give a good idea of the progress of research as part of the ERPs:



When we think of robotics, we tend to think of systems that can perform tasks without human involvement. The 'iBotics' ERP that TNO runs in partnership with the University of Twente and other partners, however, develops robot systems that actually continuously interact closely with their users. These systems include remote-controlled systems that can be used for inspection, maintenance, and repair purposes in places that are difficult to access for humans. But they also include systems that add to humans' physical abilities, such as powered exoskeletons that a human can wear to be able to work with heavy objects.



The number of solar panels installed across the world is rising fast. However, there is still a great lack of knowledge on the service life and degradation mechanisms of solar panels and similar electronics. More knowledge will make it possible to predict degradation, come up with adjustments to prevent degradation, and provide an accurate output estimate as early as when solar panels are installed. One of the feats of the STAR team is the new 'coring' technology they developed, which is a highly controlled method for taking small samples from solar cells for degradation testing purposes. It has already allowed them to study the effect of partial shading and moisture ingress on solar panels.



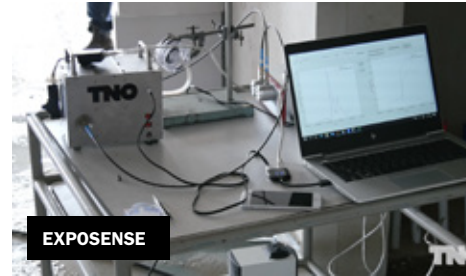
WISE POLICYMAKING

In modern-day society, everything is increasingly interconnected. This is prompting policymakers to make policy for 'wicked problems,' where an intervention in one domain has a direct effect on other domains as well. Transport and mobility policy, for example, also has a bearing on human health, housing, the environment, the climate, and the economy. This Early Research Programme (ERP) develops tools to help policymakers come to grips with this complexity. These TNO-developed tools show the expected effects of policy measures, looking beyond the effects on financial prosperity by also taking human wellbeing into consideration. One specific product of this ERP is the WISE Cube, a visualisation tool with underlying modelling of the correlation between relevant factors and their effects on the wellbeing of various demographics. Possible uses of this tool include navigating transport & mobility and urban planning issues.



HYBRID ARTIFICIAL INTELLIGENCE

This ERP, which is the largest ERP that TNO is running at the moment, develops knowledge in two key artificial intelligence (AI) knowledge domains and explores the applicability of AI through a large number of use cases. As a result, almost all TNO units are involved in this ERP. The first of these two knowledge domains looks at 'responsible interaction between AI systems and users,' with a focus on aspects such as transparency, data confidentiality, and the prevention of built-in bias. The second knowledge domain is that of 'safe autonomous systems in open environments.' One result in this domain is the successful demonstration of a robot that is able to scan areas and locate casualties in emergency situations under hazardous conditions. TNO developed a proprietary AI system for that, which was added to an existing advance robot (SPOT the robot dog developed by US company Boston Dynamics).



EXPOSENSE

Inhalation of particulate matter is a major cause of health problems. This ERP builds instruments to identify exposure to these minuscule particles. Combinations of air quality measuring and modelling are being explored, with Eindhoven and its surrounding area used as the study location. The aim is to create options both on an individual level and on the level of the population as a whole to reduce exposure and thus prevent people from getting sick. Additionally, a unique (eventually wearable) sensor has been developed to identify the chemical composition of particulate matter, which gives an indication of the source and the potential health impact. Working in partnership with Mateboer Groep, this sensor has meanwhile been used successfully to measure silicon dioxide levels in the air at construction sites. Silicon dioxide, also known as crystalline silica, is a potentially carcinogenic substance that is released when working with stony materials.

Demand-Driven Programmes (DDPs)

The year 2021 was the second year of the Mission-Driven Top Sectors and Innovation Policy (MTSIP). Part of the Ministry of Economic Affairs and Climate Policy's innovation policy, this mission-driven approach sees the government, the 'top sectors' – industries in which Dutch companies and research centres excel worldwide – and research institutions join forces on five topics: Energy and Sustainability; Agriculture, Food, and Water; Health and Healthcare; Safety and security; and Key Technologies. In 2021, TNO was closely involved in aligning the 'knowledge and innovation agendas' and translating these to research programmes for nearly all specific missions.

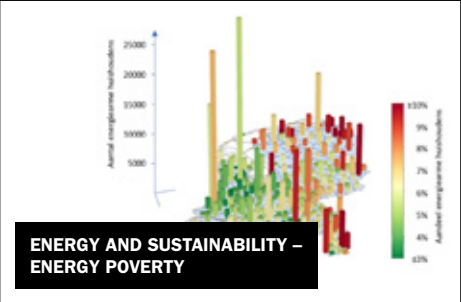
The mission-driven approach guides TNO's research programming, which is targeted on creating social and economic impact, while also acting as a bridge between the public and the private sector. Over half of the state funding that TNO receives comes under the umbrella of the MTSIP. Like in 2020, the TNO research programmes were geared specifically towards contributing to the integral topics of the MTSIP.

TNO's 40 research programmes cover nearly all mission-driven topics, with the topics of 'Energy and Sustainability' and 'Key Technologies' being the most prominent ones, followed by 'Health and Healthcare' and 'Safety and security'. To tie in with the MTSIP even more closely and thus be able to better liaise with coordinators in the public and private sector, in 2021 TNO started to consolidate research programmes. While there were 42 programmes in 2020, the aim is to consolidate this to 30 or fewer by the end of 2022. Each research programme will then have the kind of focus and critical mass behind it that is needed to be able to contribute to the missions.

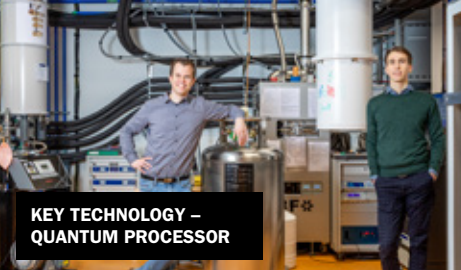
A few of these demand-driven research programmes are detailed on this page:



Together with the partners from the Construction and Engineering Innovation Centre (*Bouw en Techniek Innovatie centrum* [BTIC]), TNO launched implementation programmes in the context of the roadmap for 'Clean and zero-emission construction practices.'. Besides knowledge institutes and national, regional, and local government bodies, partners from across the construction supply chain – from material supplies and production to the reuse of materials – are also involved. We are working together on creating a stronger ecosystem so that we can up the pace of the transition to sustainable construction practices.



TNO has made an interactive energy poverty map of the Netherlands. Households struggling with energy poverty are households with a low level income and high energy costs or an energy-inefficient home. The map draws on data from Statistics Netherlands and shows energy poverty levels on a municipal and district level, making it a lot easier for local or regional authorities to design their energy policy accordingly.



QuTech, a joint venture of TNO and Delft University of Technology, achieved a crucial milestone in scalable quantum technology: a two-dimensional array of qubits (quantum bits) that jointly operate as a quantum processor. A future quantum computer will likely consist of millions to billions of such qubits. Research into harnessing the electrons inside quantum dots – semiconductor structures a few dozen nanometres in size – as a platform for quantum computers has been ongoing for as long as two decades now. A key benefit of quantum dots is that they can be defined using standard semiconductor technology, giving them great scalability potential. QuTech has now taken an important step to make quantum dot-based quantum processors possible.



In the Baltic Sea, TNO demonstrated together with various partners how twenty manned and unmanned systems in a maritime environment, such as sea vessels, can be integrated for interoperability. This was part of the European Defence Agency's OCEAN2020 project.

Photo: Marieke de Lorijn for QuTech

PUBLIC-PRIVATE PARTNERSHIP (PPP)

In a PPP, public-sector and private-sector parties work together to achieve a certain goal. PPPs in the research and innovation domain are often broad consortia of companies, government bodies, and knowledge institutes such as TNO. Together, they agree on a scope for the PPP and how to steer the research activities. All partners in a PPP contribute financially and/or in kind towards the total costs of the PPP.

See to the right for examples of PPPs.

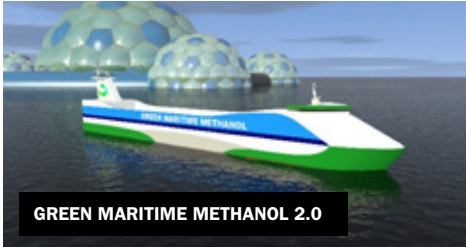
BMC's activities include creating innovative optic materials and coatings for sustainable buildings



The Brightlands Materials Centre (BMC) is an international research centre where academia, business and the public sector have joined forces to conduct research into new sustainable technologies concerning plastics and their application. An external evaluation committee led by Prof. Dr Emmo Meijer concluded in 2021 that BMC was off to a quick start, already has an impressive track record, is home to highly motivated employees, and makes excellent use of the knowledge available at TNO. Based on this evaluation, the Limburg provincial authority released the second tranche of the grant that had been reserved for BMC.



2021 also saw the launch of the Green Chemistry, New Economy (GCNE) platform. Set up by a coalition of companies, the Royal Association of the Dutch Chemical Industry (VNCI), InvestNL, the regional development companies of the provinces of Limburg, Brabant, South Holland, and the northern Netherlands region, and TNO, this platform is intended to accelerate the feedstock transition in the Dutch plastics and artificial fertilizer industry. GCNE has set green chemistry as a vision for the future; a chemistry where new technology and business models are given the chance to create a new economy that is not based on fossil feedstocks.



Like other industries, the maritime transport industry faces a major challenge following the adoption of the Dutch Climate Agreement. In order to meet the carbon reduction target set by the agreement, the maritime transport industry is going to have to switch to alternative fuels. In the Green Maritime Methanol 2.0 project, a broad consortium made up of 36 partners is exploring the feasibility of using green methanol as a fuel for the shipping industry. TNO is the leading partner on this project.

CONTRACT RESEARCH

In some cases, demand from customers and partners relates to the potential application of TNO knowledge in a competition context, which means that customisation may be needed. In most of these cases, TNO will then offer contract research that is paid for by the customer for the full 100%.

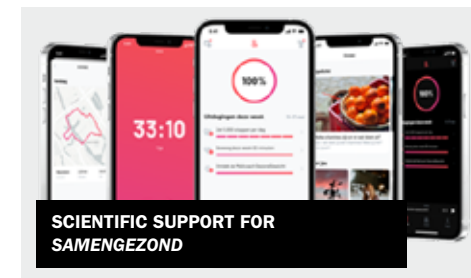
See to the right for examples of such contract research.



TNO and Delft University of Technology are running the Knowledge-Based Pavement Engineering programme for Rijkswaterstaat. Based on scientific insights, TNO makes models for service life prediction and test protocols. Rijkswaterstaat can subsequently use these methods to assess the use of new (sustainable) materials in asphalt and optimise asphalt composition, or to design road surfaces that lead to better fuel economy for vehicles travelling on them.



TNO ran an extensive measuring programme on the Haliade-X wind turbine at the Maasvlakte area of the Port of Rotterdam for GE Renewable Energy. The Haliade-X is currently the world's largest wind turbine (12 megawatt, enough to supply power to 16,000 households). The measurements were required for the wind turbine's certification. Offshore wind farms with large turbines such as the Haliade-X will help the Netherlands meet its climate targets.



TNO offers scientific support for the monitoring of your health in the *SamenGezond* (Healthy Together) app. An initiative by health insurer Menzis, the *SamenGezond* health programme helps participants make healthier choices on a daily basis and change their lifestyle.

TECHNOLOGY TRANSFER

'Technology Transfer' consists in TNO taking knowledge to market by setting up spin-offs. In 2021, five new spin-offs were set up, taking the total number of spin-offs set up since the start of the programme in 2017 to 33. As stated in the 'Report of the Executive Board', these companies jointly represent a value of €161 million and have created a total of 322 new jobs. Raising external capital is key for the growth of these spin-offs. In 2021, we reached the milestone of a total of €100 million in capital invested. It was also the year of the first exit and, unfortunately, the winding up of one spin-off.

To the right you will find brief introductions to the five spin-offs set up in 2021.



TRACXON

The TracXon spin-off produces hybrid printed electronics for its customers using roll-to-roll printing and photonic soldering and sintering of components. This leads to products such as pressure sensing mats and LED film that can be used in the automotive and horticulture industries.



ASSET HUB

Brick structures are susceptible to cracking due to a range of different causes. In a worst-case scenario, this can lead to the structure collapsing. Manual inspections to check for cracks are time-consuming, costly, and not always reliable. TNO has now developed a method to automate crack detection in brickwork, making inspections simple, cheap, and reliable.

[Read more.](#)



CALOSOL

Calosol is taking a new innovation to market that activates building fronts as energy sources, while preserving their aesthetic and functional features. The innovation consists in applying a special coating to building fronts that absorbs a large part of the infrared spectrum of sunlight and transmits it to the water system. It is a relatively low-cost way of creating energy-positive buildings.



LINKSIGHT

LinkSight makes it possible to analyse multiple datasets in a secure and privacy-friendly way without sharing the underlying data. This often concerns data that cannot be shared freely due to privacy guidelines, business confidentiality, or the risk of data breaches.

[Read more.](#)



UIDENTITY

Uidentity supplies wristbands with vein pattern detection based on thin film technology. Each wristband validates the wearer's identity for access to secure areas, to make payments, etc. The wearer's biometric data stays on the wristband.

AUDITS AND EVALUATIONS

Knowledge Position Audit

TNO's strong multidisciplinary knowledge leadership is a vital precondition to be able to meet demand for application of TNO's knowledge and innovation in the Netherlands, both today and in the future. To guarantee the quality, impact and vitality of TNO's knowledge leadership, each of TNO's research groups is subject to a Knowledge Leadership Audit (KLA) every four years. These KLAs are done by a committee of experts from the worlds of science, business, and the public sector. In 2021, a new four-year cycle started with the KLAs of the research groups of the Industry and IT units. The audit committees were impressed by TNO's knowledge leadership in these high-tech research areas. On average, both units were rated as 'very good'. On some aspects, in fact, the research groups were deemed to be 'world class'.

