




TNO Annual Report 2023



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[2023 financial statements](#)

About this report: The Annual Report 2023 describes TNO's general objectives and strategy and the results of the year, and focuses only on TNO as a legal entity under public law. In the annual report, we apply the guidelines of the IFRS Foundation's Integrated Reporting Framework as far as possible. The contents of this report are a translation. In the event of discrepancies, the original Dutch version of the annual report shall prevail.

The value creation model (see page 6) shows which sources of capital TNO uses to make an impact on society. We describe them briefly below. **Relationship capital** (ecosystems): parties collaborating in ecosystems, shared standards and values, stakeholder trust, and brand and reputation value. **Intellectual capital** (knowledge): knowledge and know-how in research, including Intellectual Property (IP) and patents. **Human capital** (employees): our diverse group of employees with their competences, skills, motivation, experience, and work capacity. **Physical capital** (facilities): facilities used by TNO to develop knowledge. These include buildings as well as the installations and equipment. **Natural capital** (natural resources): the soil, air, water, biodiversity, and mineral resources used by TNO in its processes and the impact TNO has on the environment (e.g., nitrogen emissions). **Financial capital** (funding): the financial resources with which TNO funds its research, but also the capital available to TNO to invest in, for example, facilities.

Preface by the CEO

Dear business contact,

In 2023, technological developments are following one another in rapid succession. Just look at how AI and, for example, ChatGPT are becoming established, with a growing impact on our society. All these technologies have the potential to contribute to solutions for a safe, healthy, sustainable, and digital society.

We at TNO work to achieve this on a daily basis. Because innovation is what connects us. We are constantly searching for new solutions and we assist the Dutch government in formulating and implementing policies based on factual information and scientific insights. We do so together with numerous partners.

Innovations do not stop at national borders. This means that TNO needs to be well aware of what is happening around us and how we can respond to developments. A good and competitive Dutch innovation climate is essential for the overall wellbeing of our society. Of great importance here is increasing the cumulative innovation effort of the Netherlands to at least 3% of GDP. This is a rise of 30%, or more than €6 billion a year. As a key player in the Dutch innovation ecosystem, increasing the overall innovation effort is also a key objective for TNO.

Last year, we were able to conclude that TNO is a healthy and fast-growing organisation. And we were shown to be an attractive employer. We attracted more than 740 employees in 2023, including from abroad. This makes our organisation even stronger, more diverse, and more inclusive. Further growth is also necessary to meet our objectives and make a sufficient contribution to strengthening Dutch society. To do this in a sustainable and responsible manner, we continue to work on strengthening the foundation of our corporate social responsibility.

Next year, we will focus even more strongly on areas in which we excel. Where we are a leading innovator – and where our contributions have the most impact. We do so based on a thorough understanding of market and societal needs in relation to the regional and global competitive environment. This will help us make an even greater impact in 2024.

On behalf of the Executive Board,

Tjark Tjin-A-Tsoi
Chair and CEO



‘A good and competitive Dutch innovation climate is essential for the overall wellbeing of our society.’



TNO key figures



Relationship capital

Number of PPPs*

1,067 ▲ 6.7%
2022: 1,000

Revenue of PPPs (in millions of €)

211.8 ▲ 20%
2022: 176.5



Intellectual capital

Professors and professors of applied science***

62 ▼ 4.6%
2022: 65

Publications and proceedings***

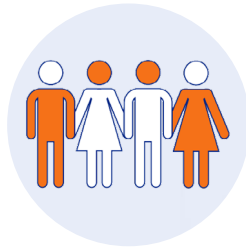
846 ▼ 11%
2022: 951

Patent families***

937 ▲ 7%
2022: 876

Premier depot**/***

67 ▲ 21.8%
2022: 55



Human capital

Number of FTE Workforce*** (as at 31 December)

4,178 ▲ 4.7%
2022: 3,991

New staff

744 ▲ 18%
2022: 631

Internships

435 ▲ 8.4%
2022: 401



Physical capital (in millions of €)

Tangible fixed assets

241.9 ▲ 3.6%
2022: 233.4

Investments

45.4 ▼ 19.6%
2022: 56.5



Natural capital

Carbon footprint (kilotonnes of CO₂-eq)

178 ▲ 1.2%
2022: 176

EcoVadis score

48/100
2022: 48/100



Financial capital

Revenue (in millions of €)

687.8 ▲ 16.4%
2022: 590.7

Research hours (million)

3.3 ▲ 3.1%
2022: 3.2

Total business valuation of spin-offs (in millions of €)

331.5 ▲ 36.6%
2022: 242.7

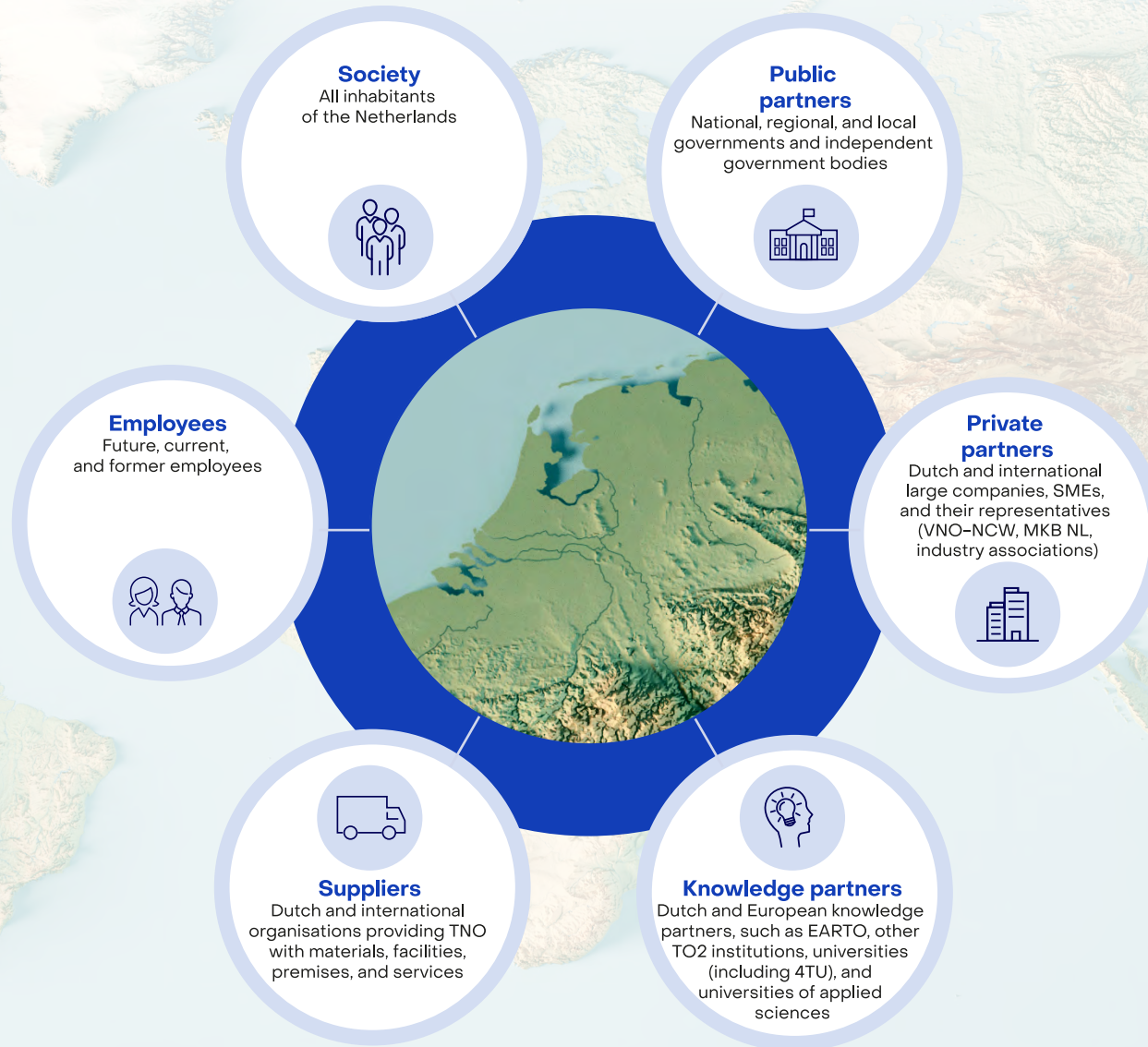
* Public-private partnerships.

** First filing of a patent application on a specific date.

*** In 2023, a limited assurance statement was issued for this KPI by EY. The Appendix explains the definition of this KPI.



Stakeholders



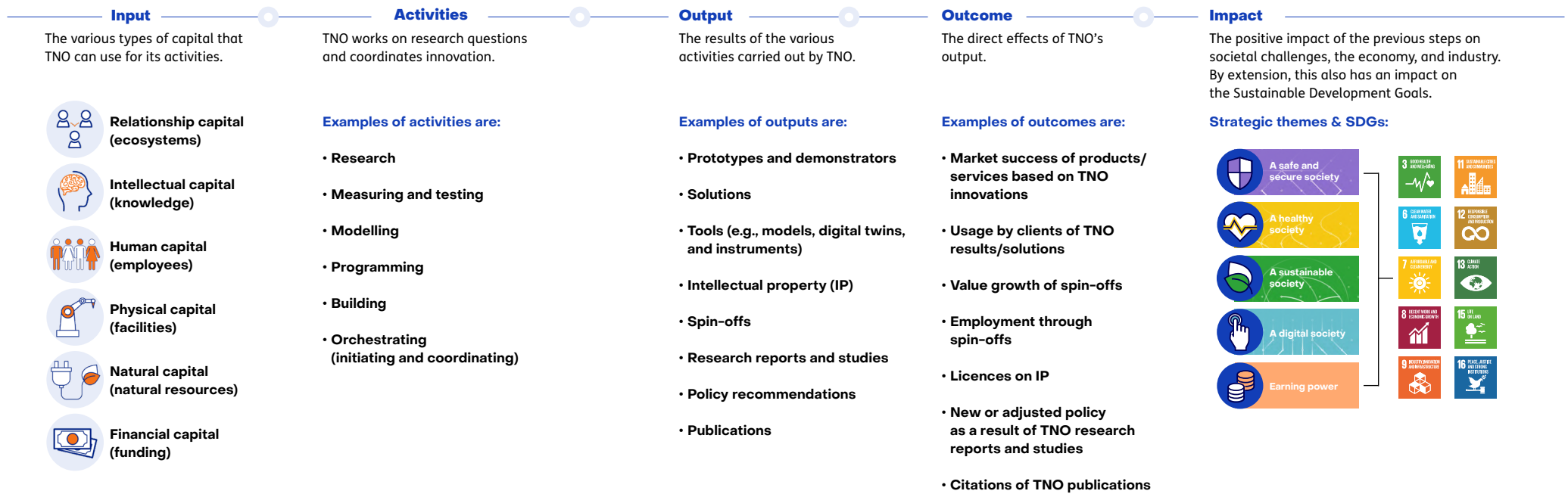


Value creation

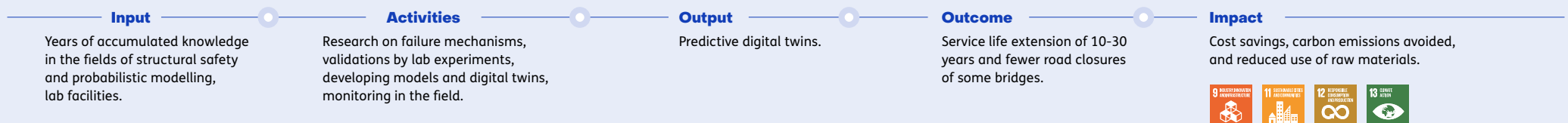
TNO is an independent research organisation established by law in 1932 to conduct technical, natural and social scientific research in the public interest, and to make this knowledge applicable for governments and companies. The organisation has the statutory task of maintaining, strengthening, and updating the knowledge base for the Dutch government in a number of key public research areas, such as Defence and the Geological Survey of the Netherlands.

For the purpose of developing and applying knowledge, TNO receives funding from the Dutch government. It carries out assignments for both public and private parties. Below, we show how we create value for our stakeholders.

TNO's mission: Creating impactful innovations for the sustainable wellbeing and prosperity of society.



Example: extending the service life of bridges*



*The example illustrating the value creation model is a summary and not exhaustive.