ARI and TNO evaluation

In the spring of 2021, the Van Saarloos committee presented the conclusions and recommendations from their evaluation of the Netherlands' five applied research institutes (ARI). The committee's evaluation looked at three criteria: quality, impact, and vitality. On all three of these criteria, TNO achieved high marks, doing significantly better than in the previous evaluation four years ago.

The evaluation committee concluded that the quality of TNO's research is high across the board and even 'world leading' in certain niche areas. Further conclusions were that TNO's portfolio management has improved, that TNO's scientific output is good, and that TNO is solidly embedded in the domestic Dutch and international knowledge and innovation ecosystem. When it comes to social impact, the committee found that TNO's research results are used by stakeholders on a large scale.

Recommendations to TNO include to improve transparency on problems arising around long-term financing of facilities, to prioritise systems thinking, and to strengthen collaborative practices. Recommendations to the Dutch government include to create permanent funding for facilities and to better utilise TNO as an independent party. Virtually all of these recommendations have already been incorporated into the strategic plan for the 2022-2025 period. TNO looks forward to hearing the government's response.

RESEARCH FACILITIES

Good research facilities are of crucial importance to knowledge development at TNO. In 2021, five new labs were funded from the Dutch government's 'Climate Envelope' funding pot. The labs in question are labs for next-generation solar-energy applications, carbon capture and utilisation, industrial electrification, industrial drying technology, and the ecological and safety-related effects of solar and wind-energy projects. At these labs, several pilot and demonstration projects are being developed that have the potential to be applied on a larger scale in the future. The five new research facilities thus contribute to the acceleration of the energy transition and the knowledge position of Dutch industry.

Additionally, the Construction Innovation lab was opened in Delft in October 2021. This lab is home to advanced research facilities for innovations in construction materials, HVAC systems, and buildings and structures.

OUTLOOK

Despite the Covid-19 pandemic, TNO can look back on a successful year, a year in which the 2018-2021 strategic period was brought to a close and the new strategic plan for the 2022-2025 was developed. Submitted to the Minister of Economic Affairs and Climate Policy in May 2021, the new strategic plan will be TNO's compass for the coming years.

TNO wants to create systemic solutions to societal challenges. The title of the 2022-2025 strategic plan suggests how TNO intends to do that: 'Connecting, changing, accelerating: innovation for life'. The new strategic plan revolves around TNO's contribution to creating a safe, healthy, sustainable, and digital society. TNO connects these four societal challenges specifically to strengthening the earning power of the Dutch economy. TNO maintains an excellent knowledge base; this is the foundation for all its activities, including its national advisory role and statutory tasks.

With its new strategic plan, TNO is positioning itself in the heart of the major societal transitions more than ever before. TNO wants to create networks with knowledge partners, companies, and public-sector parties to forge innovations that enable and accelerate societal transitions. After all, research shows that innovation is the biggest driver of sustainable economic growth. Governments are increasingly becoming aware of this as well.

TNO welcomes funding measures such as the National Growth Fund and the grant scheme for R&D in mobility-related industries (automotive, aviation and marine) as steps towards the kind of ongoing investment that is needed for knowledge and innovation. As a member of the Knowledge Coalition, TNO aims for a gradual increase in public funding in R&D to 3% of GDP over a period of ten years. This is the only way for the Netherlands to keep up with frontrunners such as Germany and maintain its earning power as a country.



GAME CHANGER IN 2021

TYOLOGY-BASED APPROACH TO EARTHQUAKE HAZARD ASSESSMENT

Gas extraction in Groningen province leads to earthquakes. Over the past years, ample research has been done into the safety of buildings across the province. Assessing buildings in Groningen on an individual basis is a highly time-consuming undertaking and the operation to shore up at-risk buildings has been off to a slow start. For the Ministry of Economic Affairs and Climate Policy, TNO has now developed a new approach to assessing building's earthquake susceptibility. This approach bases the assessment on predefined typologies. After buildings have been classified into a typology, the National Coordinator for Groningen can quickly assess whether or not they are sufficiently safe. This way, we are accelerating the reinforcement operation in Groningen, so that the region can continue to offer a safe living environment.

Partners: Ministry of Economic Affairs and Climate Policy, Ministry of the Interior and Kingdom Relations, Delft University of Technology, the Groningen Safety Advisory Council (*Adviescollege Veiligheid Groningen*), the National Coordinator for Groningen

[Read more: Earthquakes in Groningen: a method for finding out more quickly whether houses are safe | TNO](#)



BUILDINGS, INFRASTRUCTURE & MARITIME UNIT



REPORT OF THE EXECUTIVE BOARD

STRATEGY

REPORT OF THE COUNCIL FOR DEFENCE RESEARCH

REPORT OF THE SUPERVISORY BOARD

RISK MANAGEMENT AND CONTROL SYSTEM

RESPONSIBLE OPERATIONS

FINANCES

APPENDICES

GAME CHANGER IN 2021

SKILLS FOR THE LABOUR MARKET

The energy transition, digitalisation, but also economic crises and the Covid-19 pandemic – they have all revealed how the current labour market is insufficiently equipped for the challenges of the current time. TNO is, therefore, calling for a labour market that revolves around skills, so that workers can present themselves with all the knowledge and skills they have acquired throughout their careers. After all, there is more to a potential employee than their degree. It will also enable employers to express their labour needs in terms of skills. This kind of skills-based approach can help people who are in a vulnerable position on the job market. Seeing as it enables employers to look beyond the usual candidates, it can also help solve labour shortages in some industries. And it will contribute to a more diverse, inclusive work environment in the process. A future-proof labour market is a key enabling condition for the major societal transitions and will bolster the Netherlands' earning power.

Partners: Chapter, SkillsCV, Employee Insurance Agency (UWV), Organisation for Vocational Education, Training and the Labour Market (SBB), Statistics Netherlands (CBS), and CPB Netherlands Bureau for Economic Policy Analysis

[Read more: Labour market of the future | TNO](#)



HEALTHY LIVING UNIT



REPORT OF THE COUNCIL FOR DEFENCE RESEARCH

In her preface to the Ministry of Defence's Strategic Knowledge and Innovation Agenda (SKIA) for the 2021-2025 period, the Minister of Defence writes, 'Geopolitical developments over the past years have made it clear that retaining, protecting, and developing strategic knowledge, technology, and capabilities is essential for our national security. The defence industry, too, is contributing substantially to the Netherlands' economic earning power. This is something we can be proud of.'

TNO's Defence Division serves the Dutch Ministry of Defence to develop and maintain that strategic knowledge and technology. Being part of the Dutch defence industry, TNO's Defence Division contributes to the Netherlands' earning power. In 2021, the CDR's focus was on deepening, based on the SKIA, the close cooperation between the Ministry of Defence and TNO that dates back nearly 75 years. The focus was also on translating these close ties to TNO's 2022-2025 Strategic Plan, which designates safety and security as one of the four societal themes that TNO is addressing.

Like previous years, 2021 was inevitably dominated by the Covid-19 pandemic worldwide. While Covid-19 had limited impact on TNO's Defence Division as whole, it did affect new business, especially on an international level. Due to international travel restrictions, there were delays in landing new contracts. Nevertheless, 2021 was another good year for defence research. The financial results were better than estimated. The Defence Division's workforce remained unchanged in 2021.

The CDR met on five occasions in 2021 and went on a retreat in November. The composition of the CDR has not changed.

In 2021, the CDR centred a great deal of its attention on TNO's Strategic Plan for 2022-2025. The aim was to, among other things, maintain the balance between TNO's focus on societal topics, the Dutch economy's earning power, and maintaining, strengthening and upgrading the knowledge base for the government in a number of key public research domains. Most of the defence research falls into the latter category and is one of TNO's statutory tasks. TNO has a permanent role as the Ministry of Defence's principal laboratory, a role that is specifically reflected in this strategy. TNO supports strategic calls to increase the defence budget to bring the defence organisation into balance and enable investment in new developments and innovation. The defence budget increase announced by the new Dutch government in late 2021 paves the way for significant steps in this respect over the coming years. For this revitalisation, the government will have to comply with the EDA standard that requires countries to allocate at least 2% of all defence spending to research and technology development, as laid down in the 2035 Defence Vision and the SKIA for 2021-2025.

In line with the CDR's priorities for 2021, the contents of research in the CDR domain received greater attention, with a specific focus on translating the SKIA to TNO's plans. Therefore, the priorities set in the SKIA played a key role in the choices made in the Annual Plans and the Knowledge Plan for TNO's Defence Division. Activities in this area that will continue in 2022 are the further specification of these choices in the implementation of the Knowledge Plan and in the three defence roadmaps. For the Ministry of Defence, this will in the first half of 2022 be input for the further elaboration of their plans in the area of Research & Technology on the back of the new government's coalition agreement.

Like in previous years, the Ministry of Defence and TNO linked up in 2021 to participate in national and international innovation and R&D programmes such as the National Growth Fund, the Mission-Driven Top Sectors and Innovation Policy, and the European Defence Fund (EDF). Expanding the cooperation between the Ministry of Defence and TNO to include instruments outside the research commissioned and funded by the Ministry of Defence creates a joint opportunity to bolster the knowledge base and is entirely in keeping with TNO's strategy, albeit that it often requires specific funding and governance arrangements.

After over ten years, former Major-General Lex Besselink stepped down as chair of the Strategic Advisory Council for TNO's Defence Division. A new chair was found in Ms Beatrice de Graaf, professor at Utrecht University specialising in the history of security, terrorism/counterterrorism, and international relations. The CDR has appointed her until the end of the 2022-2025 strategy period. Further new members will be appointed to the Strategic Advisory Council in consultation with her.

On 29 April, the Ministry of Defence's Defence Materiel Organisation (DMO) and the knowledge institutes of TNO, NLR, and MARIN signed an agreement to strengthen their collaboration around the development and sharing of knowledge and the solving of problems. Collaboration with the Ministry of Justice and Security and the Dutch National Police received a further impulse in 2021 with the creation of a cooperation board made up of members of TNO's Executive Board, the CDR, and the broad governing board of the Ministry of Justice and Security, while the chief of the National Police also sits on this board.

At a European level, 2021 was the year when the SEA Defence project was launched by a large European consortium headed by Damen Shipyards Group. Part of the European Defence Industrial Development Programme (EDIDP), which is the precursor to the European Defence Fund (EDF), this project is an important step in the run-up to the EDF.

To further streamline the processes within the collaboration between the Ministry of Defence and TNO, the CDR reference document 'TNO Budget & Costing' and the Annual Report for TNO's Defence Division were integrated into one single reference document adopted by the CDR. Two long-term financial issues, i.e. US rates and VAT on research and development for navy ships, were closed with a future-proof solution in 2021.



The Council for Defence Research, from left to right:

Marc Gazenbeek, Auke Venema, Harold Bousché, Marja Eijkman, Maarten Tossings (chair), and André Steur.

To assess the impact of the Ministry of Defence’s investments in knowledge and technology development at knowledge partners such as TNO, NLR, MARIN, and NLDA, the Ministry and these knowledge partners come together every year at the Innovation in Defence event. Due to the Covid-19 restrictions, however, the in-person edition of the event could not go ahead in 2020 and 2021. In order to still share the results of the research programmes and projects from 2020, a digital version of the event was held on 29 April 2021. The 2022 edition is scheduled for 12 April 2022 and will, hopefully, be an in-person event. Preparations for the celebration of 75 years of defence research in 2022 also commenced in 2021. It goes without saying that TNO wants to celebrate this milestone with the Ministry of Defence and other stakeholders. The event is scheduled for 29 June 2022.

Whereas before the Covid-19 pandemic there was pressure on the available space because of the growth of the workforce, this turned into a surplus as employees worked partly from home. For classified projects, working from home for part of the time is not an option, which is why investments have gone into creating additional space that meets the applicable security requirements. The fact that the NATO Communications and Information Agency (NCIA) moved out of TNO’s premises following the completion of their new building led to space freeing up at TNO’s Oude Waalsdorperweg site. Talks with the Ministry of Defence on how to use this space in the short term are currently underway. Renovation of the wing that has now been vacated has been postponed until there is clarity on what it will be used for and on the new TNO-wide accommodation policy incorporating the consequences of hybrid working on TNO’s property needs post Covid-19. A decision has been made, however, to start implementing energy and sustainability measures and building a number of additional special work areas at the Oude Waalsdorperweg site.

The CDR has, furthermore, agreed to the establishment of a Concurrent Design Facility (CDF) for DMO at the Soesterberg site. DMO intends to use the concurrent design approach to improve and accelerate major materiel projects and plans to increasingly use this methodology together with knowledge institutes and industry. This facility supports the new way of working. On 2 December, DMO and TNO signed the agreement and building work has meanwhile started. For the Soesterberg site, it is also relevant that the CDR has decided, at the request of the Ministry of Defence, to keep the Desdemona motion simulator operational for the coming years for research and training purposes.

In 2020, the CDR reached an agreement on the required functionality and the available budget for the additional new building at Ypenburg for the CBRN department, which is currently still based at the Lange Kleiweg site in Rijswijk. This requires substantial investments in facilities that must be able to last for many years. The CDR, therefore, continued to closely monitor this case in 2021.

The reporting year was a good year for TNO’s Defence Division. Defence research was consolidated despite the challenges of the Covid-19 pandemic. After 75 years, collaboration between the Ministry of Defence and TNO is still as vigorous as ever. With the plans announced for defence and for innovation in general, on a national and a European level, TNO’s Defence Division is excellently positioned for further intensification of that collaboration over the coming years.

On behalf of the Council for Defence Research,
Maarten Tossings, Chair

REPORT OF THE SUPERVISORY BOARD

Made up of seven members, the Supervisory Board is tasked with overseeing the policy pursued by the Executive Board, and with offering it advice.