External developments



Events in the outside world affect TNO in many ways. We translate national and international challenges, trends, and developments in society into innovations for the future. We explain the most important developments for TNO below.

General trends

Geopolitical tensions, such as the conflicts in Ukraine and the Middle East, put great pressure on the international community. Moreover, these tensions reinforce calls for greater strategic autonomy. This manifests itself, among other things, in the 'chip war' between China and the US, which has an impact on Dutch companies, such as ASML. The increasing focus on knowledge security is also connected to this. At the same time, we see technologies such as Quantum and Artificial Intelligence (AI) evolving rapidly, with a growing influence on a variety of sectors, from healthcare to defence.

The extreme weather conditions of 2023 have further raised awareness of climate change. Countries and communities are working together to adapt and take action to prevent further climate change. This is accelerating the transition to renewable energy and circular materials. At the same time, there is growing awareness that climate adaptation will be inevitable, and this in turn raises other issues.

Innovation helps solve societal challenges, such as an ageing population and labour market shortages, but it is also a driver of the economy. New needs and opportunities for innovation arise especially in times of major transitions. TNO can play a crucial role in these developments, but the speed of change requires us to constantly adapt the interpretation of our strategic vision of the future and accelerated innovation.

According to the latest definitive figures for 2020, total R&D spending in the Netherlands just reached the EU27 average at 2.31% of GDP, but it was behind leaders with similar innovation systems, such as Sweden (3.49%), Belgium (3.38%), and Austria (3.22%), as well as industrial powerhouses such as South Korea (4.81%), the US (3.45%), Japan (3.26%), and Germany (3.13%).¹

As a member of the Knowledge Coalition², TNO supports the aim of a gradual increase in total R&D spending up to 3% of GDP, to be achieved within a 10-year period. Only in this way can the Netherlands continue to compete with international frontrunners and maintain its competitiveness and, by extension, earning power.

Developments supported by the public sector

In summer 2023, the fourth Dutch government led by Prime Minister Mark Rutte collapsed. The major ambitions in science and innovation were not fully achieved in the year and a half that the government was in power. Elections were held in November 2023. At the time of writing this annual report, negotiations to form a new government were still ongoing and the implications for innovation policy and TNO's position and role in it were still unknown.

Increasing programme funding

With regard to innovation and applied research, the government continued its active role last year. It is not only the Ministry of Economic Affairs and Climate Policy but also specialist ministries in particular that are increasingly engaging with TNO. In consequence, programme funding from those ministries has continued to increase, while institutional funding by the Ministry of Economic Affairs (apart from wage and price adjustments) has not. Programme funding by the Ministry of Defence in particular grew substantially in 2023. As a result, TNO has greatly expanded capacity in this research field. As well as regular additions to programmes for short-term research, large-scale, multi-year research collaborations were again defined in 2023. In addition to the ongoing 'Zero-Emission Construction' programme with the Ministry of the Interior and Kingdom Relations and the construction sector, the multi-year programmes 'Pandemic Preparedness by Ventilation (P3Venti)' and 'Lifestyle Coalition', for example, have also started with programme funding from the Ministry of Health, Welfare and Sport.

Knowledge and Innovation Covenant (KIC)

The KIC 2024-2027 was signed on 2 November. In doing so, companies, knowledge institutions, public authorities, and other organisations reaffirmed their joint commitment to the Mission-driven Top Sectors and Innovation Policy (MTSIP) for the coming years in the Netherlands. In this covenant, TNO has indicated which part of state funding it plans to use on MTSIP themes for public-private partnerships (PPPs) with participating

¹ These figures are from Eurostat, December 2023.

² The Knowledge Coalition is a partnership in the field of Dutch research and innovation, comprising the universities (UNL), universities of applied sciences (VH), University Medical Centres (NFU), the Royal Netherlands Academy of Arts and Sciences (KNAW), the Netherlands Organisation for Scientific Research (NWO), the Confederation of Netherlands Industry and Employers (VNO-NCW), Small & Medium-Sized Enterprises in the Netherlands (MKB-Nederland), and the institutions for applied research (TO2 Federation).



companies from the top sectors. As part of this, TNO, in coordination with the Ministry of Economic Affairs and Climate Policy and other ministries, gave additional impetus to key technologies (including quantum), circularity, the built environment, cleantech, Artificial Intelligence & digital robustness, and security & strategic autonomy.

National Technology Strategy (NTS)

The Ministry of Economic Affairs and Climate Policy presented a National Technology Strategy in early 2024. TNO provided intensive support to the Ministry in drafting this updated basic list of key technologies. These are technologies in which the Netherlands excels scientifically and in which scientific and economic growth are expected in the coming years.

Public-private partnerships

Revenue from competitive funding (public-private partnerships) increased sharply last year. The size of direct public-private partnerships with companies remained more or less the same, but collaboration in National Growth Fund projects increased substantially.

The results of the third round of the National Growth Fund were announced in June 2023. TNO is involved in 13 of the 18 proposals approved by the committee. In the coming years, the NGF's approval will lead to additional funding of around €279 million for TNO research over the entire period.

The basic principle of the Public-Private Partnerships allowance (PPP allowance) subsidy scheme was simple until the end of 2023. For every euro a company contributed to research and development by a research organisation, the Ministry of Economic Affairs and Climate Policy added €0.30. That PPP allowance had to be used for research and development. Until the end of 2023, the distribution of this supplement was based on what is called the realised basis, which consisted of companies' contributions to the studies. This automatically resulted in a strengthening of successful research areas. The Ministry of Economic Affairs and Climate Policy has decided that from 2024, the Top Sectors will start allocating this PPP allowance, which will continue under the name PPP Innovation Scheme. And that they will do so more on the basis of content-related choices and prospects. This means more uncertainty for TNO regarding the continuation of certain successful research areas. TNO has discussed with the Ministry of Economic Affairs and Climate Policy that the impact on TNO's research programme will be closely monitored, so that the scheme will remain at least as successful for developing new technology for the Netherlands.

The major challenges facing society call for systemic changes. Public-private innovation plays a key role in making those changes happen. The Netherlands has an extensive toolbox to support public-private innovations, but these tools are no longer a sufficient match for the new way of innovating that is needed for such systemic changes. TNO is advocating for change together with other knowledge institutions and innovation funders. A change from competition, fragmentation, closed consortia, lengthy decision-making, and detailed plans in advance to mission-driven, long-term, and adaptive collaboration in dynamic consortia, guided by coordinators with authority.

Applied Research Facilities

In the coalition agreement of the fourth Rutte government, a budget for applied research facilities was made available following the previous evaluation of the TO2 Federation (the Dutch organisations for applied research). In a first round of the Applied Research Facilities (ARF) scheme established by the Ministry of Economic Affairs and Climate Policy, three proposals by TNO were awarded funding. At the same time, it has become clear that there are still many proposals for TNO facilities on the Strategic Agenda for which no funding has been allocated as yet. The independent external advisory committee also notes that the budget for implementing the Strategic Agenda is not sufficient and trusts that a new government will therefore make additional funds available.

European collaboration and Horizon Europe

Research and innovation do not stop at the borders of the Netherlands. We can also strengthen the knowledge base of the Netherlands by working closely with leading international knowledge partners, companies, and public authorities. The knowledge we develop or acquire in the process benefits Dutch industry and helps to resolve issues in our own society.

Like its predecessors (FP7, Horizon 2020), the ninth European Framework Programme Horizon Europe 2021-2027 is a key tool for TNO to engage in EU-level collaborations. In 2023, 56 new Horizon Europe projects were launched, with the estimated value of TNO's share in these projects exceeding €30 million. In addition, TNO is again active in the European Defence Fund and Digital Europe programme, among others.

Knowledge security

In light of the aforementioned geopolitical tensions and the quest for greater strategic autonomy, all Dutch knowledge institutions, led by the Ministry of Education, Culture and Science, have also worked on improving knowledge security over the past year. For TNO,



the emphasis was on the identification of sensitive knowledge and technology areas by the Dutch Ministry of Education, Culture, and Science. A TNO-wide security awareness campaign explicitly addressed knowledge security.

Developments supported by the private sector

In practice, current Dutch private spending on R&D lags behind in an international comparison. The Netherlands spends 1.54% of GDP on R&D investment. With this rate, the Netherlands scores just above the EU average of 1.52%, but clearly below its 'peers', such as Sweden (2.52%), Belgium (2.49%), and Austria (2.24%), as well as major industrial powers such as South Korea (3.81%), the US (2.60%), and Germany (2.09%).³

If Dutch industry is to remain relevant and become less dependent on technological and other developments outside the Netherlands, innovations are needed. This is also underlined by major Dutch companies. Peter Wennink, CEO of ASML, states: "If you rely too much on other people's innovations and they create the value with which they fund their society, then you get into a position where you have nothing to bargain with and we must really watch out for that."⁴

Private R&D spending in the Netherlands is mainly dominated by a limited number of large companies (some of them international), such as ASML, Philips, Janssen, KPN, and DSM. Overall, these companies already spend a lot on research compared to their international peers, making further growth in this group unlikely. Research intensity should therefore be increased through new business activity in research-intensive sectors.

TNO can play a major role in driving innovation in sectors. By using our research capacity, companies can reduce the cost of innovation: they do not have to maintain facilities and research staff themselves for occasional projects that are new to them, or that are not part of their core business. In addition, collaboration increases the chances of an innovation project succeeding, as companies can build on TNO's broad and deep knowledge base, and our experience with previous – possibly similar – innovation projects. In this way, R&D, and thus innovation, will also become available to SMEs in the Netherlands.

³ These figures are from Eurostat, December 2023.

⁴ Source: ASML CEO Wennink on the chip war (nos.nl)

Knowledge chain developments

European Research & Technology organisations

Many partners in the knowledge chain are located in the Netherlands. But TNO has also intensified its collaboration with some European colleagues, such as Fraunhofer Gesellschaft (Germany), VTT (Finland), Imec (Belgium), and CEA (France). During President Macron's state visit to the Netherlands in April 2023, CEA and TNO signed a Memorandum of Understanding. This memorandum serves as a driver of our strategic collaboration, especially in the field of energy. For example, by contributing knowledge to the creation of a new solar panel industry in Europe and strengthening both countries' hydrogen strategies. In addition, our CEO, Tjark Tjin-A-Tsoi, has joined the board of the European Association of Research and Technology Organisations (EARTO).

TO2 Federation

TNO collaborates in the TO2 Federation with the other four Dutch applied knowledge institutions: Deltares, MARIN, NLR, and Wageningen University & Research. Because the portfolios of the various institutions are complementary, we join forces in various fields and projects. Some great examples of such collaboration are highlighted in the [annual TO2 impact report \(in Dutch\)](#). Every year, the institutions jointly organise the TO2 Day, on which they use a theme to illustrate the impact of applied research.

Universities

Intensive collaboration with universities and universities of applied sciences (hereafter: universities) is an essential element of TNO's strategy. Universities engage in fundamental research, among other things, which TNO is keen to build on. Moreover, the knowledge of universities often complements that of TNO. Universities are also places from which young researchers can take the next step in their development, through a job at TNO.

TNO is strengthening its collaboration with universities in various ways. For instance, a sizeable group of TNO top researchers also work at universities as part-time professors. There were 54 of them at the end of 2023. Some 150 researchers conducted PhD research at TNO in 2023.



A procedure was set up this year to make it easier for TNO employees to start doctoral research, in which a university and TNO collaborate on TNO research areas.

TNO and universities are also partners in major national and international research programmes. Furthermore, joint research and innovation centres have been established, such as QuTech in Delft (with Delft University of Technology in the field of quantum technology), the Chip Integration Technology Centre (CITC) in Nijmegen (a public-private partnership including Radboud University), and the Brightlands Chemelot Campus in Geleen (with Maastricht University).

At the request of the National Growth Fund's assessment committee, we have been working with universities and investment companies in recent months to resubmit the NGF Delta Plan Valorisation proposal, in which we ensure a valorisation boost by increasing the number of spin-offs from universities and TO2 Federation institutions.



Strategy

Mission

TNO's mission is to create impactful innovations for the sustainable wellbeing and prosperity of society.

Vision

Innovation is crucial in realising a secure, sustainable, healthy and digital society...