The Supervisory Board normally meets at one or another TNO location. In view of the Covid-19 restrictions, most of the meetings of the Supervisory Board and its committees were again held online last year.

TOPICS

In a general sense, the Supervisory Board has overseen the policy pursued by TNO in 2021. A number of significant issues are examined in more detail below.

Composition of the Executive Board

On 1 May 2021, Ms Susan Swarte RC became a new member of the Executive Board and TNO's new Chief Financial Officer, succeeding Ms Cis Marring, who left TNO on the aforementioned date after over seven years of service. In late 2021, Mr Paul de Krom announced that he would be leaving TNO on 1 February 2022. The search for a suitable successor started immediately in late 2021. On 1 June 2022, Dr Tjark Tjin-a-Tsoi will become TNO's new CEO and Chair of the Executive Board.

The 2022–2025 Strategic Plan

In 2021, the Strategic Plan for the coming strategy period from 2022 to 2025 was completed and presented to the Ministry of Economic Affairs and Climate Policy. The contents of the 2022-2025 Strategic Plan and the implementation thereof were regularly addressed at Supervisory Board meetings.

The Supervisory Board endorses TNO's ambition to contribute to solutions to the four societal challenges for a safe & secure, healthy, sustainable, and digital society. TNO's focus in realising this ambition is on transdisciplinary innovation at systems level for the major transitions. The Supervisory Board was actively involved in making the plan; the approach taken ensured that the plan has broad support both internally and externally.

Knowledge leadership

Once every four years, the technology portfolio of each unit goes through a Knowledge Leadership Audit (KLA) that is carried out by an outside committee. The Quality Committee discussed the results of three KLAs that were conducted, and considered the recommendations these contained and what the next steps

should be. This follow-up will also be discussed by the Supervisory Board. The Supervisory Board was delighted to read the evaluation committee's report on the TO2 institutions and especially the findings about TNO.

Thought leadership

In 2021, TNO again published various white papers that revolve around innovative insights. At each Supervisory Board meeting, one of these white papers was presented and discussed with the management of the unit in question.

Tech Transfer and fund investments

Progress made on the successful Tech Transfer programme was discussed with the Supervisory Board. This programme has meanwhile resulted in 33 spin-offs. TNO also started participations in a number of early-stage investment funds in 2021. Plans for this investment policy (in funds, etc.) were discussed by the Audit Committee and at regular Supervisory Board meetings on various occasions. TNO has a successful technology transfer programme.

First Dutch Innovations

TNO sold the remaining (minority stake) in First Dutch Innovations (FDI, formerly TNO Bedrijven) to another shareholder last year. The Supervisory Board was closely involved in this transaction and set up a temporary Supervisory Board committee made up of the chair of the Supervisory Board and the Audit Committee members to give advice and aid the decision making around this sale.

Compliance and risk management

The Supervisory and Executive Boards regularly discuss TNO's compliance with various laws and regulations. IT security was assessed in detail in 2021 as part of the annual risk management report.

Finances

On 15 March 2021 the Supervisory Board approved the 2020 financial statements; on 15 December 2021, the budget for 2022. EY has audited TNO's financial statements since 2018.

Performance of the Supervisory Board and evaluation of the Executive Board

The Supervisory Board's performance was evaluated by the Hemingway firm in 2021. Based on interviews with all Supervisory Board and Executive Board members, this evaluation reflected on the collaboration between Supervisory Board members and collaboration between the Supervisory Board and the Executive Board. The results were discussed jointly. Aside from that, a supervision agenda was defined with priorities for supervision of the implementation of the new Strategic Plan.

To evaluate the Executive Board and its individual members, the Supervisory Board conducted the annual round of performance reviews with both the Chair and the members of the Executive Board.

The Supervisory Board admires the way TNO's employees and management have coped with constantly changing conditions last year as a result of the Covid-19 pandemic, while also continuing to manage to respond to current developments with programmes such as Brains4X. TNO is active and raises its profile in the outside world.

The Supervisory Board is pleased that TNO has managed to post excellent results, despite the uncertainties. TNO is firmly anchored in the mission-driven policy. With the 2022-2025 Strategy Plan, TNO is positioning itself in the heart of major societal transitions. This future-proof strategy offers a beckoning prospect for all stakeholders and Dutch businesses and industry.



The Supervisory Board, from left to right:

Jolanda Lamse-Minderhoud, Baptiest Coopmans, Hester Bijl, Peter van Laarhoven, Louise Verheij van Wijk, Gijs de Vries (chair), and Peter-Paul Verbeek.

COMPOSITION OF THE SUPERVISORY BOARD AND ITS COMMITTEES

In 2021, Ingrid Vanden Berghe stepped down from the Supervisory Board when her second term came to an end. She was succeeded by Mr Baptiest Coopmans.

Peter van Laarhoven was reappointed to a second term starting 1 October 2021.

The three permanent Supervisory Board committees were composed as follows in 2021:

Audit Committee

Ms J.D. (Jolanda) Lamse-Minderhoud RA (chair)
Mr J.B.P. (Baptiest) Coopmans (from 1 February 2021)
Ms I.H.J. (Ingrid) Vanden Berghe (until 1 February 2021)
Ms L. (Louise) Verheij van Wijk

Quality Committee

Prof. P. P. C. C. (Peter-Paul) Verbeek (chair)
Prof. H. (Hester) Bijl

Selection and Remuneration Committee

Mr P. J. M. (Peter) van Laarhoven (chair)
Mr P. G. (Gijs) de Vries
Ms L. (Louise) Verheij van Wijk

INDEPENDENCE

In the opinion of the Supervisory Board, the requirements related to independence of action, as specified in provisions 2.1.7 to 2.1.9 of the 2016 Dutch Corporate Governance Code, were satisfied.

MEETINGS

The Supervisory Board met on seven occasions in 2021. The Audit Committee had four meetings in 2021, while the Selection and Remuneration Committee and the Quality Committee met on three and two occasions respectively. Away from the meetings, there was contact between the committees as necessary. Representatives from the Supervisory Board attended two Works Council meetings. The Supervisory Board furthermore liaised regularly with the Ministry of Economic Affairs and Climate Policy.

ATTENDANCE

The attendance record of the individual members of the Supervisory Board at its own meetings and those of its permanent committees in 2021 was as follows:

	SB meetings	Committee meetings
Gijs de Vries	7 (of 7)	3 (of 3)
Peter van Laarhoven	7 (of 7)	3 (of 3)
Hester Bijl	6 (of 7)	2 (of 2)
Baptiest Coopmans	6 (of 7)	4 (of 4)
Jolanda Lamse-Minderhoud	5 (of 7)	4 (of 4)
Peter-Paul Verbeek	7 (of 7)	2 (of 2)
Louise Verheij van Wijk	7 (of 7)	7 (of 7)

GAME CHANGER IN 2021

TWO WORLD RECORDS IN SOLAR ENERGY

In order to meet the climate targets, the use of solar power will have to grow fourfold over the 2020-2030 period and tenfold beyond that through to 2050. To make this happen, it is essential that yields increase considerably and the ecological footprint be reduced. Solar panels will also have to be integrated into roofs, building fronts, noise barriers, and agricultural areas in a visually attractive and eco-friendly way. The solution lies partly in 'tandem solar cell systems' where two solar cells are stacked one on top of the other. TNO developed the expertise and posted two world yield records from this type of solar panel. This is very promising technology indeed for acceleration of the energy transition.

Partners: TNO's partners on this project include imec, Eindhoven University of Technology and Delft University of Technology

[Read more: Solar energy: limits to yield extended further](#)



ENERGY TRANSITION UNIT



RISK MANAGEMENT AND CONTROL SYSTEM

Risk management is the process of identifying, assessing, and controlling risks. Risks are caused by various factors, ranging from financial uncertainties and legal obligations to strategic choices, accidents, and natural disasters. A successful risk management system helps TNO make decisions based on the broadest possible view of all the risks involved, while also identifying the impact that risks may have on TNO's strategic goals. This section will explain TNO's risk appetite in 2021, while further details of the risk management and control system will be provided separately in an appendix.

RISK VISION

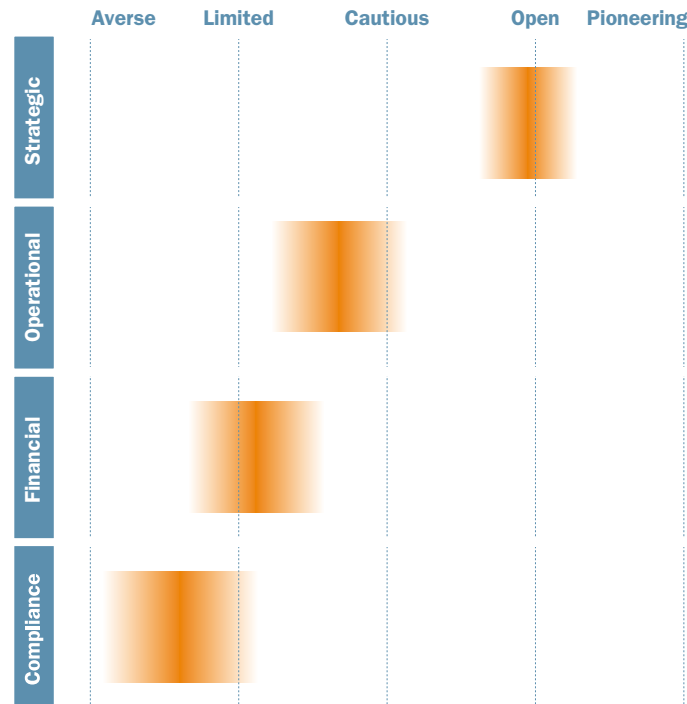
TNO wants to protect its legitimacy and continuity to be able to achieve its strategic goals. This protection is delivered by risk management processes that weigh opportunities against risks.

RISK MANAGEMENT RESPONSIBILITY

The Executive Board is responsible for developing, implementing, and monitoring TNO's complete risk management and control system, which is intended to secure achievement of TNO's objectives by adequately managing the risks involved in pursuing them.

RISK APPETITE IN 2021

TNO's risk appetite is related to TNO's objectives on the one hand and to the unique nature of TNO as a research and technology organisation on the other. It is not about avoiding risk altogether, but rather about creating the right assessment framework for deciding which risks to take. TNO's risk appetite can be represented and described as follows:



TNO wants to be a leading player in society in order to boost competitiveness and increase well-being across society. We are ready to take on challenges in developing unique, distinctive, multidisciplinary knowledge and using world-class facilities, as well as to generate impact by bringing knowledge to market.

Given its strategic objective, TNO wants to operate from an enterprising mindset. In projects, we are prepared to operate in an innovative way and want to be a reliable and efficient partner, albeit always on the condition that the integrity of our internal systems and processes and the safety of our employees are adequately safeguarded.

TNO's financial strategy is designed to provide a sufficient buffer to allow it to accept certain financial risks as well as to invest in new facilities and sustain existing facilities without jeopardising its continuity.

TNO operates in a playing field wedged between public and private interests that is governed by regulation and ethical standards. TNO embeds control measures in a way that is responsible and as efficient as possible. When it comes to compliance risks, TNO's risk appetite is minimal.

TNO-WIDE RISK ANALYSIS FOR 2021

For 2021, TNO's Executive Board designated the following risks as 'top risks':

Risk	Owner
Risk of a significant drop in future revenue	COO
Risk of TNO losing its right to play	CEO
Risk of inadequate quality of research deliverables	CSO

Throughout 2021, these risks were evaluated by TNO's Executive Board during the business reviews, partly based on input from the units and support departments. It led to the conclusion that in 2021 there were no developments worth mentioning in the risks that have been identified. The risks and implementation of measures remain a constant focus.



SET-UP OF THE RISK MANAGEMENT AND CONTROL SYSTEM

TNO has based the set-up of its risk management on the COSO Enterprise Risk Management (ERM) approach, which is outlined in the figure below and detailed further in the 'Risk management and control system' appendix to this annual report. Alongside COSO ERM as the guiding principle, TNO goes by the lines of defence model in the set-up of its risk management and control, as explained in the appendix.

The Governance & Culture component covers how TNO gives substance to the value, importance, and culture around the management of opportunities and risks, and the way this has been formalised. There were no major changes in this area in 2021.

The Strategy & Objective Setting component extends to the management of risks in the context of TNO's strategic and other objectives. Opportunities and risks are weighed dynamically based on TNO's risk appetite. In 2021, TNO's risk appetite was reconfirmed by TNO's Executive Board.

The actual weighing of opportunities and risks happens in the Performance component. This is monitored and any control measures taken are validated in the Internal Control Framework (ICF).

The Review & Revision component is where the risk management and control system is evaluated, based partly on the outcome of internal audits and management reviews. Since a new strategy period will start in 2022, the ICF was adjusted in late 2021 to bring it into line with the new strategic vision and objectives.

No particular shortcomings were found in the functioning of the current risk management and control system, which was confirmed by internal and external audit reports received in 2021.

Under the Information, Communication & Reporting component, there is continuous internal and external communication and information provision on how opportunities and risks have developed, as well as on the risk management and control system, such as in this risk section with appendix.

CONCLUSION

The Executive Board concludes that the internal controls and risk management with respect to finances, privacy, and export control and sanctions compliance (from the completion of the roll-out in late April 2021) are organised adequately and have proven to be effective in 2021. There were no indications to the contrary. As far as the other aspects of operations are concerned, no evidence has emerged that these do not comply with current requirements. It should, however, be noted that risks may also occur that cannot be anticipated, and that not all inaccuracies, losses, fraud or non-compliance with laws and legislation can be ruled out.

GAME CHANGER IN 2021

**GREEN CHEMISTRY,
NEW ECONOMY**

By 2050, Dutch industry is to have reduced its carbon emissions to zero. To make that happen, the chemical industry is going to have to decarbonise fast. When facing such a massive challenge, cooperation between government, companies, and knowledge institutes is crucial. TNO plays a key role in bringing parties together and scaling up innovations.