As we navigate the first half of the 21st century, we encounter several significant challenges. To shape a better future, society must limit climate change while also adapting to it. Our economy needs to foster innovation and competitiveness, while embracing sustainability, including circular practices. Our population is ageing, and we all want to lead longer, more prosperous, healthy lives – at work and at home. In a changing geopolitical landscape, marked by rising military conflicts and a greater emphasis on strategic autonomy, people are seeking greater security. Simultaneously, as societies grow more complex, there is a growing demand for reliable information to inform evidence-based policymaking and effective governance. We must harness the full potential of digitalisation and information technology to achieve these goals.

Technical novelties and scientific insights only have a significant impact on society and economic development if they are used, at scale, in the real world. Not every ingenious invention or insight meets a significant need or can feasibly be produced or adopted on a large scale. Therefore, a keen understanding of customer needs, international supply chains, and the broader landscape of national, European, and global market trends is vital. As global investments in research and development (R&D) surge, and value chains span multiple borders, the innovation arena is transcending national boundaries. It is increasingly becoming a fiercely competitive landscape, in which TNO has to articulate its right to play in each of the fields in which it is active. Just like any other region, country, or organisation, the Netherlands in general, and TNO in particular, must amplify their collective innovation efforts. This means leveraging our unique strengths in specific fields – those that hold the most promise – to secure sustainable competitive advantages and establish strategic footholds (control points) within global value chains.

... With TNO as leading innovator







TNO, as a trusted, independent, and pioneering applied science and technology organisation, plays a multifaceted role. We innovate, investigate, and orchestrate, collaborating closely with governments, universities and the private sector. We inform government on policies and empower evidence-based decision-making through rigorous investigations, cutting-edge scientific insights, and reliable measurements. By building national and international consortia and ecosystems, we drive technological and methodological breakthroughs that help to realise a secure, sustainable, healthy, and digital society, and strengthen the earning power of the Dutch economy.

TNO aims to help elevate the cumulative innovation effort in the Netherlands towards R&D investment of at least 3% of GDP, an increase of 30% (more than €6.7 billion) compared to 2022, mainly from private contributions. Therefore, we also have to increase TNO's innovation effort, as a core part of the Dutch innovation ecosystem. To maximise the impact of our innovative efforts, we concentrate on fields where we truly excel – where we lead the way in innovation – and where our contributions therefore have the most impact. We base our decisions in this regard on a thorough grasp of societal and market needs, a realistic assessment of emerging value chains and industrial hubs in the Netherlands, as well as the international competitive landscape. These factors co-determine the success or failure of an innovative effort. We remain committed until technical and social inventions evolve into successful innovations.

Together, we will forge a more focused and responsive organisation: one that thrives on collaboration and agility, where our employees can flourish, and where they feel empowered to create truly impactful innovations that contribute to the sustainable wellbeing and prosperity of society.

Stakeholders

TNO creates value for a wide range of stakeholders:

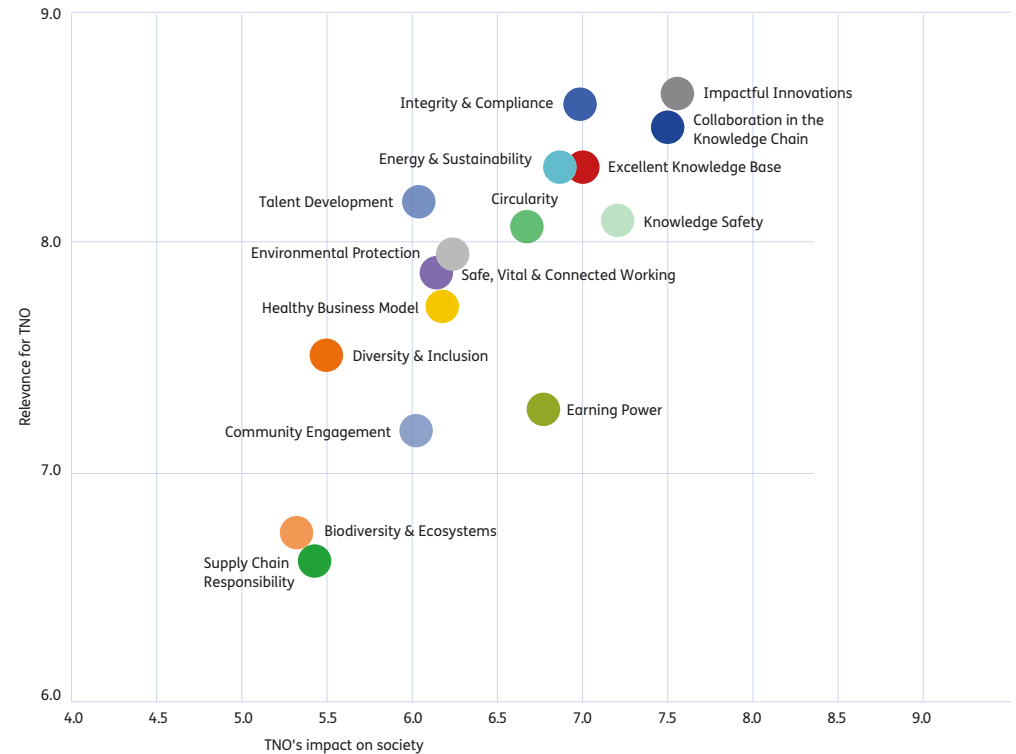
Stakeholder	Value created
 Society	Demonstrable impact with innovations applied to create a safe, healthy, sustainable, and digital society.
 Public partners	Sustainable knowledge development used for public policy and applied to meet societal challenges.
 Private partners	Product, service, and process innovation for greater earning power and innovative applications for more sustainable operations.
 Knowledge partners	Better knowledge development through collaboration on both research and the knowledge organisation.
 Suppliers	Generating revenue and encouraging responsible and sustainable business operations.
 Employees	Self-development with equal opportunities, resulting in engaged and motivated employees who contribute to societal impact.

Materiality analysis

To effectively create value for our stakeholders, it is important to understand which issues are significant to them. In addition to regularly measuring client satisfaction and employee engagement, we conducted a stakeholder analysis as part of our four-year Strategic Plan. We also conducted a materiality analysis at the end of 2022, in which we assessed a list of 16 material themes for relevance and degree of impact. In the analysis, we applied the principle of ‘double materiality’, by including both the ‘inside-out’ and ‘outside-in’ perspectives. The inside-out perspective looks at TNO’s impact on society, specifically Environmental, Social & Governance (‘ESG’) issues; the outside-in perspective

focuses on society’s external impact on TNO. The list of 16 material themes, including definitions, was drawn up on the basis of desk, peer, and media research, as well as TNO’s own strategy.

The resulting materiality matrix helps TNO determine the themes on which to focus its attention when forming its strategy, carrying out its activities, reporting, and in disclosures. It is clear from the results of the materiality analysis that the most material themes are close to TNO’s strategy: ‘Impactful Innovations’, ‘Collaboration in the Knowledge Chain’, and ‘Integrity & Compliance’. TNO’s top strategic priorities are described below. In our strategy, we seek to connect with the material themes from the materiality matrix.



Core tasks

TNO has two core tasks:

- The first core task is to support the Dutch government in carrying out statutory government tasks in the public interest. Through research and advice, TNO works on the one hand to provide facts and science-based insights as input for policy processes. On the other hand, TNO supports the effective and efficient execution of government tasks through research, consultancy, testing, and innovation. This ranges from research for the Ministry of Defence to mapping the subsurface, and from policy advice for all ministries to supporting the energy transition.
- TNO's second core task is to strengthen the earning power of the Dutch economy and increase employment through applied research, valorisation, innovation, and collaboration. TNO innovates on behalf of both private and public organisations. In addition, we develop intellectual property, for which licences are granted. TNO also founds new companies (spin-offs) based on technological innovations, in addition to other forms of valorisation. In this way, we support the pursuit of a competitive, innovative, and dynamic knowledge economy that will ensure prosperity in the Netherlands well into the future and provide the financial and economic capacity necessary to finance solutions to major societal challenges.



Representation of the themes from TNO's strategy and the SDGs to which they contribute.

TNO in the media

Last year, TNO was mentioned in some 1,900 articles in Dutch print media, such as newspapers and magazines, and 280 times in foreign print media. For online media, those figures are 2,500 mentions in the Netherlands and 400 abroad. Added to this are nearly 2,000 entries in blogs and on websites and similar platforms.

In 2023, our press officers received some 625 queries from more than 420 different journalists. We also approached journalists proactively. The top five media outlets that contacted us were: BNR, Volkskrant, Financiële Dagblad, RTL News, and Trouw. TNO employees spoke on the radio around 90 times and appeared on TV in some form 70 times in 2023.

Strategic Plan

In May 2021, the Strategic Plan 2022-2025 was submitted to the Dutch Ministry of Economic Affairs and Climate Policy. This plan is reviewed every year and it was sharpened in 2023.

Three times a year, the Executive Board discusses TNO's progress on its activities, impact, and strategic plan with the Teams of Directors of TNO's units. Key performance indicators are also discussed during these consultations. The units also regularly discuss implementation of the TNO strategy in their unit with their Strategic Advisory Council.

Impact

Scientific insights, technical inventions, and even 'demonstrators' are not in themselves innovations with impact. To achieve real impact, TNO focuses on the difficult last steps to the successful market launch of a product or service. This does not mean we should or can do this all by ourselves. We often collaborate with companies and public authorities that have extensive knowledge of the relevant end markets and value chains. In addition, the research portfolio is increasingly focusing on promising valorisation.

TNO constantly works to build a strong knowledge base and specifically follows relevant scientific and technological trends. A major trend in this context is the stronger emphasis that universities have also come to place on impact and valorisation. TNO sees this as an opportunity to seek and strengthen collaboration with universities. Various collaboration models are conceivable here.

TNO has an explicit ambition to increase its impact. Our unique knowledge and infrastructure built up over the past decades provide an excellent basis for tackling the important and complex societal challenges that we face.

Through its work, TNO contributes to achieving the United Nations' Sustainable Development Goals (SDGs). These sustainable development goals are a universal representation of the societal challenges facing the world. The Strategic Plan establishes a link between the strategic themes (safety, sustainability, health, and digitalisation) that TNO is working on and the SDGs to which these themes contribute, as shown in the image with SDGs. Since 2023, TNO has been the alliance coordinator of SDG 9 – Industry, Innovation & Infrastructure – for SDG Netherlands to further strengthen contributions to this goal.

Valorisation

It is very important for TNO knowledge to end up in new products and services that offer solutions for a safe, healthy, sustainable, and digital society. We 'cash in' on our knowledge (valorisation) by setting up spin-offs and granting licences, among other activities (see page 15). The Tech Transfer programme helps with valorisation by providing support in developing business cases, finding the best route to market, and encouraging entrepreneurship. The programme explores whether setting up a new company – a TNO spin-off – is a good route or whether granting a licence to an existing party is a better valorisation option. The aim is to maximise TNO's impact and get more TNO knowledge into the market faster.

Spin-offs

In 2023, TNO set up three new spin-offs, taking the total created since the start of the Tech Transfer programme in 2017 to 41. The value of these companies totals €331.5 million and they provide 631 jobs. Attracting external capital is important in the early years for these spin-offs to grow. A total of €273 million in external funding was raised, up from €66 million in 2023.

The spin-offs set up in 2023 are:

AIKON Health

AIKON Health develops wearable biosensors aimed at telemonitoring health information, such as heart monitoring. Heart failure is a common condition from which many people die. The risk of death is highest immediately after discharge from hospital following surgery. Remote monitoring of signs of heart failure can save lives, as it enables early detection and intervention. [Meet AIKON Health](#)



Peregrion

Advanced Accelerator Mass Spectrometer (AMS) technology and knowledge of microtracers are accelerating the development of new drugs. As a result, drugs can be made available to patients faster and more cost-effectively.

Enfoil

Enfoil enables manufacturers to integrate solar cells based on thin-film technology into various surfaces, such as shipping containers and roof tiles. The spin-off is based on knowledge and technology from imec, Hasselt University, and TNO (Solliance). [Meet Enfoil](#)



Licences and other IP transactions

Another form of valorisation is licensing to existing companies at home and abroad. But, of course, valorisation does not take place only in the form of new business activity. TNO grants many licences to existing companies in the Netherlands and abroad every year. Licensing is based on market rates taking into account the licensee's desired level of use. In this way, technology can be deployed in multiple sectors as efficiently as possible and a proportionate share of the underlying development costs is borne by actual application of that technology. If the technology is no longer considered strategic, TNO chooses to divest patent positions by selling them.