In this particular case, this role is fulfilled by TNO's 'Green chemistry, new economy' task force. Several major chemical companies, development companies, and financial institutions have meanwhile joined this initiative. Together, these parties explore ways to use disruptive innovations and develop new value chains within the chemical industry. TNO spin-off Relement is one of the group's showcases. These joint efforts not only accelerate the transition, but will also create jobs in the long run.

Partners: Various companies, government bodies, and knowledge institutes

[Read more: 'Green chemistry': fewer CO₂ emissions, more jobs | TNO](#)



STRATEGIC ANALYSIS & POLICY UNIT



RESPONSIBLE OPERATIONS

TNO is committed to treating its employees, the environment, and society responsibly. This section will go into how exactly TNO does that, based on three subjects: The 'TNO as a House for Talent' section will explain TNO's HR policy in greater detail and go into the results of the annual employee engagement survey. Next, the 'Corporate Social Responsibility' section will speak to the objectives and achievements on a societal level, in line with the UN Global Impact and the Sustainable Development Goals. Lastly, the 'Compliance and Integrity' section will set out how TNO handles personal data and the Public Administration and Complaints Act.



TNO AS A HOUSE FOR TALENT

Empower

Empower, which is TNO’s current evaluation and remuneration policy, plays a crucial role in the operationalisation of the ‘House for Talent’ that TNO intends to be, with a view to strengthening TNO employees’ motivation and work performance. This happens by stimulating employees to take control of their career at TNO, by maintaining ongoing dialogue on personal and professional development, and by linking employee goals and values to organisational goals. To support the further implementation of Empower, a range of training, inspirational, and support materials were developed and made available to TNO employees in 2021. Several focus groups were organised to get feedback on several fundamental changes to the new evaluation and remuneration policy. Implementation of Empower will continue in 2022.

A safe, healthy and connected way of working

It is important to TNO that its employees can work in a way that is safe, healthy, and connected. Since 2019, TNO has been running the Fit for Your Future programme that lets employees work on their mental and physical health. In 2021, there was again ample attention for the impact of the Covid-19 pandemic. Besides greater flexibility for employees who suddenly had to combine their work with caring for children or family members, employees were also given the opportunity to set up a home workplace. This latter facility included advice on ergonomic support equipment and an allowance towards the costs of a home workplace.

In addition, a decision was made to implement a new mobility policy in 2023 that will rest on the pillars of flexibility, sustainability, and vitality. Hybrid working is central to the new mobility policy, as employees will be given the opportunity to choose where they work (from home or on site) and how they

commute on a day-by-day basis. Sustainable mobility options such as cycling and public transport will, therefore, be encouraged and also have a positive effect on employees’ physical and mental health.

Diversity & Inclusion

When it comes to diversity and inclusive employment practices, TNO has a clearly defined ambition. TNO wants everyone to feel at home and have equal opportunities for personal and professional development. Gender, religion, sexual orientation, cultural background, nationality, neurotype, or physical impairments should not be a factor in that. TNO aims to create an inclusive learning and work environment that draws on the differences that exist within it to stimulate creativity, innovation, and talent development to the maximum degree possible. This ambition features prominently in the new TNO strategy for the 2022-2025 period and was backed up with the appointment of a D&I Officer in late 2020.

2021 was an eventful year in terms of Diversity & Inclusion (D&I). A D&I Board was appointed and work started on a four-year D&I plan, which will take effect in early 2022. A recruitment project that TNO ran in 2021 aimed to reduce bias in selection procedures and increase diversity among candidates for vacancies. The Dutch Inclusion Monitor was used to map the level of inclusion at TNO, yielding a 52% response rate among employees.

TNO carried out equal pay studies to canvass the existence and extent of gender pay gaps within the organisation. The first conclusions drawn based on this research are that differences in the salaries of men and women at TNO are almost entirely due to factors such as age, starting salary, job grading, type of appointment, part-time factor, absence history, performance review

history, starting age, and unit/SO. Further research is currently ongoing. Various webinars, bias training sessions, and roundtable discussions with specific demographics were organised in 2021, as well as the ‘Week of Diversity.’

In 2021, 11.5% of TNO staff were internationals (not Dutch). The gender ratio for the total TNO workforce was 68.5% male to 31.5% female. At the highest level of the organisation (Supervisory Board, Executive Board, and first echelon), it was 54.2% male to 45.8% female.

Employee engagement survey

In 2021, 62% of TNO employees took part in the employee engagement survey. Employee engagement fell slightly in 2021, coming in at 7.3 out of 10, compared to 7.5 in 2020. TNO does not believe this is cause for concern. Given the difficulties caused by the Covid-19 pandemic, a score of 7.3 in this period of prolonged homeworking can still be considered a good score. What is also a positive is that the scores on a number of specific points improved compared to 2020, such as on ‘level of autonomy experienced,’ ‘identification with TNO’ and ‘clarity of performance assessment criteria.’

Despite various interventions, the number of burnout-related problems, however, was up 5% on 2020, rising to 26%. Young employees (25-34 years old) in particular are experiencing these problems. The Executive Board considers this an unacceptable development. Therefore, work will go into developing solutions step by step, which will have to be tailor-made solutions due to the fact that problems are not the same in all TNO areas.

In 2022, work will also go into a peer consultation programme for managers, and various roundtable discussions will be held around this topic.



CORPORATE SOCIAL RESPONSIBILITY

The Corporate Social Responsibility policy adopted in 2020 has laid the foundation for TNO’s societal ambitions. TNO aims to make its operations climate neutral by 2040, takes its supply chain responsibility towards its suppliers and customers, and commits to the 10 principles of the UN Global Compact regarding socially responsible business practices. The figure [on page 32](#) shows how these principles have been translated to ten CSR priorities at TNO and the associated Sustainable Development Goals of the United Nations.

In 2021, further meaningful steps were taken in the ‘Energy & Sustainability’ and ‘Supply chain responsibility’ domains. such as exploring ways for TNO to reach climate neutrality by 2040, further decarbonisation of TNO’s buildings by installing solar panels, and adoption of a new sustainability-based mobility policy. This latter policy reimburses employees in full for travel on public transport, makes electrification of TNO’s fleet of leased cars compulsory, implements charges for emissions from air travel, and makes it compulsory to use the train for distances of up to 700km.

In terms of taking its supply chain responsibility, TNO has made good progress in strengthening its sustainable procurement practices in line with ISO 20400 on sustainable procurement through closer involvement of the CSR Officer in procurement practices and by setting tighter sustainability requirements for certain procurement categories.

Potential environmental, social and governance (ESG) risks in the Business Relationship Due Diligence (formerly ‘customer acceptance’) process were also assessed. In this second year into the Covid-19 pandemic, TNO again worked to ensure a ‘safe, healthy, and connected way of working’ for employees and took specific steps to increase diversity and inclusive employment practices (see ‘House for Talent’ earlier in this section). A continued cause for concern, however, is the high rate of burnout-related problems that employees again drew attention to in 2021 through the employee engagement survey.

The fourth priority of ‘Innovating responsible’ is so important to TNO that it has been anchored in the basis of the TNO strategy for the 2022-2025 period. TNO thus reiterates that its work is all about striking a balance between (sometimes conflicting) societal interests in a transparent way. Finally, it is important to note that the international community is increasingly finding its way to TNO’s publications: use of the open-access repository rose further in 2021, when it was consulted nearly 13 million times.

COMPLIANCE AND INTEGRITY

General Data Protection Regulation

The General Data Protection Regulation has now been in force for over three years. In that time, TNO has made sure that employees are aware of the GDPR rules and have received the appropriate training. TNO’s privacy policy and privacy statement were also revised to better align them with TNO’s practical implementation of compliance with data protection legislation. In 2021, data subjects submitted six requests to TNO under the GDPR.

Security

In April 2021, TNO was the target of an advanced cyberattack that involved – as turned out later – a nation state actor trying to access TNO’s IT network. Thanks to TNO’s security measures, the attack was detected early and stopped, thus limiting the damage to one single infected laptop. IT security is being tightened further, including by creating a shielded environment for Departmental Confidential information.

In 2021, there was also a great deal of attention for the topic of knowledge security. Representing all the Dutch applied research institutes, TNO was involved in drawing up a Knowledge Security Guideline under the management of the Ministry of Education, Culture, and Science, together with representatives from universities, the Netherlands Organization for Scientific Research (NWO), and the Royal Netherlands Academy of Arts and Sciences (KNAW). In 2022, TNO will decide based on this guideline what additional measures it needs to take in this context.

In late 2021, TNO launched a Security Awareness programme to raise awareness of security risks among TNO employees and explain what they can and have to do to counter these risks. This also extends to the careful handling of personal data and reporting of data breaches. TNO detected fourteen data breaches in 2021, three of which it reported to the Dutch Data Protection Authority.

Export control and sanctions

TNO is determined to strictly comply with international and national legislation and regulations on the export of knowledge. Since December 2019, TNO has had an Internal Export Compliance Programme (IECP) in place. In 2021, this programme was implemented in full across all nine TNO units.

The IT used to monitor the IECF was developed further in 2021. There was also a particular focus on implementation of the EU's new Dual Use Regulation and TNO sought collaboration with Dutch and European knowledge institutes and universities in the area of export control compliance.

Business Relationship Due Diligence (BRDD)

In 2020, TNO adopted a Business Relationship Due Diligence process (formerly: customer acceptance policy) to support careful decision making on customers, partners, and projects. By implementing the BRDD process, TNO ensures the required level of meticulousness and prudence. Following the start in 2021, initial implementation is to be completed in 2022. The aim is to automate the Business Relationship Due Diligence process as fully as possible.

Research involving human subjects and animal testing

TNO's work also covers research involving human subjects, and research for which personal data is collected. Some of this research is subject to the Medical Research Involving Human Subjects Act (*Wet Medisch-wetenschappelijk Onderzoek met mensen*), and is reviewed by an external medical ethics review committee. All research that is not subject to this legislation is assessed by a TNO-wide internal-review committee, which evaluated over 140 proposals in 2021. The internal review is itself evaluated annually, and the results are reported to the Executive Board.

TNO conducts biomedical research with a view to improving human health. Its ambition is to keep animal testing to an absolute minimum. Wherever testing is unavoidable, TNO will do its utmost to carry out the research involved in a meaningful way, using as few animals and causing as little distress as possible. TNO's policy in this respect is that of the 3 Rs (replacement, reduction, and refinement).

TNO has this research reviewed by an independent external animal testing committee, while it is also subject to project permits from the Central Authority for Scientific Procedures on Animals. TNO also has its own Animal Welfare Body with a test animal expert, which is responsible for internal supervision, reviews, advice, and policy in the area of animal welfare in animal testing.

Nagoya Protocol

Some of the genetic material used by TNO for research counts as 'genetic resources' under the Nagoya Protocol¹. This protocol lays down rules for the use of genetic resources. The aim of these rules is the fair and equitable sharing of the benefits arising from use of the resources. The year 2021 was all about the implementation of the Nagoya policy adopted in 2020 and the Nagoya procedure at TNO. Five units turned out to be using genetic resources that do or may come under the Nagoya Protocol. At these units, Nagoya local points of contact were designated, while a central point of contact was appointed for the other units. Various sessions were organised to train the local points of contact for their role. Nagoya has also been incorporated into the 'Biological safety' e-learning course.

¹ EU Regulation 511/2014 on compliance measures for users from the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation in the European Union and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity, which is a supplementary agreement to the Convention on Biological Diversity.

The Government Information (Public Access) Act

TNO's ambition is to respond in a timely fashion to all requests made under the Government Information (Public Access) Act (*Wet openbaarheid van bestuur, WOB*). In 2021, 29 requests for access to information were made of TNO under this act, two of which were submitted to TNO directly. Twenty-seven requests were for the opinion of another administrative body. All requests were addressed in accordance with statutory requirements. On one occasion in 2021, an objection was raised against a primary decision by TNO. No objection was lodged against a TNO decision on a complaint. In 2021, five appeal cases were pending in relation to an appeal that had been lodged prior to the reporting period against a TNO decision on a complaint. On 1 May 2022, the Open Government Act replacing the Government Information (Public Access) Act will come into force. TNO is in the process of taking stock of all the consequences for the internal process at TNO and will try to make the transition as smooth as possible.

Integrity and anti-corruption

TNO aims to live up to the highest standards of integrity in its operations. The TNO Code forms the basis for that. Knowledge of the TNO Code is an integral part of the TNO's terms and conditions of employment: all TNO employees must know the code and act in accordance with it. All TNO employees must report annually on all side activities they engage in that are relevant to TNO.

The annual employee engagement survey conducted in 2021 shows that the majority of employees are familiar with the TNO Code (an average score of 5.7 on a seven-point scale), and that they also feel integrity is upheld (an average score of 5.9 on a seven-point scale).

Following a corruption risk assessment from 2020, TNO's business and social integrity was monitored and audited in 2021.

In addition, there is ongoing preventive dialogue with the TNO management about such matters as conflicts of interest and risks related to corruption. No incidents of corruption were reported to the Integrity Office in 2021.

Employees are kept involved via the existing Dilemma Bank on the TNO intranet. Last year, dilemma dialogues were added that let all TNO employees take part in a digital interview by chat with a guest who reflects on a dilemma.

Issues that arise between TNO employees and management regarding an employee's intention to engage in political activity or endorse lobby statements by third parties require additional attention. TNO's independence must never be undermined. Besides, such lobby statements are often not sufficiently scientifically substantiated, meaning that TNO simply cannot and does not want to put its name to them.