The majority of IP licences granted in 2023 were royalty-based transactions, where revenues depend on the turnover the licensee can achieve. In 2023, TNO earned €4.5 million from existing licences. Licence transactions are usually confidential in nature and cannot be disclosed unilaterally by TNO.

Electrolyser technology

As part of the energy transition, TNO is conducting research on electrolysers (including for hydrogen production). Advanced electrolyser cell test equipment is crucial for accelerating electrolyser development. TNO has developed and also licensed this equipment. The high-temperature Solid Oxide electrolyser (SOE) is the most efficient electrolyser currently available. TNO is working on the development of SOE cells and stack. It has now concluded a comprehensive licensing agreement with a company to bring this technology to market.



* Source: State of Tech 2023

Mobile telephony

The technology behind the current generation of mobile phones is highly standardised. This is the only way for phones and network equipment from different manufacturers to communicate seamlessly with each other.

Over the years, TNO has developed a lot of technology in this area, mainly through contract research. This has resulted in a number of Standard Essential Patents – patents for which a manufacturer must obtain a licence in order to comply with the underlying technical standard. These patents are largely valorised indirectly through companies TNO works with. TNO is also a member of several patent pools in which a large number of patent holders have pooled their Standard Essential Patents. A patent pool grants bundles of licences to manufacturers on behalf of patent holders on fair, reasonable, and equal terms. This reduces total transaction costs.

Small and medium-sized enterprises

Start-ups, scale-ups, and small and medium-sized enterprises (SMEs) are an essential part of the Dutch economy. They are active in all economic chains and play a crucial role in achieving key transitions, such as the energy transition, the growth of high-tech manufacturing, and improvements in healthcare. It is noticeable that the Netherlands lags behind our neighbouring countries in scaling up from start-up to scale-up.* Scaling up highly innovative start-ups to scale-ups is becoming increasingly relevant and increasing market share with this target group is one of TNO's priorities for the coming years.

To support these and other SMEs, we have launched TNO FastTrack. This platform – with a simple onboarding process – displays TNO's offer and our facilities. We put the company's query front and centre, and maintain speed with simple modules. Part of the programme is a pilot scheme in which a reduced introductory rate makes access to our services affordable. Moreover, pre-financing of feasibility studies is possible. Affiliated partners include the Regional Development Agencies, Invest-NL, incubators, and other investors. TNO wants to continue building this partner network in the coming years. In the past year, we conducted more than 250 intakes and launched 25 projects. Of these, four are now growing into larger projects. Internally, we worked hard last year to build an expert and committed team to support this TNO priority area.



In 2023, we also launched Fast Track Insights, a webinar series covering topics relevant to entrepreneurs. The first edition attracted more than 600 companies. This shows the growing need for this kind of knowledge exchange.

High-tech industry 2040

The rapid development of technologies such as AI, quantum, and photonics, together with societal challenges, are creating new opportunities for Dutch high-tech. To capitalise on these opportunities, companies, knowledge institutions, and government need to draw up a joint strategy, including structural funding for R&D. The sector makes an important contribution to the earning power of the Netherlands. TNO looked at how the sector can continue to deliver this value to society in the future. It is expected that by 2040, 50% of sales will be generated from new value chains, such as laser satellite communications and renewable energy equipment. To maintain the competitive position of the Netherlands in high-tech, the sector needs to become 150% more productive and transform into a 100% sustainable business. For greater strategic autonomy, TNO believes we need to build these new value chains and focus our innovation policy on them over the long term. This will give Dutch high-tech the potential to produce a handful of new ASMLs in the coming decades.

Time to market

It is no longer so much a question of whether an innovation will emerge, but more of who will come up with it first and thus reap the associated benefits. Speed – or in other words, a short time to market – is essential here. Acceleration is to a great extent an intrinsic part of our method of short-cycle innovation. TNO applies this way of working in research projects where an urgent question needs to be answered.

One example is the ‘Industrial Modular Prefabrication’ innovation programme, a sub-programme of the knowledge and innovation programme ‘Zero-Emission Construction’. The programme aims to implement measures that help reduce nitrogen and other emissions in the construction sector. TNO has the role of coordinator and knowledge partner in this programme. A special feature of the programme is the novel approach to innovation of the various parties – SMEs and other companies, knowledge institutions, and public authorities – with fast decision-making and agile procedures. Short-cycle working helps us arrive quickly at innovative validated materials and building concepts. Effective valorisation requires us to further improve our time to market, speed, and agility.

Focus and mass

The innovation landscape is becoming increasingly international and competitive. Therefore, the Netherlands in general and TNO in particular need to strengthen their

collective innovation efforts. That means combining our unique strengths in the most promising areas, so that we can secure the sustainable Dutch competitive advantage and establish strategic footholds in global value chains.

By bringing more coherence and focus to the research portfolio, TNO will be able to increase its impact while also becoming more effective and efficient. To achieve greater impact, specific ‘moonshots’ – TNO’s goals – were further developed in 2023. These goals must produce results before 2030.

Strategic programmes

Customer Excellence

We have clients and partners both in the public sector and in various segments of industry. If we want to further increase our social impact and potential, it is essential that we fully understand the complex context in which our clients and partners operate. For this reason, we launched the Customer Excellence programme in 2021, which we developed substantially last year. In 2023, we conducted market analyses, identified innovation needs, and held successful and enthusiastic meetings with potential clients for several pilot projects within this programme. Examples of pilot projects are Smart Industry, Medical Wearables, Circular Packaging, and Air Quality. In 2024, we want to run pilot projects in several sectors and focus on embedding the working method – adapted in some cases – in the TNO organisation, for example by offering training courses. In addition, a supportive Market Office has been set up, which conducts in-depth market analyses and investigates new markets and how to improve service to existing clients.

Systems thinking and system innovation

In our society, we increasingly face extremely complex problems and transitions, such as climate change, pandemics, and the energy transition. To solve these problems, we need to consider the context and all the facets of such a systemic change. Because our main goal is to achieve a demonstrable impact, our strategy focuses on understanding systemic changes and how to accelerate them. This is why we launched the Systems Innovations strategic programme, which aims to develop practical actions to address these complex societal problems. We want to foster collaboration between different parties and look at issues from multiple angles.



In September 2023, we presented a systems innovation concept map. This was used to develop a systems innovation knowledge agenda, which we will implement in the coming year. In addition, we have launched two research programmes focusing on systems innovation: Empowering Citizens Collectives and Sustainable ICT. The first systems strategies and practical actions, on nitrogen emission reduction and a healthy society, were ready in November 2023. We are also working on a systems strategy on Critical Raw Materials (CRM) and a 'Safe Digital North Sea'.

In addition, we held a well-attended TNO systems innovation event in May 2023, with over 100 participants. Last year also saw the publication of an article entitled 'Transdisciplinary Research: If it's so important, why aren't we all doing it?' This article was written in collaboration with the Center for Unusual Collaborations (Eindhoven University of Technology, Wageningen University & Research, Utrecht University, and Utrecht UMC) and was published in the AWTI newsletter.

In June 2023, TNO Vector was introduced to the market. This centre of analysis for societal developments considers how current challenges intersect and can be addressed collectively. Organising innovation begins by seeking collaboration between companies, public authorities, and knowledge institutions, taking account of societal acceptance, sustainability, safety, and economic growth. This is where TNO Vector plays an important role.

Fit and healthy organisation

TNO wants to facilitate a safe, healthy, and connected way of working, aimed at the sustainable employability of its staff. As an employer, TNO is also committed to diversity and inclusiveness, ensuring a workplace where everyone feels at home and is given equal opportunities to develop.

Due to the additional work from many different National Growth Fund programmes that TNO is involved in, and the sharply increasing amount of work for the Ministry of Defence, TNO expects to grow by around 30% by 2027, compared to 2022. This growth forecast will present TNO with a major staff recruitment and retention challenge in the coming years. Achieving this growth requires efforts in all parts of the organisation, coordinated by the Vital Organisation programme.

We have been increasing recruitment since 2022. With success, as some 740 new employees joined TNO in both 2022 and 2023. A significant proportion of these are internationals (non-Dutch employees), coming not only from Europe but also from the rest of the world.

In addition to recruitment, we pay at least as much attention to employee retention. The annual employee engagement survey and interim 'Pulse Surveys' reveal specific areas for improvement, both for the organisation as a whole and for departments and units specifically. A key theme is a greater focus on individual employees, their wellbeing, and their development. In 2023, among other actions, we therefore split up large research groups and departments, giving managers a smaller span of control. This enables them to give their people more attention. We also took several initiatives to reduce work-related stress and promote employee wellbeing and vitality, for example through hybrid working and reducing bureaucracy.

**Strategic theme:**

Safe and secure society

Protecting what we hold dear and ensuring that people can live together in freedom and safety: that is what we stand for. TNO is developing strategic knowledge, technology, and capabilities to achieve this. Maintaining our security is essential for our freedom, prosperity, wellbeing, and democracy. However, geopolitical developments make it clear that such security cannot be taken for granted and that the threats are becoming more complex. Europe and the Netherlands must stand up more strongly for their own interests.

Technology and innovation are increasingly making a difference in safeguarding freedom. The Dutch Ministry of Defence will therefore greatly strengthen its innovative capacity in the coming years. This will be done in close collaboration with industry and knowledge institutions, as well as with allies and other partners.

In a rapidly changing world, our mission is clear: to strengthen partnerships, promote collaboration, and build a strong, secure future for the Netherlands. Our main goal is to work with the Ministry of Defence and other stakeholders to effectively manage our shared portfolio.

We encourage collaboration between industry, government, and knowledge institutions to tackle complex security challenges in an integrated way. In addition to our substantial contributions to Defence, we are working to become the top institute for applied technological innovations within the justice and security domain in the Netherlands.



TNO's goal for 2030

→ **Seeing without being seen**

With our impact within the Safe and Secure society theme, TNO contributes to the following Sustainable Development Goals:





Strategic theme: Safe and secure society

TNO GOAL FOR 2030

→ Seeing without being seen

Obtaining accurate and up-to-date information is of vital importance to any military action. TNO is making sure that the Netherlands continues to be the global leader in the race to see without being seen. Together with the Dutch Ministry of Defence and the business community, we are developing the world's most advanced camouflage and sensor solutions. In this way, we are making sure that our country and our military personnel are and remain safe.

Technology and collaboration

A safe sea - Sea Bed Security

The North Sea is an area with a huge number of cables, pipelines, and wind farms that enable our energy supply, internet connections, and ultimately our democracy. Vital seabed infrastructure must be protected from sabotage and digital attacks. Innovative solutions and collaboration between various parties should help us perform this key task. In May 2023, TNO brought the protection of the North Sea to the attention of the Dutch House of Representatives and called for stakeholders to join forces and for new technologies to be deployed.

[Read more \(in Dutch\)](#)

Innovation

MilSpace 2 - Information-driven action by the armed forces

In the MilSpace2 project, SpaceX successfully launched the Norwegian-Dutch nanosatellites 'Birkeland' and 'Huygens' in early 2023. The MilSpace2 project is a collaboration between the Dutch and Norwegian Ministries of Defence, the Norwegian Defence Research Establishment (FFI), NanoAvionics, the Royal Netherlands Aerospace Centre (NLR), and TNO. The project aims to develop a more accurate geolocation capability for ground systems, such as radars. The satellites, which are named after Kristian Olaf Birkeland and Christiaan Huygens, are only the size of a milk carton

and will contribute to the information-driven action of the armed forces, in which space plays an essential role, according to the Defence Vision 2035.

The Strategic Mutual Assistance in Research and Technology (SMART) project highlights the military use of space (MilSpace) and scientific collaboration between the Netherlands and Norway. As well as improving geolocation capabilities, this mission provides an opportunity to gain experience in steering and adjusting satellites in orbit, which is not possible with the earlier BRIK II satellite.

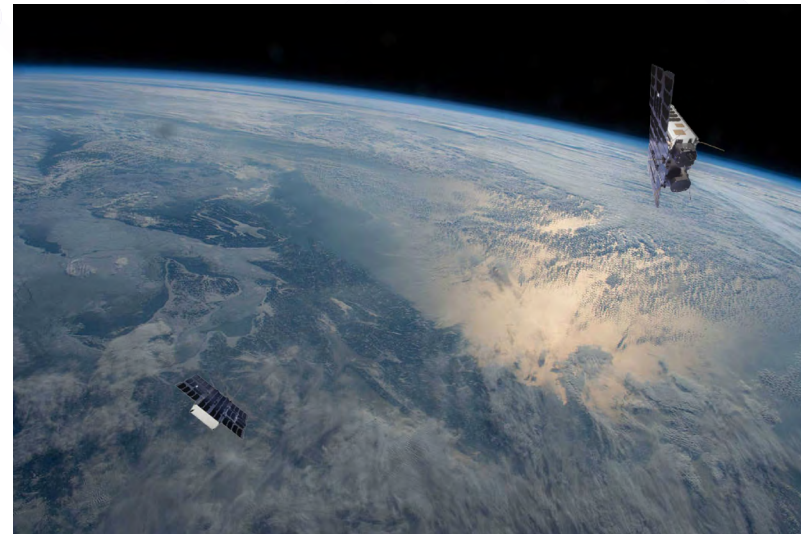


Photo: NanoAvionics



Strategic theme: Safe and secure society

Event

Opening SeaSEC

The Northern Naval Capability Cooperation's (NNCC) Seabed Security Experimentation Centre (SeaSEC) has been officially opened at Campus@Sea in The Hague. The Netherlands is working with Denmark, Germany, Finland, Norway, and Sweden to secure undersea infrastructure. The centre focuses on developing advanced techniques for monitoring the seabed to a depth of 30 metres to protect crucial elements such as pipelines, cables, and platforms with wind turbines.

SeaSEC researchers will use a vast amount of data from military and civilian databases in the six participating countries to create a virtual representation of the seabed and identify potential threats in real time. In addition, SeaSEC has a 10 x 10 nautical mile test area where researchers can carry out experiments with unmanned surveillance vehicles.

At the opening, extensive demonstrations were given by TNO in collaboration with industry.

Event

REAIM – First global conference on AI in the military domain

The first worldwide 'Summit on Responsible Artificial Intelligence in the Military Domain' – REAIM 2023 – took place at the World Forum in The Hague on 15 and 16 February. TNO took part in the conference, actively contributing to the discussion on the main conditions, opportunities, challenges, and risks related to military applications of AI. We also published a position paper on the subject. [Read more](#)



REAIM Responsible Innovation Demonstrations



[elands-2023-operationalization.pdf](#)

Event

Innovation in Defence - the Defence innovation fair

The Dutch Materiel and IT Command (ComDef), the Purple Nectar event, and the Innovation in Defence networking event teamed up in 2023 at the biggest Defence innovation fair.

At Kamp Soesterberg military base, visitors had the chance to see and experience the latest developments in Defence innovation. The results of the TNO, NLR, and MARIN research programmes were also presented. Later in the same year, Innovation in Defence organised two more days of in-depth sessions, called Deep Dives, to share extensive research findings widely within the defence organisation.





Strategic theme:

Healthy society

Improving people's health, both physically and mentally: that is our ambition. With opportunities for all children to grow up healthy and benefit from good health later in life. With active and healthy individuals using their talents and thereby contributing to a productive society. This requires innovation and continuous renewal in healthcare. The Dutch government has drawn up a number of missions for the coming years. The goal is that by 2040, all Dutch people will live in good health at least five years longer. And the health gap between the lowest and highest economic groups should have been reduced by 30%. To achieve these goals, TNO is working with partners on unique technology and knowledge, such as effective prevention and behavioural intervention, personalised digital health and lifestyle interventions, better drug development, a healthy, innovative work environment, and a healthy living environment.

TNO's goals for 2030

- Speed up the drug development process by 2 years
- A promising start for every child
- 50% reduction in lifestyle-related diseases
- Targeted approach to particulate matter brings big health gains
- A healthier old age simply by looking through your eyes



With our impact within the Healthy society theme, TNO contributes to the following Sustainable Development Goals:





Strategic theme: Healthy society

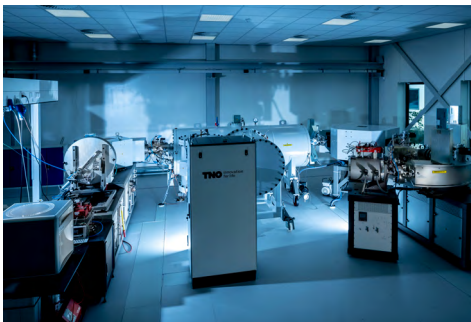
TNO GOAL FOR 2030

→ Speed up the drug development process by 2 years

To improve quality of life, prolong lives, and reduce healthcare costs, medicines need to be available faster and more cheaply. This decade, we will help accelerate the drug development process by two years. TNO and its partners are moving this goal closer to reality with microtracer technology and ongoing process innovations. Together we are contributing to the life of tomorrow. [Read more about this ambition](#)

Spin-off Peregrion

When drug research is done on human subjects, the medicine is made radioactive. This enables researchers



to track the drug through the human body. TNO has made it possible to reduce the radioactive dose by a factor of 100 by using an Accelerator Mass Spectrometer (AMS). This makes the process faster and less risky because the research can take place earlier in the development process and with fewer risks to the health of test subjects. The estimated time saving is two years out of a total development time of 12 years. In addition, TNO has developed a machine specifically for the AMS that reduces sample preparation time from five days to 12 minutes.

Innovation

Accelerating drug development using organs in a machine

Organ perfusion is a technique to keep organs viable outside the body with the help of a machine. To this end, TNO uses a heart-lung machine with, for example, an animal liver that is similar to human organs in terms of the way it functions. We receive offal with healthy organs to use in this research. The machine with its attached tubing mimics the functions of the heart and lungs, allowing the organ to work as it would inside a body. Once we've added a medication, we measure how the organ deals with it and how it responds to

the drug. This is an innovative method to test drugs and obtain reliable information on the behaviour of medicines in humans. The aim is to make drugs available to patients faster.

[Read more](#)



In recent years, this AMS application has proven to be of great added value for new drug development, resulting in a growing order book from the pharmaceutical industry. As a result, TNO has opted to carve out the routine AMS business to a wholly owned subsidiary set up for that purpose in 2023: Peregrion BV. This will enable us to give sufficient space to all new research activities. We now conduct AMS studies for a large number of Top 20 Pharma organisations, including Pfizer, Astra Zeneca, and Boehringer Ingelheim.



Explaining how drug development is accelerated using organs in a machine



Strategic theme: Healthy society

TNO GOAL FOR 2030

→ A promising start for every child

The first 1,000 days of life are crucial for children’s safe and healthy development. TNO develops measurement tools and interventions to optimise care and give child welfare professionals insight into the development of the very young. Our insights and innovations are of benefit not only to newborns, but also to unborn children and their mothers. With this broad view, we contribute to a promising start for all children, a healthier society, and lower healthcare costs.

[Read more about our ambition](#)

Innovation Centering

Starting in 2012, TNO and several partners developed a new model of care in the Netherlands, in which pregnant women receive antenatal care in a group setting and participants play an active role and provide input. This model (Centering) replaces the usual model of care in which pregnant women and new parents receive one-to-one care. Centering meetings involve basic medical care, with patients themselves having an active role. They exchange knowledge and experiences with each other, building a supported network.

TNO research has shown that the model leads to positive effects on maternal and child health. It has now been decided that midwives offering Centering can claim an additional fee from the health insurer



Oeuvre Prize

Stef van Buuren – winner of the 2023 H.A. Lorentz Oeuvre Prize

TNO’s prestigious H.A. Lorentz Prize was awarded to Prof. Stef van Buuren in 2023 for his body of work in groundbreaking applied scientific research with extraordinary societal impact. On Thursday 14 December at Teylers Museum in Haarlem, he received the award from outgoing Minister of Education, Culture and Science Robbert Dijkgraaf for his years of pioneering work on universal standards to measure and monitor children’s growth and development worldwide.

[Read more \(in Dutch\)](#)

from 1 January 2024. TNO believes that prevention can be practised even earlier and more widely. We are therefore focusing on researching a model with groups that participate continually from the pre-conception period up to and including the first 1,000 days after birth, also involving all chain partners and the social domain and neighbourhood.



Strategic theme: Healthy society

TNO GOAL FOR 2030

→ 50% reduction in lifestyle-related diseases

To live longer in good health, a healthy lifestyle is often the most potent medicine. We will help halve the number of people with lifestyle-related diseases such as diabetes and obesity within 10 years. TNO and its partners are making this possible with personalised interventions, help with behavioural change, and advice on policy. Together we are working to improve the life of tomorrow. [Read more about this ambition](#)

Innovation

A healthy lifestyle as the best medicine

Type 2 diabetes, a common lifestyle disease, was long seen as a progressive disease. It is now known that a timely and sustained lifestyle modification slows down and even reverses the disease process. Cardiovascular disease can also be positively influenced by lifestyle changes. Modifying one's lifestyle requires a behavioural change, which is sometimes difficult to maintain. But much can be achieved with the support of technology.

[Read more](#)



Collaboration

Lifestyle in Healthcare Coalition

The Dutch Ministry of Health, Welfare, and Sport has established the Lifestyle in Healthcare Coalition. The aim of this coalition is to promote the use of lifestyle interventions in the prevention and treatment of health problems. In September 2022, the Integral Care Agreement was signed by many healthcare parties. It set out that the Ministry of Health, Welfare, and Sport will provide funds from 2023 for a broad-based lifestyle coalition to implement 'lifestyle' in healthcare. The coalition's mission is that by 2025, lifestyle should be an integral part of mainstream healthcare, so that lifestyle interventions can be used effectively to make the treatment of health conditions, disorders and diseases unnecessary. The Lifestyle in Healthcare Coalition consists of parties active in and around lifestyle in healthcare - in care practice, policymaking, science and innovation, or otherwise. All these

parties are convinced that by working together in this coalition, they can give lifestyle an appropriate place in healthcare – more quickly and in a better manner. TNO is in charge of coordinating the coalition.



Listen to the podcast [Lifestyle diseases halved by 2030 \(in Dutch\)](#)

[Spotify](#) [Apple](#) [TNO podcasts](#)

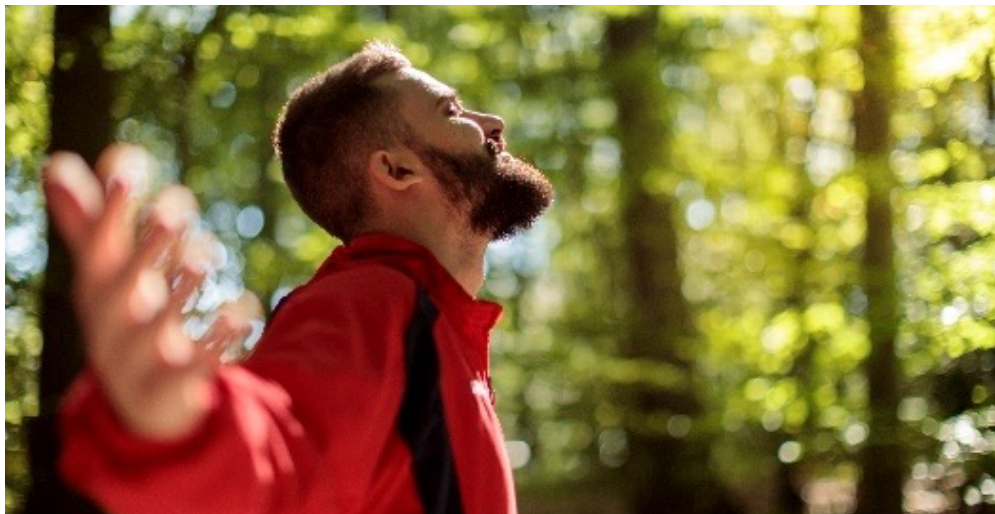


Strategic theme: Healthy society

TNO GOAL FOR 2030

→ Targeted approach to particulate matter brings big health gains

Inhaling particulate matter leads to 9,000 premature deaths in the Netherlands every year. The associated burden on society and healthcare costs run into billions. To take effective action, it is important to target the most harmful particles where they cause the greatest health risk. Using our models and measurements, TNO can precisely map the origin and harmfulness for each particle type. With these data, targeted measures can be taken that will enable a 50% improvement in health by 2030.