Scientific integrity

TNO has committed itself to the Netherlands Code of Conduct for Research Integrity (NCCRI). TNO's compliance with this code was subjected to an internal evaluation in 2021. This evaluation showed that TNO largely has the formal aspects of the NCCRI in order. The real challenge lies in ensuring and continuing to ensure that the aspect of integrity in TNO's scientific research gets the permanent attention it deserves. TNO monitors this process in various different ways and will continue to do so over the coming years.

Reports and complaints

TNO has an Internal Complaints Procedure, an External Complaints Procedure, and a system for addressing cases in which wrongdoing is suspected. One complaint was submitted based on TNO's External Complaints Procedure in 2021. This complaint was handled in an informal manner. Under TNO's Individual Complaints Procedure, four complaints were filed in 2021, two of which were dismissed as inadmissible, one has already been settled, and one is still pending further review. No formal reports were submitted by employees in the context of TNO's system for addressing cases in which wrongdoing is suspected. Management, however, has informed the Integrity Office on certain things that did not go well. These were addressed.

In a case regarding a whistleblower statement made in 2016 under the whistleblower regulation valid at the time, a court found in favour of TNO on all essential points in 2020. A recommendation from the Dutch Whistleblowers Authority has meanwhile also been published. TNO is satisfied with the decision by the Authority, which is essentially in line with a previous decision handed down by the court, concluding that TNO has not wronged the complainant in relation to his report. The complainant has appealed the court's previous judgement with the court of appeal. TNO also faces these proceedings with confidence.

COMPOSITION OF THE EXECUTIVE BOARD

MEMBERS OF THE EXECUTIVE BOARD

Mr P. de Krom (1963), Chair/CEO

Since 01/03/2015.

Outside activities:

- Executive Board member, Federatie van Samenwerkende Organisaties in het Toegepast Onderzoek (Federation of Applied Research Institutes)
- Supervisory Board member, HTM Personenvervoer (public transport provider in the City of The Hague)
- Director, Koninklijke Hollandse Maatschappij der Wetenschappen (Royal Netherlands Society for the Sciences)
- Vice-Chair of the Supervisory Board, HU University of Applied Sciences, Utrecht
- Member, Zuid-Holland Economic Board
- Chair, Holland International Distribution Council

Mr M.G.L.H. Tossings (1962), COO, Rear Admiral

Since 15/03/2019.

Outside activities:

- Board member, The Netherlands Industries for Defence & Security (NIDV)
- Executive Committee member, Netherlands Maritime Construction Cluster (NMC)
- Board member, *Stichting Maritiem Kenniscentrum* (MKC) (Centre for Maritime Expertise)
- Supervisory Board member, First Dutch Innovations B.V. (FDI) (until 15/07/2021)
- Chair, Digital Task Force, Zuid-Holland Economic Board
- Supervisory Board member, Holland Metrology (from October 2021)
- Board member, Dcypher (from March 2021)

Ms F. Marring RA (1963), CFO

From 01/02/2014 to 01/05/2021.

Outside activities:

- Board member, Stichting Pensioenfonds TNO (pension fund) (until 01/05/2021)
- Supervisory Director and Chair of the Audit Committee, Novex B.V.
- Board member, Nederlandse Vereniging van Financial Executives (Netherlands Society of Financial Executives)
- Supervisory Board member and Audit Committee member, Stichting Sint Antonius Ziekenhuis (hospital)
- Supervisory Board member, Stichting de Noordzee (The North Sea Foundation)

Ms S.M. Swarte RC (1968), CFO

Since 01/05/2021.

Outside activities:

- Non-executive director, Toxys BV
- Supervisory Board member, Audit Committee chair, and Remuneration Committee member, Acta Marine Holding BV

Prof. P.J. (Peter) Werkhoven (1959), CSO

Since 01/05/2019.

Outside activities:

- Professor, Utrecht University
- Board member, Top Consortium for Knowledge and Innovation, High Tech Systems and Materials
- Member, Technology and Innovation Committee, VNO-NCW (employers' organisation)
- Supervisory Board member, PhotonDelta
- Board member, Stichting Toekomstbeeld der Techniek (Foundation for the Future of Technology)
- Social Advisory Council member, Royal Netherlands Meteorological Institute

Mr W.C.A. Maas (1967), Secretary

Since 01/01/2018.

GAME CHANGER IN 2021

LASER COMMUNICATION FOR AIRCRAFT

Self-driving cars, social media with lots of videos, and the Internet of Things will place an increasing demand on our data connections in the future. Today's radio frequency connections will simply not be up to the task. Since 2014, TNO has been working on laser communication, a form of connection that offers unparalleled transfer speeds for the entirely secure sending and receiving of information. Broadband and secure internet traffic will benefit a lot of industries and thus boost our economy and convenience.

In 2021, TNO partnered with Airbus on the 'UltraAir' programme to experiment with laser communication for aircraft. Initially intended only for military purposes to enable aircraft to connect to a combat cloud, it can also be used to give passengers on commercial flights access to secure and reliable internet at great altitudes.

Partners: FSO consortium (TNO with VDL, DEMCON, and GTM-AS) and Airbus Netherlands

[Read more: Communicating with satellites](#)



COMPOSITION OF THE SUPERVISORY BOARD

Mr P.G. de Vries (1958), Chair

Since 01/07/2019; first term runs up to 01/07/2024.

Professional activities outside TNO:

- Chair of the Supervisory Board, Erasmus University Medical Center Rotterdam
- Chair of the Supervisory Board, Arbo Unie (occupational-health service)
- Chair of the Supervisory Board, Netherlands Comprehensive Cancer Organisation (IKNL)
- Chair of the Board, Stichting Achmea Slachtoffer en Samenleving (Achmea victim and society association)
- Coach at Executive Sherpa Coaching/Mind&Health
- Member of the Advisory Board, Erasmus Center for Leadership
- Chair of the Board of Stichting National Monument Kamp Amersfoort (since September 2021)

Mr P.J.M. van Laarhoven (1959), Vice-Chair

Since 01/10/2016; second term runs until 01/10/2026.

Professional activities outside TNO:

- Chair of the Supervisory Board, CQM
- Chair of the Supervisory Board, Port of Moerdijk
- Chair of the Supervisory Board, Arnhem and Nijmegen University of Applied Sciences Foundation
- Supervisory Board member, CB Logistics
- Supervisory Board member, H&S Holding
- Vice-Chair, the Netherlands National Commission for UNESCO
- Chair of the Supervisory Board, Dutch Touring Opera (since 1 November 2021)

Ms I.H.J. Vanden Berghe (1962), member until 1 February 2021

Since 01/02/2011; second term runs until 01/02/2021.

Professional activities outside TNO:

- Administrator-General, National Geographic Institute
- Member, Council of Administrators-General of State-Owned Organisations
- Chair, the Belgian federal government's G-Cloud Strategic Board
- Visiting Professor, Catholic University of Leuven
- Chairwoman of the Executive Board, VITO (Flemish organisation for technology research)
- Member of the Management Committee, Royal Museum for Central Africa and Royal Belgian Institute of Natural Sciences
- Member of the Management Committee, Royal Meteorological Institute, Royal Institute for Space Aeronomy, and Royal Observatory of Belgium
- Co-Chair, United Nations Global Geospatial Information Management Committee of Experts

Prof. H. Bijl (1970)

Since 01/09/2018; first term runs up to 01/09/2023.

Professional activities outside TNO:

- Vice-Rector Magnificus, Executive Board, Leiden University (until 8 February 2021)
- Rector Magnificus, Executive Board, Leiden University (since 8 February 2021)
- Professor of Numerical Mathematics, Mathematical Institute, Leiden University
- Board member, Leiden Bioscience Park Foundation
- Advisory Board member, Space Campus Noordwijk
- Supervisory Board member, Impuls Zeeland (since 20 January 2021)

Mr J.B.P. Coopmans (1965), member since 1 February 2021
Since 01/02/2021; first terms runs up to 01/02/2026.

Professional activities outside TNO:

- Senior Vice-President, Executive Leadership Team member, Liberty Global
- Supervisory Board member, Burg Group
- Supervisory Board member, VodafoneZiggo

Ms J.D. Lamse-Minderhoud (1969)

Since 01/11/2014; second term runs until 01/11/2024.

Professional activities outside TNO:

- Executive Board member, PricewaterhouseCoopers Netherlands (PwC)
- Supervisory Board member, Wildlife Justice Commission

Prof. P.P.C.C. Verbeek (1970)

Since 01/05/2012; second term runs until 01/05/2022.

Professional activities outside TNO:

- Professor of the Philosophy of Human-Technology Relations, University of Twente
- Co-Director, DesignLab, University of Twente
- Honorary Adjunct Professor, Aalborg University
- Chair, UNESCO World Commission on the Ethics of Scientific Knowledge and Technology (COMEST)
- Vice-Chair of the Board, Rathenau Institute
- Chair of the Committee on Freedom of Science and Technology of the Royal Netherlands Academy of Arts and Sciences
- Board member, Social Sciences and Humanities Domain, Netherlands Organization for Scientific Research (NWO)
- Commission member, Social Sciences and Humanities Sector Plans OCW
- Programme Board member, Maatschappelijk Verantwoord Innoveren (MVI) (Socially Responsible Innovation), Netherlands Organization for Scientific Research (NWO)
- Member, the Netherlands National Commission for UNESCO
- Member, Royal Netherlands Academy of Arts and Sciences

Ms L. Verheij van Wijk (1964)

Since 01/10/2019; first term runs up to 01/10/2024.

Professional activities outside TNO:

- Member, IT & Innovation Think Tank of the Netherlands Comprehensive Cancer Organisation
- Chair of the Supervisory Board, Star-shl (since March 2021)
- General Director, MRI Centrum

Mr W.C.A. Maas (1967), Secretary

Since 01/01/2018

Ms Vanden Berghe is a Belgian national.
The other members are Dutch nationals.

GAME CHANGER IN 2021

BIOAROMATICS FOR A SUSTAINABLE CHEMICAL INDUSTRY

Around 40% of all chemicals are aromatic. Products we use on a daily basis, ranging from plastics to fabric, are almost all made up of aromatics. However, these chemical raw materials are still extracted from petroleum, which is a process that releases extensive carbon emissions. TNO is working to produce aromatics from biomass, following lab tests that confirm that this is possible, and has now reached the point where these efforts have to be scaled up to be able to produce bioaromatics for commercial purposes in the future. TNO has been active in the Shared Research Center Biorizon for several years, where we work with companies and knowledge parties to develop technologies for the production of aromatics from hemicellulose residual biomass. TNO spin-off Relement will be scaling up and optimising this knowledge to be able to produce bioaromatics commercially from mid-2023. Relement is thus showing the world that TNO's technology really works. In a market worth approximately €6.9 billion, there is great potential to effectively decarbonise the petrochemical industry.

Partners: Relement spun off from TNO research activities as part of the Shared Research Center Biorizon. Biorizon is an initiative by TNO and VITO.

[Read more: Relement | Extracting aromatics from biomass | TNO](#)

 CIRCULAR ECONOMY & THE ENVIRONMENT UNIT



COMPOSITION OF THE COUNCIL FOR DEFENCE RESEARCH

Mr M.G.L.H. (Maarten) Tossings, chair, TNO, Executive Board member/COO

Mr M. (Marc) Gazenbeek, vice-chair, Ministry of Defence, Deputy Secretary-General

Ms M.J. (Marja) Eijkman, member, TNO, Managing Director, Defence & Security Unit

Major-General A. (André) Steur, member, Ministry of Defence, Operational Policy and Planning Director

Mr A.P. (Auke) Venema, member, Ministry of Defence, Strategic Knowledge & Innovation Advisor

Mr H.F. (Harold) Bousché, secretary, TNO



COMPOSITION OF THE STRATEGIC ADVISORY COUNCILS

Each TNO unit has a Strategic Advisory Council (SAC) made up of representatives from business and industry, the public sector, and knowledge institutes. Each council supports its units with advice on priorities, and draws attention to new developments, thus fulfilling a key role in TNO's innovation strategy.

SAC members are appointed for a period that runs concurrently with the Strategic Planning period.