Innovation

Five-step 'Healthy Air Approach' plan for municipalities

TNO is introducing the Healthy Air Approach, a new way to help policymakers accurately map where and when people are exposed to poor air and which sources are responsible. In five practical steps, policymakers can improve outdoor air quality for residents.

TNO's Healthy Air Approach provides detailed information on air quality in a municipality or province.

We combine daily measurements with specific data on the locations where residents are during the day. This creates an accurate picture of the impact and origin of poor air quality. On this basis, you can make informed decisions on air quality management in relation to health.

[Read more](#)



I4D - TNO's Innovation for Development

TNO method adopted by the World Health Organisation

The World Health Organisation (WHO) has launched Global Scales for Early Development (GSED). This is a new method to assess the development of children up to 36 months using measurements that are culturally neutral, easy to apply, freely accessible, and understandable to caregivers and children. TNO was part of the team that developed the GSED package. With the 'Developmental score', we provided the main supporting structure of the GSED. In this way, we are contributing, through the WHO, to the global improvement of children's health. This result was achieved together with TNO Innovation for Development, which focuses on impactful innovations in low- and middle-income countries. [Read more](#)



Listen to the podcast [Boosting innovation and entrepreneurship in low- and middle-income countries \(in Dutch\)](#)



Strategic theme: Healthy society

TNO GOAL FOR 2030

→ A healthier old age simply by looking through your eyes

The older we become, the higher the risk of diseases such as Alzheimer's, Parkinson's, cataracts, and diabetes. An earlier diagnosis makes treatment easier, cheaper, and more promising. Thanks to TNO research and technology, by 2030, doctors will be able to detect common age-related ailments early, reliably, and in a patient-friendly way with a simple but very smart eye scan. This is how we are enabling healthy ageing and helping keep healthcare affordable.

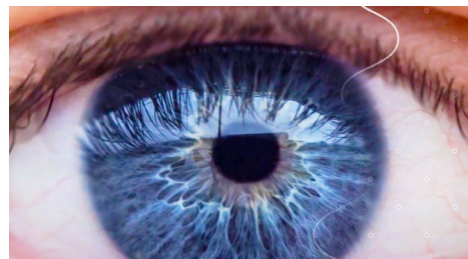
Innovation

Diagnosis through the eye with Retinal Imaging

The back of your eye, the retina, is considered to be a window onto your health. It is the only place in your body with direct visual access to vascular and neural structures. Better visualisation of diagnostically relevant features in the retina requires new innovative retinal imaging modalities.

In a public-private partnership with Heidelberg Engineering and VU University Amsterdam, TNO is developing a Scanning Laser Ophthalmoscope with functionality for retinal oximetry.

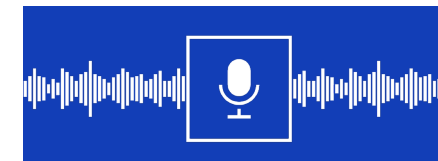
To check whether the Scanning Laser Ophthalmoscope really measures what it is designed for, TNO and the VU have developed a model eye setup for retinal oximetry.



Brains4Work

Short-cycle innovation for employment

With the Brains4 programme, TNO is helping find solutions to pressing issues. Each year, a different theme is put under the spotlight. In 2023, eight teams – under the name Brains4Work – set to work using their expertise to develop solutions to current labour market challenges. Supporting young people who are struggling to navigate the job market is one such challenge. Another is reducing the influence of bias in the recruitment and selection process when filling vacancies. The goal of the Brains4 programme is to arrive at an implementable innovation within a few months, in order to achieve an impact rapidly. [Read more](#)



Listen to the podcast [The impact of technology on employees \(in Dutch\)](#)

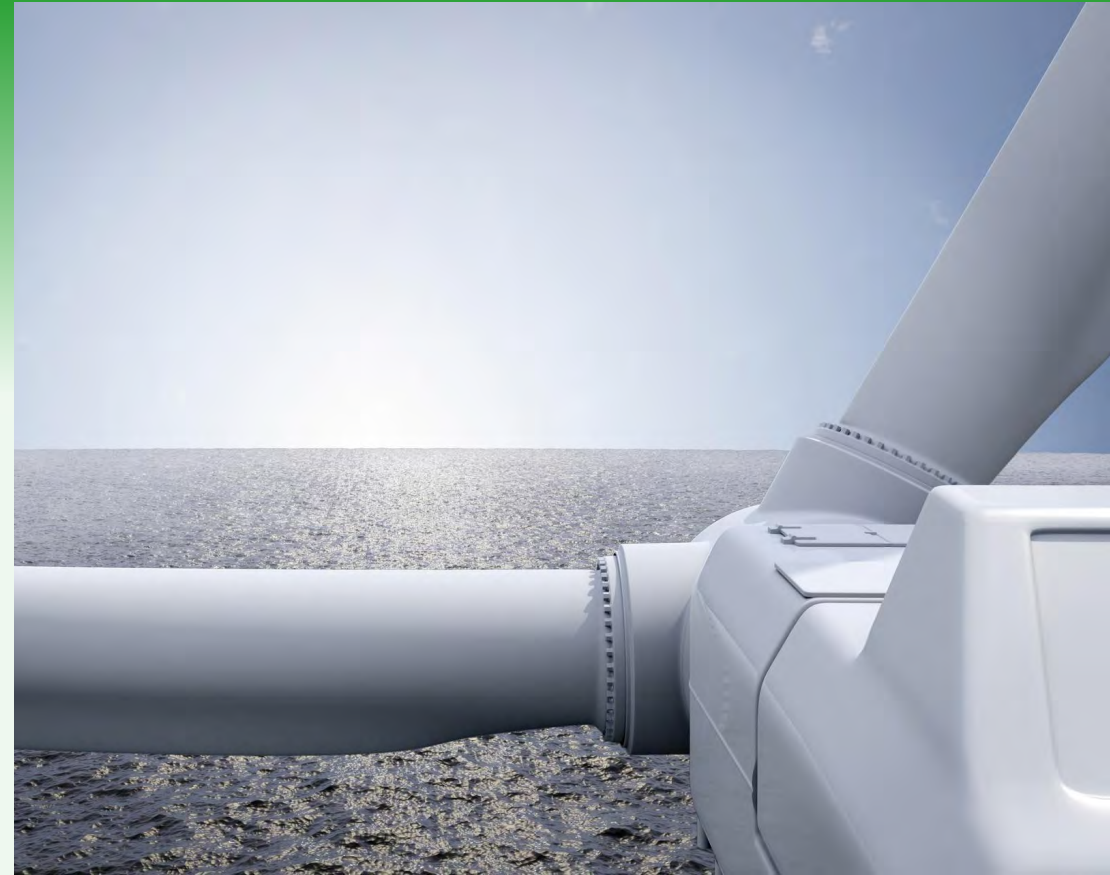
[Spotify TNO podcasts](#)



Strategic theme:

Sustainable society

TNO wants to contribute to creating a sustainable society. A society that is resilient to the changing climate and has a circular economy. To this end, we have to emit fewer harmful substances, build a circular economy, and be prepared for changes in our climate. To achieve this, we seek integrated solutions at the system level. These are solutions that create a balance between the changing needs of society, the environment, and the economy.



TNO's goals for 2030

- 50% of plastics will be circular by 2030
- Using any surface for renewable electricity
- Offshore green hydrogen for sustainable onshore industry

With our impact within the Sustainable society theme, TNO contributes to the following Sustainable Development Goals:





Strategic theme: Sustainable society

TNO GOAL FOR 2030

→ 50% of plastics will be circular by 2030

To combat resource depletion and climate change, it is essential to reduce plastic waste. Our ambition is for half of all plastics to be designed for circularity by 2030. TNO is developing scenario models for this circular transition. Together with our partners, we are working on new designs and production and recycling technologies. [Read more about this ambition](#)

Research

Recycling plastic food packaging

New European legislation states that by 2030, all food packaging must contain at least 10% recycled material, and by 2040, this must be 50%. We are currently only at 0.5% for widely used PP and PE packaging, so there is still a long way to go to meet the required quota. TNO is investigating how to dramatically improve the quality of recyclate.



Explanation on circular food packaging

Event

The Ocean Race – Tangible microplastics

During The Ocean Race, top-class sport is combined with science. In this competition, sailboats race around the world in eight to nine months. The motto of the 2023 edition was ‘Racing with Purpose’. One way this motto was expressed in practice was by collecting water samples. The boats visit many different parts of the world’s oceans, making the race an ideal opportunity for research. And what did we find out? The amount of microplastics is 18 times higher compared to the previous measurement from 2018. Between 11 and 15 June 2023, The Ocean Race visited The Hague. At the TNO stand at the Ocean Live Park, we made the problem tangible and concrete by showing what microplastics can look like, what their main sources are, and what can be done about them. [Read more](#)



I4D – TNO’s Innovation for Development Less plastic pollution in Indonesia

TNO is helping to reduce plastic pollution in Indonesia. Dutch-Indian social enterprise SweepSmart has set up a Smart Waste Centre that collects and sorts plastic waste on the island of Ambon. As a result, more than 800 tonnes of waste a year no longer end up in landfills and more than 30 formal, secure jobs have been created. TNO documented the impact of the project, receiving financial support from Partnering for Green Growth and the Netherlands Enterprise Agency (RVO). This project is part of TNO Innovation for Development, which focuses on impactful innovations in low- and middle-income countries. [Read more \(in Dutch\)](#)



Strategic theme: Sustainable society

TNO GOAL FOR 2030

→ Using any surface for sustainable electricity

To generate green energy on a large scale, we will have to be smart in using the scarce space available in the Netherlands. We will therefore ensure that within 10 years, any suitable surface can be used to generate renewable electricity. With due regard for the landscape and the natural world. Together with our partners, we are developing innovations such as floating solar farms and power-generating buildings and infrastructure. This is how we are helping to boost sustainability in the Netherlands. [Read more about this ambition](#)

Innovation

Floating solar panels

Much research is still needed to implement floating solar energy systems on a large scale. We do not yet know enough about the effect of wind and waves on solar panels and their service life under these special conditions. There are several field labs in the Netherlands engaged in testing solar panel islands, for example on the IJsselmeer and Oostvoornse lake. At the same time, research is being carried out there on



the ecological impact of these systems on marine life and water quality. [Read more](#)

Spin-off Enfoil

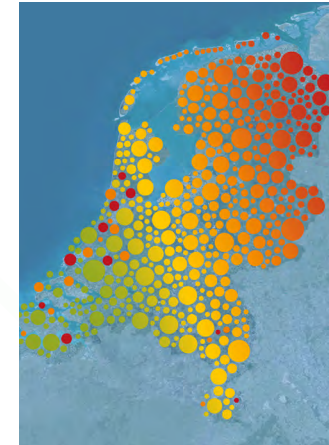


Generating solar energy with flexible, rollable, impact-resistant, and processable foil. That is what the start-up Enfoil is focusing on. Enfoil is a spin-off of TNO, Hasselt University, and Imec. The flexible shape of PV interconnection technology enables surfaces to be activated to produce green energy. [Read more](#)



Listen to the podcast [Using any surface for renewable electricity \(in Dutch\)](#)

[Spotify](#) [Apple](#) [TNO podcasts](#)



Research

Energy poverty

Many households in the Netherlands struggle to pay their energy bill every month. TNO is looking into how to prevent this energy poverty.

In collaboration with Statistics Netherlands (CBS), TNO has mapped energy poverty by nature, extent, and regional distribution. In 2022, 600,000 households were found to be living in energy poverty. They have high energy costs, live in a house that is not well insulated and have low incomes.

The study on energy poverty highlighted the issue in the Netherlands for the first time. The interpretation of the results enabled the government to take effective support measures. Analysis shows that financial compensation has significantly curbed the rise in energy poverty. Without this financial support, the number of households struggling to pay their energy bills would have doubled to almost one million compared to 2020.

[Read more](#)



Strategic theme: Sustainable society

TNO GOAL FOR 2030

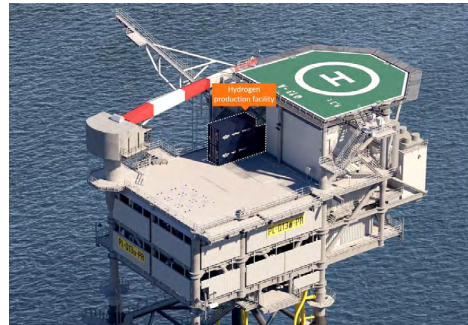
→ Offshore green hydrogen for sustainable onshore industry

Hydrogen is essential for a more sustainable energy supply. TNO innovations will enable offshore energy hubs to produce 500 MW of green hydrogen generated with offshore wind power within a decade. Thanks to this scale-up, we are working with government and industry to accelerate industry sustainability.

Innovation

PosHYdon - Green hydrogen from seawater

Off the Dutch coast, more than 10 kilometres from The Hague, the PosHYdon installation will produce green hydrogen from sustainable electricity generated by wind and solar. This is a first step towards large-scale offshore hydrogen production from wind power. Shown here is the first fully green electrified platform in the Dutch North Sea. The PosHYdon consortium comprises Nel Hydrogen, InVesta, Hatenboer, Iv-Offshore &



Energy, Emerson, Nexstep, Neptune Energy, Gasunie, Noordgastransport, NOGAT, DEME, TAQA, Eneco, EBN, and TNO. [Read more](#)

Innovation

Green hydrogen production - 200 times less iridium

The energy transition is changing the need for raw materials. Green hydrogen, produced through electrolysis using electricity from solar and wind, has a crucial role to play in the transition from fossil fuels to renewable energy. Iridium is a scarce material that is presently essential to electrolyzers working with the commonly used Proton Exchange Membrane (PEM) technology. Researchers at TNO have been the first to develop a method that will require 200 times less iridium.



Innovation

Noxestimator - Nitrogen emissions on construction sites

Nitrogen emissions on construction sites may have adverse effects on the natural world and are therefore a reason for limiting the number of building permits granted. The Dutch Ministry of the Interior and Kingdom Relations has asked TNO to devise solutions specifically for housing in a national programme. TNO has developed a calculation tool that gives policymakers and the construction industry insight into measures that can directly reduce nitrogen emissions on construction sites and in logistics. The tool looks at the entire chain: from production and logistics to the construction site.

[Read more \(in Dutch\)](#)





Strategic theme: Sustainable society

Collaboration

'TDI 500' – Sustainable Installation Team 500

The energy transition benefits from a decisive and efficient approach to sustainability. Together with a consortium of 10 leading installers in the Netherlands, TNO is making it possible to install an additional 500 heat pumps per day within three years. That amounts to 100,000 heat pumps a year. Innovative tooling and a novel approach make products and processes more efficient, enabling more installations, in less time, with fewer people, and with an even higher quality.



Critical raw materials

Critical Raw Materials

Critical raw materials (CRMs) are critical because users depend on a very small number of suppliers and/or supplying countries for these materials. But they are also crucial (critical) for energy transition products (batteries, PV panels, electrolysers, and wind turbines).

TNO plays a key role in orchestrating and answering the many interrelated research questions and topics. The aim is to support the Dutch government in policy- and decision-making related to our strategic autonomy and security of supply, and in preparations for a Netherlands Materials Observatory (NMO).

Our role also includes special studies, such as the potential of the Urban Mine (recovery of CRMs from electronic waste and other recycling streams), or vulnerability analyses of future technologies, such as electrolysers or quantum techniques.

Innovation

DME – Converting CO₂ into fuels and chemicals

The use of dimethyl ether (DME) is still very limited. But it has the potential to replace diesel and LPG as a fuel for homes and SMEs, or farms not connected to the gas grid. In Europe alone, that is a huge market. TNO has developed a method to produce DME from CO₂ very efficiently and cheaply.

The CO₂ can be captured directly from outdoor air or from biogenic waste streams on companies' sites, after which it is converted with great efficiency. By producing DME from CO₂, TNO is helping companies move away from fossil fuels. [Read more](#)





Strategic theme:

Digital society

TNO wants to contribute demonstrably to making the Netherlands the digital leader of Europe. After all, digital technology supports and accelerates all efforts to tackle major innovation challenges. TNO develops IT technology that respects public values and fundamental rights, creates a global level playing field, and safeguards national security. We also contribute to cyber security in the Netherlands. Finally, TNO aims to support its partners and clients in the digitalisation challenge by developing techniques and tools that can be used in multiple domains. One example is maintaining the prominence of the Dutch high-tech industry through pioneering innovations. It is precisely the combination of IT technologies that ensures innovation. Open infrastructures, data sharing, and AI-driven analytics require approaches that can deal with complexity. TNO achieves this by developing and integrating key supporting IT technologies from the Dutch and European digitalisation agendas.

TNO's goals for 2030

- Digital privacy and security for everyone
- Targeting poverty with new insights from data
- Quantum technology heralds a new era



With our impact within the Digital society theme, TNO contributes to the following Sustainable Development Goals:





Strategic theme: Digital society

TNO GOAL FOR 2030

→ Digital privacy and security for everyone

Privacy and cyber security are the cornerstones of our digital society.

In 10 years, we will ensure that everyone can exchange data online with complete peace of mind. TNO and its partners are making this possible with smart innovations in data encryption, quantum-safe data sharing, and secure digital infrastructure. We share the same ambitions and are working together to secure the future of the Netherlands.

Innovation

Self-Sovereign Identity: a privacy technology

Self-Sovereign Identity (SSI) is one of the technologies TNO is working on in the area of privacy in data sharing. SSI gives the user control over which personal and other data are shared and with whom. The recipient can quickly verify these shared data electronically, for example for authenticity and validity. The process uses cryptographic technologies, such as

- '(decentralised) public-key cryptography', 'zero-knowledge proofs', and in some cases also 'distributed ledger technologies'. This enables an efficient exchange of verifiable digital information, where a high level of trust can be achieved. Even between parties who do not naturally trust each other. [Read more](#)



Listen to the podcast [Digital privacy and security for all](#) (in Dutch)

[Spotify](#) [Apple](#) [TNO.nl](#)



Innovation

Concept version of self-driving car

The past year brought a lot of bad news about self-driving cars. Experiments in San Francisco showed that autonomous cars have too many difficulties with unfamiliar situations to be able to cope in traffic. TNO is working on a way out of this problem using hybrid AI. As well as learning from examples, the AI in the TNO car can also reason about the situation in which it finds itself and what behaviour is expected in that case. This enables the self-driving car to deal better with unfamiliar situations. But at the same time, we can align the car's behaviour with human values. And that is an important prerequisite for using these kinds of high-risk systems in the real world. A concept version of this hybrid AI was successfully demonstrated in the TNO car on the test track in a limited number of situations. [Read more](#)



TNO self-driving car on test track



Strategic theme: Digital society

TNO GOAL FOR 2030

→ Targeting poverty with new insights from data

One in 20 people in the Netherlands do not have enough to live on. Many of them struggle with an accumulation of debts. But because data from different government agencies cannot be securely shared, these very people are often overlooked. With technologies from TNO, public authorities can change that. Securely combining information from multiple data sources will finally enable us to see many different debts as one single problem. This will make tackling poverty more targeted and effective.

Innovation

Poverty reduction can be made more effective with data analysis

New technologies such as Multi-Party Computation (MPC) offer solutions to help implementing authorities contact individuals who are entitled to additional support. To find out how MPC can help reduce poverty in practical terms, TNO has set up a pilot project with the Dutch Social Insurance Bank (SVB) and Employee Insurance Agency (UWV). The initial results of this small-scale pilot project have led to 28 households being identified and receiving benefits. [Read more](#)

Article

Poverty reduction with privacy technology

TNO is collaborating with the Dutch government on technologies that can contribute to poverty reduction in a responsible and safe way. The number of Dutch citizens living below the poverty line is continuing to rise. To address poverty in a targeted way, help must reach the right people. You can read how that technology can contribute to poverty reduction in this article. [Read more](#)



Listen to the podcast **Poverty reduction with privacy technologies (in Dutch)**

[Spotify](#) [Apple](#) [TNO.nl](#)



Innovation

Saving people with the help of AI

Artificial Intelligence (AI) offers unprecedented possibilities and it increasingly has societal applications. TNO is exploring the potential for data- and knowledge-driven robotic systems to operate in the real world by means of AI. The research focuses on training the system's understanding of how to interact physically within a framework of operational rules. One example is to consider having a robot open a particular door. The research may lead, for example, to robots capable of saving people even before rescue workers arrive at the scene. [Read more](#)

Research

TNO and Kieskompas study voting advice for elections with AI

Generative AI language models (large language models) that fill in the voting attitude form provided by the Kieskompas (Electoral Compass) voting advice website end up on the left of the political spectrum. In addition, models do not give consistent answers to subjective questions and quickly exhibit very different behaviour due to small changes in the question. These are results of an experiment conducted by TNO and Kieskompas. [Read more \(in Dutch\)](#)



Strategic theme: Digital society

TNO GOAL FOR 2030

→ Quantum technology heralds a new era

Quantum technology will revolutionize computing power and information security. By 2030, this will allow us to tackle problems that we cannot currently solve due to a lack of computing power, as well as ensure Internet security. TNO is working with partners to lay the foundations for an entirely new industry.

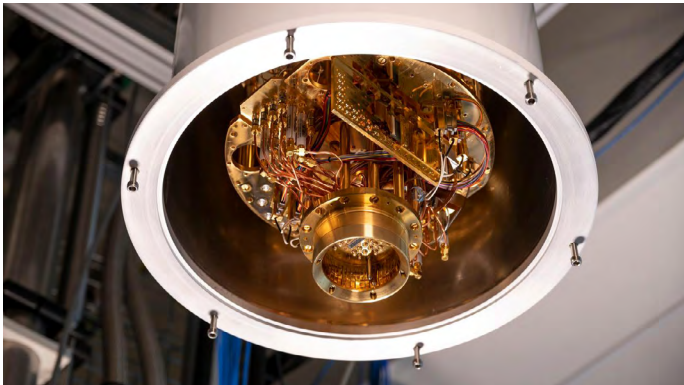
Article

Quantum technology in development

Quantum technology is a key technology that enables new products and services. The potential of quantum computers, simulators, networks, and sensors holds enormous promise for society, industry,

and science. This brings us to the brink of a technological revolution that can help provide solutions to a variety of major societal challenges.

[Read more](#)



Listen to the podcast [Quantum technology heralds a new era](#) (in Dutch)

[Spotify](#) [Apple](#) [TNO.nl](#)



Collaboration

FSO instruments: collaboration leads to products for use in space

The Netherlands is strengthening its position in the global value chain of free-space optics. Demcon and VDL Groep have formed a new joint venture, FSO Instruments. The company develops, manufactures, and supplies high-quality instruments for free-space optics, in particular products for laser satellite communication. FSO Instruments builds on the technology developed by TNO together with Demcon and VDL ETG.

[Read more](#)



Operations

A number of things are essential to the organisation of TNO's research: The way we are organised, what types of research we conduct, the way we programme our knowledge, the research facilities we invest in, and the researchers who conduct our research. All these aspects are necessary for a well-functioning TNO. We will explain them below.



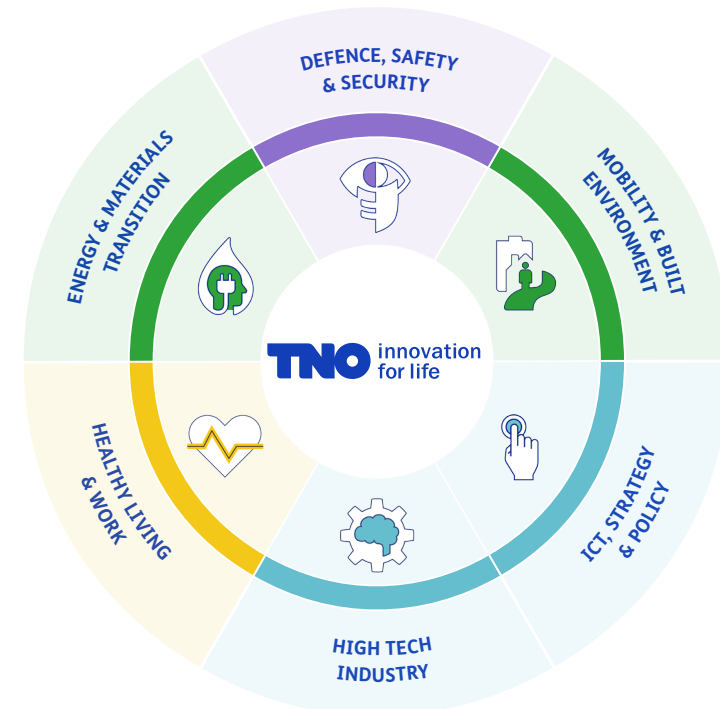
The Executive Board consists of (from left to right) Tjark Tjin-A-Tsoi (CEO), Susan Swarte (CFO), and Maarten Tossings (COO).