BUILDINGS, INFRASTRUCTURE & MARITIME UNIT

MD – Ms M.G.M. de Kroon

Mr J.H. Dronkers, Ministry of Infrastructure and Water Management, Secretary-General

Ms M.H.W. van Buren, Rochdale, Chair of the Executive Board

Mr C.F. Eggink

Ms T. Muusse

Ms C. Reiner, Techniek Nederland, Vice-Chair

Mr J. Roodenburg, Huisman, President

Mr M.R. Schurink, Ministry of the Interior and Kingdom Relations, Secretary-General

Mr F. Vermeulen BA, Mayor of Wageningen

Prof. L. Volker, University of Twente, Faculty of Engineering Technology, Professor of Integrated Project Delivery

Mr R.P. van Wingerden, Executive Advisor to the National Coordinator for Groningen (NCG)

DEFENCE & SECURITY UNIT

MD – Ms M.J. Eijkman

Prof. B.A. de Graaf, Utrecht University, Humanities Faculty Professor

Mr R. Berkvens, Damen Shipyards, Advisor to the Executive Board

Mr J.C. Dicke, Ministry of Economic Affairs and Climate Policy, Commissioner for Military Production

Brigadier General J.P. Duckers, Ministry of Defence, Army Command, Knowledge Development Director

Prof. P.H.A.J.M. van Gelder, Delft University of Technology, Professor of Safety Science

Mr H.G. Geveke, Member, National Police Board

Mr C. Haarmeijer, Re-LiON, CEO

Rear Admiral J.H. Hulsker, Ministry of Defence, Deputy Navy Commander

Mr M.G.M. Koning ter Heege, Thales, Research Director, Technology & Innovation

Mr G.A. Kuiper, Ministry of Defence, DG Policy, Strategy Director, Policy Development and Innovation

Mr J.G. Kuijper, Ministry of Defence, Director of the MIND centre for innovation

Commodore A.R. Laurijssen, Ministry of Defence, Air Force Command, Materiel Maintenance Director

Mr H.J.J. Lenferink, Mayor of Leiden

Major-General M.T.J. Messerschmidt MPA, Royal Netherlands Military Constabulary, Deputy Commander of the Royal Netherlands Military Constabulary

Mr R. Nulkes, Netherlands Industries for Defence & Security (NIDV), Director

Prof. P. J. Oonincx, Netherlands Defence Academy, Dean of the Faculty of Military Science

Brigadier General M.L.E. Schmidt, Ministry of Defence, Defence staff, Planning Director

Ms H.J.M. Somsen, Cyber Security and Nation-State Actor Threats Director, NCTV

CIRCULAR ECONOMY & THE ENVIRONMENT UNIT

MD – Ms M.H. Wijngaard
 Mr T.J.A. Wagenaar
 Prof. L.M.C. Buydens, Radboud University Nijmegen, Institute for Molecules and Materials, Analytical Chemistry
 Prof. S.R.A. Kersten, University of Twente, Faculty of Science and Technology
 Mr R.P. Lapperre, Ministry of Infrastructure and Water Management, Directorate-General Environment & International Affairs
 Ms M. Rietbergen, Design Innovation Group
 Mr B. Rüter, Rabobank
 Ms J.C.M. Sap
 Mr M. Waas, Nouryon

ENERGY TRANSITION UNIT

Mr A.C. de Jong
 Mr G.J. Lankhorst, VEMW
 Mr J. Atema, NAM, General Director
 Mr H. Fennema, Gasunie, CEO
 Mr A.F. Gaastra, Ministry of Economic Affairs and Climate Policy, Director-General
 Mr M.E. Galjee, Nouryon, Energy Director
 Prof. M.P. Hekkert, Utrecht University, Professor
 Prof. P.M. Herder, Delft University of Technology, Professor
 Mr J.W. van Hoogstraten, EBN, CEO
 Prof. N.J. Lopes Cardozo, Eindhoven University of Technology / Netherlands Organisation for Scientific Research, Exact and Natural Sciences
 Mr R. Miesen, NWE Generation SE, CEO
 Ms M. Minnesma, Urgenda, General Director
 Prof. A. Polman, Amolf/University of Amsterdam, Scientific Group Leader
 Mr Y. Sebregts, Shell Global Solutions International B.V., EVP Technology and CTO

HEALTHY LIVING UNIT

Mr P. van Dijken
 Prof. H.A.P. Pols
 Ms L.T. Bouwmeester
 Ms G.M. Fijneman, Zilveren Kruis (health insurer), Chair of the Board
 Prof. A.J. van Gool, Radboud UMC, Professor of Personalized Healthcare
 Ms A.W.M. de Groot, FNV trade union, Director of Policy, Strategy & Lobbying
 Ms M.E.Y. Koster, Janssen-Cilag B.V., Lead, Strategic Alliances Netherlands
 Mr T.A.J. Oostrom, Dutch Kidney Foundation, Director
 Mr H.J. Smid, ZonMW, Advisor

INDUSTRY UNIT

Mr A.P. de Jong
 Prof. E.M. Meijer, 'Standard Bearer' for the Dutch chemical industry
 Mr P. M.T.M. van Attekum, Synovac BV
 Prof. F.P.T. Baaijens, Eindhoven University of Technology, Rector Magnificus
 Prof. S.C.M. Bentvelsen, Nikhef, Director
 Mr J. ter Harmsel BSc, Zeton BV, Managing Director
 Mr H. van Houten, Royal Philips, CTO
 Prof. P.F. Levelt, Royal Netherlands Meteorological Institute, Head of R&D, Department of Satellite Observations
 Mr P. J. Nieuwenhuizen, Enerkem, VP Strategy & Development
 Mr P. M. Smeets, Ministry of Economic Affairs and Climate Policy, Directorate-General for Business and Innovation
 Mr H. Tappel, Bronkhorst High-Tech B.V., General Director
 Mr M. Wubbolts, Corbion, CTO

INFORMATION & COMMUNICATION TECHNOLOGY UNIT

Mr H.J. Vink
 Mr R. Penning de Vries
 Ms S. Heukelom-Verhage, Pels Rijcken, lawyer and partner
 Mr S.B. Luitjens
 Mr T.D. Poelhekkens, Koninklijke KPN B.V., CTO
 Prof. M.R. van Steen, University of Twente, Scientific Director, Digital Society Institute

STRATEGIC ANALYSIS & POLICY UNIT

Ms S. van Kooten
 Prof. K.M. Becking, Nyenrode Business University, Chair of the Executive Board and Rector Magnificus
 Prof. N.M.P. Bocken, Maastricht University, Maastricht Sustainability Institute (MSI)
 Ms M. Demmers, Natuur & Milieu, Managing Director
 Mr P. A.J. Geluk, The Boston Consulting Group
 Prof. M.L.P. Groenleer, Tilburg University, Scientific Director, Tilburg Center for Regional Law and Governance
 Prof. R. de Jong, Retired Member, Executive Committee, Royal Philips
 Mr R. Zonneveld, InnovationQuarter, Director

MOBILITY & LOGISTICS UNIT

MD – Ms E.P. Lastdrager
 Mr M.B. Unck, RET NV (Public transport operator in Rotterdam), CEO
 Ms M.M. de Jager, Royal Dutch Touring Club, CEO
 Mr P. van Nunen, Brainport Development N.V., Director
 Prof. G. Odekerken-Schröder, Maastricht University, Professor of Customer-Centric Services Science
 Mr R. Paul, Chair, Board of Supervisors, Portbase
 Mr B. Schultze, Royal IHC, Managing Director
 Mr A. Toet, Sequel Work, strategic advisor
 Mr G. Veenstra, Keolis Nederland, Head of Corporate Affairs

GAME CHANGER IN 2021

DIGITALLY RESILIENT WITH AUTOMATED SECURITY OPERATIONS

Rapidly increasing digitalisation is making the Netherlands more susceptible to cyberattacks. In some cases, a cyberattack can go unnoticed for a long time and it can take targeted entities days to weeks to mount an adequate response. The Automated Security Operations (ASOP) consortium offers innovative solutions to ensure resilience in the face of cyberattacks, both today and in the future. ASOP has developed a cloud-based security platform for automation of cybersecurity operations to enable implementation of changes in the IT infrastructure at machine velocities. What makes this platform unique is that it enables end users to automatically identify, detect, and respond to cyberrisks, empowering organisations to control their cyberrisks and Dutch cybersecurity firms to strengthen their international competitive position.

Partners: The core partners in the ASOP Next Generation Security Platform are BiZZdesign, KPN, VMware, TNO, the City of The Hague, the Ministry of Economic Affairs and Climate Policy, and the Zuid-Holland provincial authority

[Read more: Automated security solutions | TNO](#)



**INFORMATION & COMMUNICATION
TECHNOLOGY UNIT**



GAME CHANGER IN 2021

SAFER EUROPEAN ROADS THANKS TO TRUCK PLATOONING

Truck platooning sees lorries drive closely together in small convoys using an automated driving support system. It improves traffic flow, increases road safety, saves fuel, and reduces carbon emissions. The ENSEMBLE project is now elevating truck platooning to the next phase.

The partners on the ENSEMBLE project are going for multi-brand truck platooning, which means that each lorry in a convoy behaves correctly in every traffic situation. TNO developed the platform that allows the systems in the lorries to communicate with each other. Launched in 2018, the ENSEMBLE project has already run platooning trials with lorries from seven different manufacturers, paving the way for further development across Europe.

Partners: DAF, Daimler Trucks, Iveco, MAN Truck & Bus, Renault Trucks, Scania, and Volvo Trucks

[Read more: Safer European roads thanks to breakthrough in truck platooning | TNO](#)



TRAFFIC & TRANSPORT UNIT

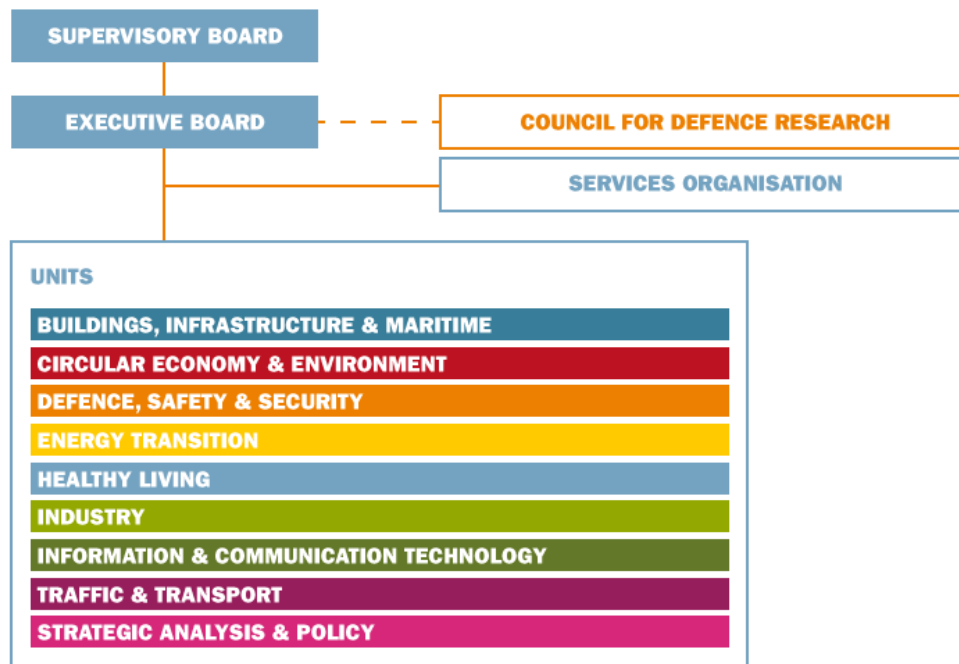


TNO ORGANISATION

As this chart shows, the core of TNO comprises nine units.

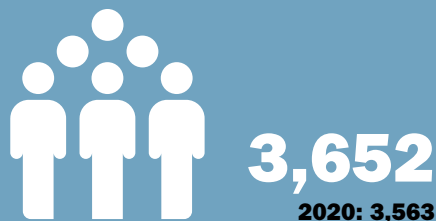
The Managing Directors of these units report to the Executive Board. The Executive Board and the units are supported by the Services Organisation. The Executive Board reports to the Supervisory Board.

The Defence Research Council has specific legally defined powers with respect to the Defence, Safety & Security unit.



TNO: KEY FIGURES

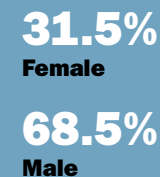
NUMBER OF EMPLOYEES AS AT 31 DECEMBER



NATIONALITY



GENDER RATIO ALL OF TNO



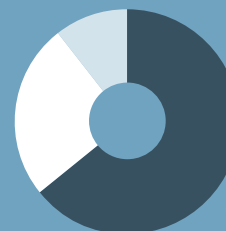
SICKNESS ABSENCE



FULL TIME/PART TIME

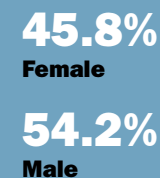
21.4% Part time 90% - 100%

11.9% Part time < 90%



66.7% Full time

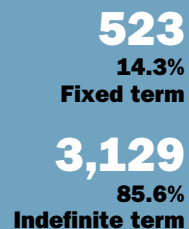
GENDER RATIO TNO SENIOR MANAGEMENT (EB, SB AND 1ST ECHELON)



EMPLOYEE ENGAGEMENT



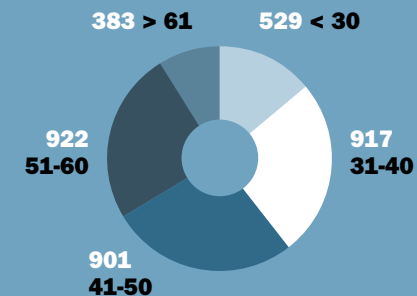
CONTRACT



RECRUITMENT NEW HIRES IN 2021



BREAKDOWN BY AGE



TNO: KEY FIGURES



	2021	2020	
STATE FUNDING	268.7	258.8	+ 3.8% ↑
MARKET REVENUE	291.2	282.2	+ 3.1% ↑
TOTAL	559.9	541.0	+ 3.4% ↑

PATENTS

Active patents



868 -1.4% ↓
2020: 880

First filing*

*First filing of a patent application on a specific date



58 -36.3% ↓
2020: 91

PROFESSORS AND LECTURERS



68 +4.6% ↑
2020: 65



FINANCIAL INDICATORS

(in millions of €)	2021	2020	2019
TNO consolidated result			
Operating income	572.5	553.5	553.9
revenue	559.9	541.0	534.7
other operating income	12.6	12.5	19.2
Revenue breakdown			
Market revenue	291.2	282.2	292.1
State funding	268.7	258.8	242.6
Costs			
Operating expenses	546.9	540.7	537.7
personnel costs	362.4	356.5	340.2
impairments	-	4.7	1.7
Net result			
Net result	45.4	65.6	15.4
result from participating interests	26.7	52.0	3.6
Cash flow for the financial year			
	38.8	105.3	5.8
Capital			
Operating capital invested ¹	418.3	361.3	297.9
Equity	374.3	328.9	263.3
Solvency ratio ²	56%	54%	53%
Assets			
Tangible fixed assets	219.9	204.7	192.5
Investments in tangible fixed assets	44.1	46.3	42.3

¹ Invested operating capital = total balance sheet – current liabilities

² Solvency ratio = equity divided by total capital

	2021	2020	2019
Staff			
Number of TNO employees (average FTEs)	3,278	3,243	3,079
Number of FTEs at year's end	3,337	3,263	3,173
Number of group company employees (average effective)	2	3	2
Number of group company employees (effective as at year's end)	2	3	2
Number of FTEs at year's end	3,339	3,266	3,175
Average number of FTEs	3,280	3,246	3,081

FINANCES AT A GLANCE

NOTES TO THE CONSOLIDATED FINANCIAL STATEMENTS

Result

The result for TNO excluding participating interests was €20.2 million positive.

With a healthy volume of work, sufficient orders coming in, and the various homeworking options for employees, TNO weathered the second year of the Covid-19 crisis fairly well. During periods in 2021 when schools and childcare facilities were closed due to government-imposed restrictions, as in 2020 employees were once more offered the option to, in consultation with their manager, take special leave. New employees whose induction period was split up into remote induction and on-site induction received special attention.

Though the number of billable hours per employee was lower than planned in 2021, the number of FTEs increased and, as a result, net revenue was higher than expected. Operating expenses were lower than expected in 2021, which contributed significantly to the result. Expenses were down in a number of specific areas of expenditure, with travel and accommodation expenses and direct project expenses showing the sharpest decrease. On the other hand, the operating expenses include a one-off item recognised under the other provisions that relates to onerous leases. The above factors led to a net result of €20.2 positive after tax, not including the result from participating interests.

A gain of €25.2 million was realised on participating interests. This includes an exceptional one-off result of €26.2 million from the sale of TNO's remaining minority stake in First Dutch Innovations.

[Click here for the 2021 financial statements.](#)

NOTES TO THE FINANCIAL STATEMENTS

Revenue

Revenue was up €19.8 million, rising to €559.9 million in 2021. Both market revenue (€9.9 million) and revenue from state funding (€9.9 million) showed an increase. Under market revenue, contracts from foreign customers (€9.2 million) and contracts from international organisations (€4.6 million) showed the most growth. Revenue from public contracts (€4 million), on the other hand, lagged behind the 2020 figure, while contracts from domestic customers remained stable. This result comes primarily on the back of one-off factors such as growth in capacity, a higher attendance rate, and lower costs as a result of Covid-19.

In 2021, the average ratio of public funding to market revenue was €1.00 to €1.08 (2020: €1.00 to €1.09).

Volume of work

The total volume of work at year-end 2021 represented a value of €492 million, up €121 million on the volume of work at year-end 2020 (€371 million).

Other operating income

Other operating income totalled €12.6 million in 2021, remaining at virtually the same level as in 2020 (€12.4 million).

Operating expenses

Personnel costs amounted to €362.2 million in 2021, an increase of €6.1 million compared to 2020. Of these personnel costs, €12 million went to higher wages and salaries, including for pension and social insurance contributions, as well as for changes in personnel provisions. This increase is due to the workforce growth in 2021, the increase in the employer's pension contributions, and the 1% one-off pay rise implemented on 1 January 2021. This is offset by a drop in costs incurred for

the engagement of external staff, which totalled €5 million, and the fact that other personnel costs were lower on balance, coming in at €0.9 million.

At €93.5 million, other operating expenses remained at virtually the same level as in 2020. Accommodation and energy costs, materials, general management costs, and outsourced work showed a net increase of €5.6 million. This increase is neutralised by a €6.8 million drop due to the lower costs of technical equipment, changes in facilities, other expenses, and contributions issued. Like in 2020, travel and accommodation expenses and expenses incurred to attend symposia and conferences were lower in 2021 than in pre-Covid-19 years.

Direct project costs rose from €60.7 million in 2020 to €66 million in 2021. This €5.3 million increase breaks down into a €3.7 million increase in project costs for materials and a net increase of €1.6 million in other project costs.

Depreciation charges were down €3.3 million in 2021 compared to 2020, coming in at €23.4 million due to impairments totalling €4.7 million that were recognised in 2020, while no impairments occurred in 2021. This is offset by higher non-recurring depreciation charges of €1.4 million.

Taxes

Corporate income tax returns for 2019 and 2020 have meanwhile been filed and we are awaiting confirmation by the Dutch Tax and Customs Administration.

The corporate income tax item in the profit-and-loss account is €5.7 million negative and consist of the following items:

- the immediate tax liability for 2021 and prior years totalling €6.5 million negative
- the movement in the deferred tax receivable of €0.8 million positive

Equity

Of TNO's equity totalling €374.3 million at year-end 2021, €135.6 million relates to TNO's projects for the Ministry of Defence.

The reserve for a new building for TNO's projects for the Ministry of Defence grew by €3.9 million in 2021, totalling €32.7 million at year-end 2021. This increase was the net result of additions to this reserve totalling €8.3 million and withdrawals for investments of €4.4 million.

The statutory reserve, containing non-distributable profits of group companies, decreased by €12.7 million.

Taken together, the above movements and the positive result of €45.4 million lead to a €54.2 million increase in the general reserve.

The general reserve has grown sharply over the past few years on the back of the sale of participating interests. Funds held in this reserve will, in coordination with the Ministry of Economic Affairs and Climate Policy, be used for strategic investments in research and innovation.

Liquid assets

At year-end 2021, the balance of liquid assets stood at €236.8 million (against €226 million at year-end 2020).

The €10.8 million increase in liquid assets in 2021 came as a result of various causes that are explained in more detail below:

On balance, tangible fixed assets were up €15.5 million. Coming in at €44.1 million (including €15.7 in investments funded from the government's 'Climate Envelope' funding pot), the investment level exceeded the depreciation charges of €28.4 million. Disinvestments amounted to only €0.2 million in 2021.

Working capital fell by €8.1 million, partly due to a transfer of €13 million in investment resources from the working capital to the investment resources equalisation account for non-current liabilities. Not until the assets funded from investment resources have been delivered will the transfer to non-current liabilities actually be effected. This €13 million change in working capital is offset by a net increase of €4.9 million.

Non-current liabilities showed a net increase of €10.4 million, primarily as a result of the aforementioned transfer of investment resources from working capital to non-current liabilities.

Taken together, the positive result including corporate income tax and excluding results from participating interests of €20.2 million and other balance sheet movements totalling €3.8 million drove up the liquid assets balance at year-end 2021 by €24 million.

Of the liquid assets, an amount of €64.2 million was reserved for public funding yet to be spent on the one hand and for the settlement of funds received in advance in the context of the coordinated partnerships on the other.

An amount of €32.7 million in liquid assets was also set aside for future investments in defence-related real estate.

Shortly after the start of the Covid-19 crisis, TNO reduced the payment term on procurement invoices from '30 days' to 'immediate payment upon procurement invoice approval.' This arrangement still applies.

The 2022 investment budget totals approximately €71 million, which is €45 million more than the depreciation charges.

Solvency

The solvency ratio was up in 2021, rising from 53.8% at year-end 2020 to 54.6% at year-end 2021.

Number of employees

In 2021, the average number of FTEs went up by 35, from 3,243 in 2020 to 3,278.



APPENDICES

TNO innovation
for life



REPORT OF THE
EXECUTIVE BOARD

STRATEGY

REPORT OF THE COUNCIL
FOR DEFENCE RESEARCH

REPORT OF THE
SUPERVISORY BOARD

RISK MANAGEMENT
AND CONTROL SYSTEM

RESPONSIBLE
OPERATIONS

FINANCES

APPENDICES

RISK MANAGEMENT AND CONTROL SYSTEM

In addition to the 'Risk management and control system' section, this appendix will explain TNO's risk management practices in greater detail, along the lines of the various components of the COSO ERM model.

RISK VISION

Strategic translation

TNO will have to come through on any promises it makes. With this mind, TNO has defined priorities for implementation, among other things. Monitoring this means managing the promise and priority for each plan on a strategic and tactical level. Any risks jeopardising this are mitigated and continuously monitored in a transparent manner. Every year, there are three occasions to make any changes as necessary, including during the business reviews with TNO's Executive Board.

Operationalisation (ICF)

Translated to TNO's operations, the risks, control measures, and their validation are identified and registered in the Internal Control Framework (ICF). This is monitored and updated very frequently and dynamically in the executive processes.

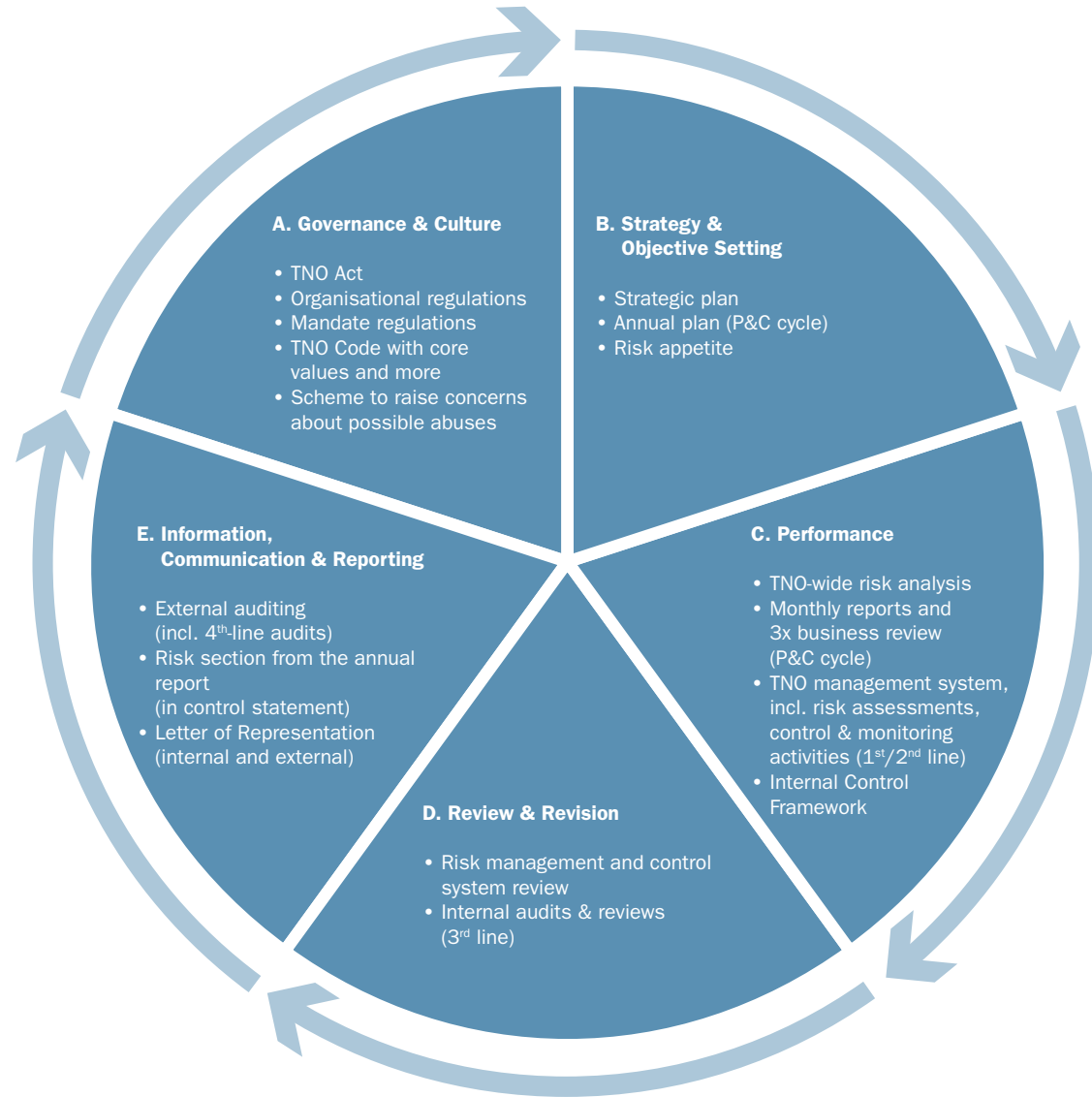
LINES OF DEFENCE

The lines of defence model that TNO uses has been implemented as follows:

- First line: controlled execution of the primary process by all TNO employees within the internally and externally defined frameworks in order to achieve the objectives concerned.
- Second line: support for, and monitoring of, the correct execution of these activities.
- Third line: internal audits of primary and secondary processes at TNO, focusing on quality, health and safety, the environment, compliance, internal financial and administrative control, and efficiency.
- Fourth line: audits by third parties, focusing on financial aspects (such as by the external auditor) but also on non-financial aspects. This includes quality audits of ISO certificate requirements, IT audits, Knowledge Position Audits, and inspections of compliance with laws and regulations (such as permits relating to health, safety, and the environment).

COSO ERM

The COSO ERM model that TNO uses has been organised as follows and will be explained further below:



A. GOVERNANCE & CULTURE

The TNO Act¹ sets the following objective: ‘The Organisation’s object is to conduct applied technical and scientific research and associated social sciences and other applied research in an effective manner to serve the public interest and particular interests within that domain.’

The organisational regulations, including the mandate regulations, stipulate mutual responsibilities as well as powers and obligations. A system of internal mechanisms for advice and approvals ensures adequate checks and balances as part of careful preparations for decision-making.

TNO’s organisational culture and conduct hinge on four core values: integrity, independence, professionalism, and social commitment. Various tools are used to actively encourage the target behaviour, including the TNO Code, the scheme to raise concerns about possible abuses, the integrity organisation, the central compliance function, the external and internal complaints procedure, and policy instruments such as the outside activities policy and the data protection policy.

The TNO Code puts into operation a number of important core values for ethical behaviour. Every TNO employee confirms that they will comply with the TNO Code upon commencement of employment, and will be asked to take regular note of it and of any changes to.

¹ Act of 19 December 1985, regulating the Netherlands Organisation for Applied Scientific Research, TNO, Art. 4.

B. STRATEGY & OBJECTIVE SETTING

Risk management is linked to TNO’s strategy and annual targets. The TNO annual plan sets out the main risks and control measures relating to these annual targets. It is the role of the portfolio holder on the Executive Board to assess whether the mitigation measures taken are adequate and to, if necessary, initiate additional measures, in accordance with TNO’s risk appetite.

The Managing Director of each unit is responsible for implementing the TNO strategy and for carrying out their department’s annual plan. The annual plans specify the risks and measures for the objectives, as well as TNO-wide risks. Implementation of control measures is the Managing Director’s responsibility and included in their performance management review as an objective.

C. PERFORMANCE

Progress made on the strategic plan and the annual plans, including the risks identified and control measures defined, is monitored on a periodic basis. Each month, a unit’s results for the preceding month are discussed by its Managing Director and the controller, as well as by the COO and the CFO. Three times a year, each unit’s management team and the Executive Board hold a business review on the basis of milestones and KPIs, during which progress is assessed and any necessary adjustments are made. The business review includes a progress review of risks and measures.

TNO management system

All TNO processes and procedures are recorded in the TNO management system. Internal control measures have been laid down on this level in process descriptions and work instructions (first and second lines of defence). The primary process of TNO conducting research, for example, has a ‘dynamic risk management’ element to it. Research projects start with a risk assessment and the risks identified are monitored dynamically through progress reviews held roughly every six weeks (first and second line of defence combined).

Internal Control Framework (ICF)

This framework is intended to provide comprehensive insights into the main risks, the controls associated with them, and to how these are documented. In this context, ‘comprehensive’ means that all kinds of risks – strategic, operational, compliance-related, and financial – are assessed in their interrelationships across the entire TNO organisation. This also brings any ‘white spots’ (less evident/uncovered risks) into focus. The Internal Control Framework also establishes a link between the risks assessed and the risk appetite that the Executive Board articulated. Finally, the Internal Control Framework is intended as a verifiable substantiation of risk-control efforts, so that TNO can issue an ‘in control statement.’ In 2021, the focus was on risks and control measures related to finance.

Finances

Target	Risks	Controls/Management Steps
Reliable and healthy finances	Unreliable control information	<ol style="list-style-type: none"> 1. Planning and control cycle: framework letter, bottom-up budget process, adoption of budget, adoption of annual plan, monthly reporting, monthly review, and forecasting. 2. Description of the financial model, definition of target values, translation of target values for the various units, follow-up on improvement plans, and inclusion of these in the budget.
	Inadequate financial accountability	Process-based and data-driven checks to guarantee accuracy, timeliness and completeness of financial data reported.
	Inappropriate use of public funds	<ol style="list-style-type: none"> 1. Predefined process within the Knowledge Procedure. 2. Formulating Knowledge Plans for projects paid for entirely through state funding. 3. The use of state funding in mixed funding is audited by the Internal Audit Committee. 4. The monitoring of projects with regard to time, content, and money. 5. End-of-year review by Corporate Control of the use of state funding in mixed funding.
	Non-compliance with tax legislation	Tax Control Framework.
	Insufficient insurance coverage	Risks are identified and insured in consultation with the insurer.
	Non-compliance with European tendering rules	<ol style="list-style-type: none"> 1. Capacity planning for the procurement department. 2. Spend analysis. 3. Tender reporting.

Compliance

Target	Risks	Controls/Management Steps
Compliance with laws, regulations, and ethical standards.	Non-compliance with sanctions and laws and regulations regarding export controls.	<ol style="list-style-type: none"> 1. Risk-based checking of all opportunities and/or projects for risks with respect to i) international sanctions, ii) permit requirements when exporting controlled technology. 2. Applying for the required permits.

The Internal Compliance Programme (ICP), an integrated part of the Internal Control Framework, is geared towards controlling non-financial risks that may affect TNO’s social licence to operate and right to play. Compliance with laws and regulations and ethical standards is guaranteed by, among other things, the creation of a central compliance role held by the Head of the Corporate Legal & Compliance department, who is supported in this role by the Compliance Officer and Integrity Officer. The function of the central compliance role is to identify and raise any concerns about compliance, suggest frameworks for compliance, and monitor progress in implementing policy. In 2021, the action plan for this programme was further fleshed out by adding greater detail to the tasks and responsibilities in the second of the three lines of defence.

One component of the ICP is the Export Control Internal Compliance Programme that ensures that TNO verifiably complies with the requirements of international sanction and export control laws and regulations. Implementation of the compliance organisation continued in 2021², enabling TNO to issue an in control statement with respect to compliance with export control and sanctions.

In the area of IT, risks were differentiated in terms of the availability, reliability, and integrity of systems and data. Control measures that are deemed necessary are detailed in various security guidelines, and include data and document classification and compartmentalisation, the separation of functions with layered roles and rights, and the monitoring of compliance with agreed procedures. TNO has organised the security of its systems and data in line with the principles of ISO 27001.

² See page 34 of this Annual Report.

These security measures include data-processing agreements with providers of externally procured IT solutions. These agreements are audited by an external party, which, among other things, carries out an ISAE 3402 audit. In addition, TNO's external auditor audits relevant business management systems for information security as part of the overall audit of the financial statements. This includes general application controls, such as automated separation of functions and system access.

The Information Security Management System (ISMS) was implemented in 2021. The ISMS is used to monitor IT risks and to gain insights into the effectiveness of control measures. In 2021 and 2022, the ISO 27001 controls and management steps respectively were successively activated in the ISMS. The aim is for all controls defined to be carried through successfully and verifiably at least once in 2022. TNO has, therefore, set the ambition to obtain ISO 27001 certification.

D. REVIEW & REVISION

The Operational Excellence & Auditing department conducts internal operational and financial audits. The Supervisory Board has signed off on a three-year cycle for implementation of the auditing plan, which is based on the risk analysis and process descriptions across TNO in the TNO management system. The audit focus is primarily on the organisation, existence, and functioning of internal controls, and secondarily on the effectiveness and efficiency of processes. The internal auditor, who comes under this department, reports directly to TNO's Executive Board and liaises with the Audit Committee of TNO's Supervisory Board. Audit reports are thus discussed with the Executive Board and fed back to the Supervisory Board's Audit Committee. The outcomes and recommendations serve as input for various improvement processes. In addition, within the expertise groups, Knowledge Leadership Audits take place periodically in each of TNO's areas of expertise. These are

conducted by committees made up of certified experts, who assess the quality and societal relevance of TNO's knowledge base.

The internal audits performed in 2021 did not return any significant findings and recommendations with respect to internal controls and the administrative organisation. Most of the findings concern mainly the further improvement of operational efficiency and effectiveness.

Risk management and control system review

To complement the Internal Control Framework, a more top-down and strategic approach was taken in 2021 for the TNO-wide risk analysis as it existed until 2020. The initial experiences are very positive. It was agreed to evaluate this approach after two years. The results are detailed under 'Performance'.

The internal evaluation of the risk management and control system resulted in the following emphases for further developments. The emphasis for 2022 is on strengthening TNO's Internal Control Framework and the ensuing risk management policy among other things by implementing the concept of risk appetite on a larger scale at the organisation. Once the new CEO has taken office in 2022, the risk appetite will be updated. In 2022, the focus will be put more fully on those elements of the Internal Control Framework that have received less attention so far, such as the other elements of operations and topics that are pertinent, from an operational perspective, in the primary process. It is expected that the in control statement can be extended to include IT operations in 2022, given that the ISMS will then have been operational for a full year.

E. INFORMATION, COMMUNICATION & REPORTING

The TNO organisation is audited by various external bodies every year. The most important are the following:

- TNO's management system, under ISO 9001, is audited by Det Norkse Veritas GL.
- The financial statements, efficacy of state funding spending, fees, and approximately 150 grant projects are audited by an external auditor.
- Compliance with security legislation and regulations is audited by the Dutch Military Intelligence Service (MIDV) and the Dutch General Intelligence and Security Service (AIVD).
- Compliance with working conditions and environmental legislation and regulations is audited by Dutch Customs and the competent authority within one and another permit-issuing authority.
- Quality audits at labs for Good Laboratory Practice and ISO standards. The outcomes of these external audits do not concern material findings.

Any recommendations made based on audit outcomes are implemented. TNO's Executive Board is required to issue the external auditor with a Letter of Representation along with the annual report. TNO has an internal Letter of Representation procedure in place for this purpose. Under this procedure, the main managers and controllers are asked to co-sign the Letter of Representation to attest the completeness and accuracy of the data provided and the adequacy of risk controls in the report. In its annual report, TNO renders account on its risk management performance and practices in the 'Risk management and control system' section, which includes this appendix.

CORPORATE GOVERNANCE

STANDARDS FOR GOVERNANCE AND OVERSIGHT

TNO, the Netherlands Organisation for Applied Scientific Research, was founded by law in 1932. For close on 90 years, TNO has been connecting people and knowledge to create innovations that boost companies' competitiveness and increase wellbeing across society in a sustainable way.

'Corporate governance is a set of rules, standards and institutions for the administrative set-up of the organisation, intended to ensure adequately supervised ethical, responsible and transparent operations.

The corporate governance set-up is based on the specific legislation governing TNO, i.e. the TNO Act. TNO is also governed by the Code of Conduct for Applied Research Institutes (*Gedragsregels voor TO2-organisaties*), which are included in the Dutch government's 'Vision for applied research' (*Visie op toegepast onderzoek*), and by the 'Common system of standards for financial management and oversight of semi-public institutions' (*Gemeenschappelijk normenkader voor financieel beheer en het toezicht semipublieke instellingen*).

TNO is an organisation governed by public law. TNO is committed to adhering to the governance code for companies (2016 Corporate Governance Code) and governance code for public sector organisations (2015 Governance code for public service providers (*2015 Code goed bestuur publieke dienstverleners*), even if TNO is not legally required to adhere to these codes.

The rules of procedure for TNO, the Executive Board, the Supervisory Board, the CDR, the SABs, and the Works Council comprise TNO's organisational regulations along with the Mandate Regulation. These regulations stipulate mutual responsibilities as well as powers and obligations.

The Mandate Regulation gives a precise indication of the powers granted within the organisation. A system of internal mechanisms for advice and approvals ensures adequate checks and balances as part of careful preparations for decision-making.

THE EXECUTIVE BOARD

The members of the Executive Board are appointed by the Crown, with one member appointed at the recommendation of the Minister of Defence and the chair and other members appointed at the recommendation of the Minister of Economic Affairs and Climate Policy. They are remunerated in compliance with the Senior Executives in the Public and Semi-Public Sector (Standards for Remuneration) Act (*Wet normering bezoldiging topfunctionarissen publieke en semipublieke sector* [WNT]).

The Executive Board is responsible for governing TNO: for defining objectives, policy and strategy, for implementing these, and for the ensuing results. As required under the TNO Act, the Executive Board applies a peer management system.

THE SUPERVISORY BOARD

The Chair and the members of the Supervisory Board are appointed by the Crown for a term of five years. Members can be reappointed for one further term. They are remunerated in line with the Senior Executives in the Public and Semi-Public Sector (Standards for Remuneration) Act (*Wet normering bezoldiging topfunctionarissen publieke en semipublieke sector* [WNT]).

The Supervisory Board is responsible for overseeing the Executive Board's policy and its implementation as well as for supporting it in an advisory capacity. The TNO Act and the organisational regulations specify the decisions for which the Executive Board needs the Supervisory Board's approval or consent.

COUNCIL FOR DEFENCE RESEARCH

The Council for Defence Research adopts the policy that the Defence Division will pursue, in accordance with the relevant provisions set with respect to the Executive Board.

The Council for Defence Research supervises implementation of the strategy and the structure and sustainment of the long-term defence knowledge base and the associated risks. The Chair of the Council for Defence Research is also an Executive Board member, representing the Defence Division.

EMPLOYEE PARTICIPATION

Employee participation at TNO takes the form of the Works Council and Unit Committees. Members of the Works Council are elected by the employees of TNO. The Works Council debates all matters relevant to employees in general and TNO as an organisation, issuing solicited and unsolicited advice to the Executive Board.

There are also Unit Committees for each unit. The unit's Managing Director has regular meetings with the Unit Committee for their unit to discuss matters related to it. There is also a Unit Committee for the services organisation (SO).

STRATEGIC ADVISORY COUNCILS

A Strategic Advisory Council is made up of leading individuals from across business and industry, the public sector and knowledge organisations. These members are appointed by the Executive Board for a term that runs concurrently with that of the Strategic Plan. Seeing as a new strategy period starts in 2022, the composition of the SACs changed as of 1 January 2022.

The SACs have advisory competences with regard to setting priorities generally and to selecting research priorities and programmes in the field the unit in question covers. They identify external developments in the field the unit covers, and share these with the board of the unit.

Each SAC meets at least twice a year, and their meetings are attended by a member of the Executive Board. The Chairs of the SACs are invited at least once a year for strategic deliberations by the Executive Board.

DIRECT TNO SUBSIDIARIES

TNO has transferred its participating interests to three holding companies: TNO Tech Transfer Holding B.V., TNO Affiliates Holding B.V., and TNO International Holding B.V.

TNO Tech Transfer Holding B.V. is a venture capital company that administers shares – often minority stakes – in spin-off companies. Creating a spin-off is a business transaction in which TNO pursues equality and transparency. TNO is not involved in the day-to-day operations of the interests it has transferred to TNO Tech Transfer Holding B.V. Aside from that, TNO enters into agreements with these spin-offs on market terms, such as the leasing of TNO facilities or the provision of a licence to intellectual property rights owned by TNO, such as patents and know-how. An exit policy also applies to these participating interests, focused on the divestiture by TNO of its remaining shareholdings in the medium term.

TNO Affiliates Holding B.V. holds shares in other Dutch entities that are not TNO spin-offs. For reasons related to transparency, taxation, or cooperation with third parties, these entities are kept at arm's length from TNO.

TNO is generally more actively involved in these entities than it is in participating interests that are held by TNO Tech Transfer Holding B.V. Moreover, no exit policy applies to these entities.

TNO International Holding B.V. holds shares and similar stakes in TNO's branch offices outside the Netherlands. These branch offices were set up for reasons related to transparency, taxation, and risk management.

› PUBLICATION DETAILS

› If you would like to find out more about TNO, or have questions after reading this report or any ideas you would like to share, please drop us a line: info@tno.nl.

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