Organisational structure

TNO consists of six units and a centralised Services Organisation. The Managing Directors of the units and the Services Organisation report to the three-member Executive Board. The Executive Board reports to the Supervisory Board. In addition to the Executive Board, the Defence Research Council has specific, statutory powers regarding defence research. TNO's corporate governance is based on the TNO Act and can be found on our website, [tno.nl](https://www.tno.nl).

Each TNO unit has a Strategic Advisory Council made up of representatives from business and industry, the public sector, and knowledge institutions. Civil society organisations and NGOs are also represented in the Strategic Advisory Councils. The Executive Board regularly engages with TNO's various stakeholders including public, private, and knowledge partners.

TNO includes the following six units:





Types of research

TNO develops knowledge by carrying out Early Research Programmes (ERPs) and Shared Research Programmes. This precompetitive and public-private knowledge development, co-financed by state funding, focuses to a great extent on research areas identified in the Dutch government’s Mission-driven Top Sectors and Innovation Policy.

The accumulated knowledge forms the basis for solutions to client queries. We find these solutions through Contract Research and Technology Transfer. Contract Research is involved if questions from clients and partners concern specific, potentially competitive applications of TNO knowledge and where there is customisation. This can also take the form of recommendations or consultancy. This type of research is paid for entirely by the client. In this way, knowledge developed by TNO is brought to market through its clients’ products and services. In Technology Transfer, TNO brings knowledge to the market by setting up spin-offs and by leveraging its 900 or so active patent families in the form of licences to existing companies.

Programming TNO’s knowledge (intellectual capital)

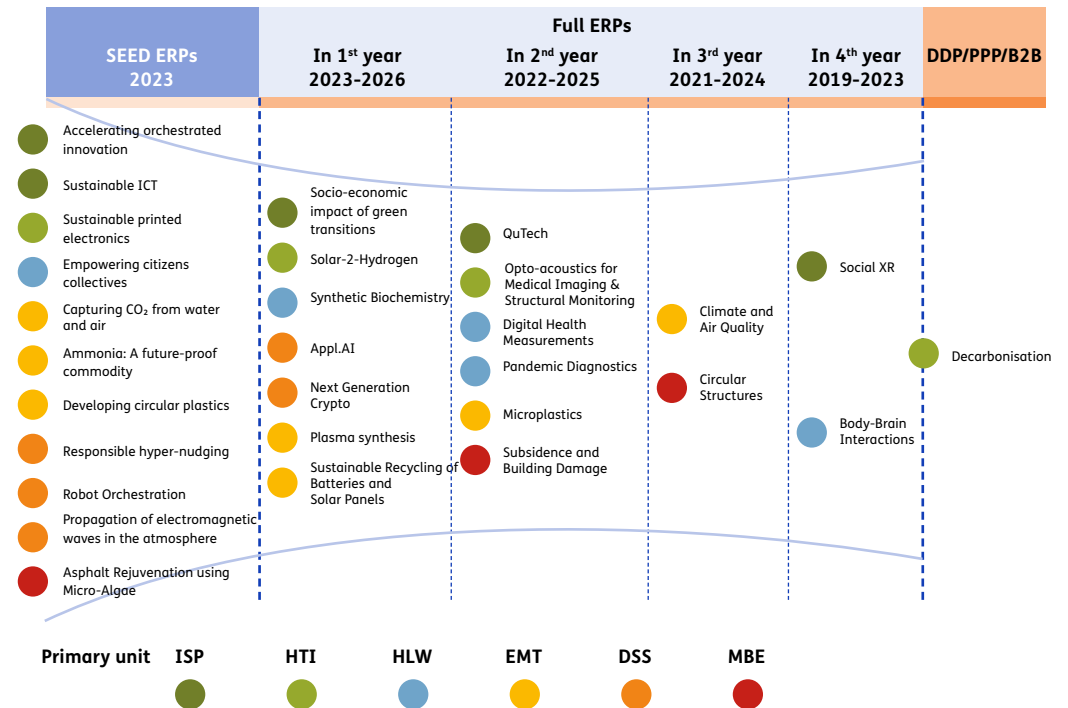
The agenda and programming of knowledge development at TNO are created through close coordination with partners and clients and are based on national and international (European) policy and on statutory tasks, such as defence research and the Geological Survey of the Netherlands. This forms the basis of our knowledge development.

Propositions

TNO manages the strategic programming of research through a portfolio of propositions distributed across the units. Propositions are logical combinations of offerings and capacities, with the unique promise of adding value for clients in the relevant market. The propositions set out the social and economic impact of the intended product/market combinations, the required investments in technologies and methodologies, the mix of funding sources, and the research facilities needed.

Early Research Programmes (ERPs)

With the Early Research Programme (ERP), TNO renews and maintains its knowledge, focusing on intensive collaboration with knowledge partners and stakeholders. The ERP focuses on urgent issues with high societal and economic potential and a value increase of the TNO position through contract research, licences, and spin-offs. The following new ‘Full ERPs’ (four-year programmes) kicked off in 2023: ‘Socio-economic impact of green transitions’, ‘Solar-2-Hydrogen’, ‘Synthetic biochemistry’, ‘Next generation crypto’, ‘Plasma synthesis’, and ‘Sustainable recycling of batteries and solar panels’. These programmes involve clear scientific challenges and have high social relevance. These Full ERPs were selected from among 10 ‘Seed ERP’ projects from 2022. In addition to the new Full ERPs, 11 new Seed ERPs were also selected. These Seed ERPs are one-year programmes in which we explore the potential of a new technology.





Demand-Driven Programmes (DDPs)

The year 2023 was the fourth year of the Mission-Driven Top Sectors and Innovation Policy (MTSIP). In the mission-driven approach, government, top sectors, and knowledge institutions work together on five themes: Energy and Sustainability; Agriculture, Food and Water; Health and Healthcare; Safety and Security; and Key Technologies.

TNO's research programmes fit within almost all mission-driven themes. Over half of the state funding that TNO receives comes under the umbrella of the MTSIP. 'Energy and Sustainability' and 'Key Technologies' are by far the most prominent themes for TNO, followed by 'Health and Healthcare' and 'Safety and Security'. Examples of DDPs include 'Biomedical and digital health' on lifestyle medicine, the DDP 'CO₂ Neutral Industry', which focuses on efficiently converting CO₂ into fuel, and the DDP 'Sustainable Construction', which focuses on prefab construction. To strengthen the connection to the MTSIP and provide more focus, we have gradually reduced the number of demand-driven programmes from 42 in 2020 to 26 in 2023, in consultation with the public and private sector.

Quality of research

The research groups within TNO are reviewed every four years by an external audit committee consisting of leading representatives from science and industry. They carry out a Knowledge Position Audit (KPA). In addition to observations and recommendations, the committee also gives a quantitative assessment of the groups. They do so regarding three aspects: quality, impact, and viability. A KPA is carried out in each unit or, for the larger units, in each cluster of research groups. The outcome of the KPA is one of our Key Performance Indicators (KPIs). A good KPA result means the group is internationally recognised, competitive, has a good focus, and shows potential for innovation. A KPA took place within the ICT, Strategy & Policy unit in 2023. This KPA was successfully completed.

Open Access publications

The TNO Repository has been accessible since 2013 and allows anyone to download research publications free of charge. In 2023, the repository became fully owned by TNO, where it was previously managed by TU Delft. The technical system behind it has also been updated.

Over 57,000 TNO publications are now available. Almost daily, TNO adds new publications. These are not only new publications but also old TNO publications that have recently been digitised. For around half of the publications, the full text can be downloaded; for the other half, only the metadata is visible and the full text is available on request.

More and more people are finding their way to the TNO Repository. In 2023, over 2.3 million publications were downloaded and almost 3.3 million visitors consulted the database. That is an increase of 800,000 visitors compared to 2022. Since 2013, more than 18.5 million visitors have consulted the database and more than 11.3 million publications have been downloaded.

World-class facilities (physical capital)

High-quality research facilities are of crucial importance to TNO. In these facilities, TNO works with partners in the relevant ecosystems. To continue to do so, it is important to maintain the quality of these valuable and leading research facilities, to expand them, and to build new facilities.

To this end, the Ministry of Economic Affairs and Climate Policy has made funds available through the Applied Research Facilities (ARF) scheme from 2023. A total of €475 million is available in this scheme for research facilities of TO2 institutions and National Knowledge Institutes, spread over a 10-year period.

A total of €140 million was available for the first round of this scheme in 2023.

In 2023, three TNO proposals were approved with a total financial volume of €45 million:

- 1 GPT-NL: a facility for a sovereign Dutch language model
- 2 Innovation Centre for Sustainable Powertrains (ICSP)
- 3 Biobased Building Materials Innovation Center (BBMIC)

Realisation of these new facilities will start in 2024. The proposals that have not now been approved are part of a Strategic Investment Agenda, which will be supplemented by proposals that are still being developed. This Strategic Investment Agenda forms the basis for proposals to be submitted in subsequent rounds of the ARF scheme.

Highlighted research facilities



PlasmaLab, Geleen

The chemical industry uses a lot of natural gas to make bulk chemicals for e.g. plastics and fertilisers. It serves both as a raw material and as fuel to run high-temperature chemical reactions. By using plasma reactors at the heart of these processes, huge amounts of natural gas can be saved. At the Brightsite Campus in Geleen, we are working with Maastricht University to understand plasma processes at a fundamental level and immediately apply this knowledge at pilot scale in collaboration with the regional processing industry.



Rijswijk Centre for Sustainable Geo-energy (RCSG)

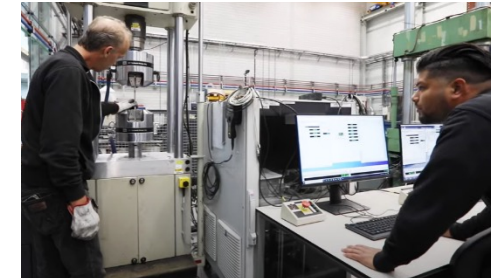
Geothermal energy is set to play an important role in the energy transition, alongside other renewable sources such as solar energy, wind energy, and biomass. Eventually, heat from the subsurface could provide a quarter of heat demand of homes, offices, and industry. However, this would require breaking down technical barriers that currently prevent the profitable extraction of geothermal energy. In the Rijswijk Centre for Sustainable Geo-energy (RCSG) field lab, TNO, together with companies and universities, is developing, testing, and validating new well designs, sensor technology, new drilling techniques, and materials to accelerate the further development of geothermal energy.



Hydrogen Lab (Faraday), Petten

Hydrogen may be an important future energy carrier as natural gas is increasingly scarce and causes carbon emissions. However, hydrogen has to be created. Green hydrogen is made by electrolysis, using sustainably generated wind or solar energy to split water into hydrogen and oxygen.

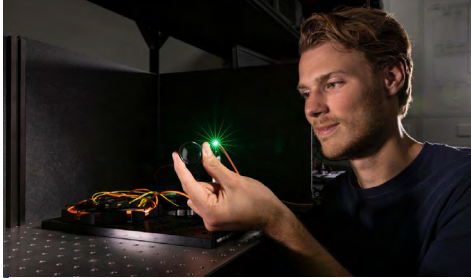
The Faraday Lab in Petten collaborates with universities and industries on increasing the service life, reducing manufacturing costs, and improving the efficiency of electrolyzers.



Biobased Building Materials Innovation Centre, Delft

Biobased construction uses building materials made from wood and wood products or agricultural raw and residual materials. These are grown and harvested in an ecologically responsible manner. They are made into building products that meet private and public requirements and are suitable for reuse. Compared to traditional construction, bio-based construction is more sustainable, healthier, and perfectly suitable for large-scale prefabrication. In large volumes, bio-based building materials can help solve major societal challenges such as CO₂ and NO_x emissions, labour shortages, and lack of affordable housing. In the new research facility, funded by the Ministry of Economic Affairs and Climate Policy, TNO will be working with a wide range of partners from the knowledge and value chain to research how bio-based products can be made safely, sustainably, and affordably. Producing 0 series, test set-ups, monitoring, and measurements will support and accelerate the development of bio-based construction.

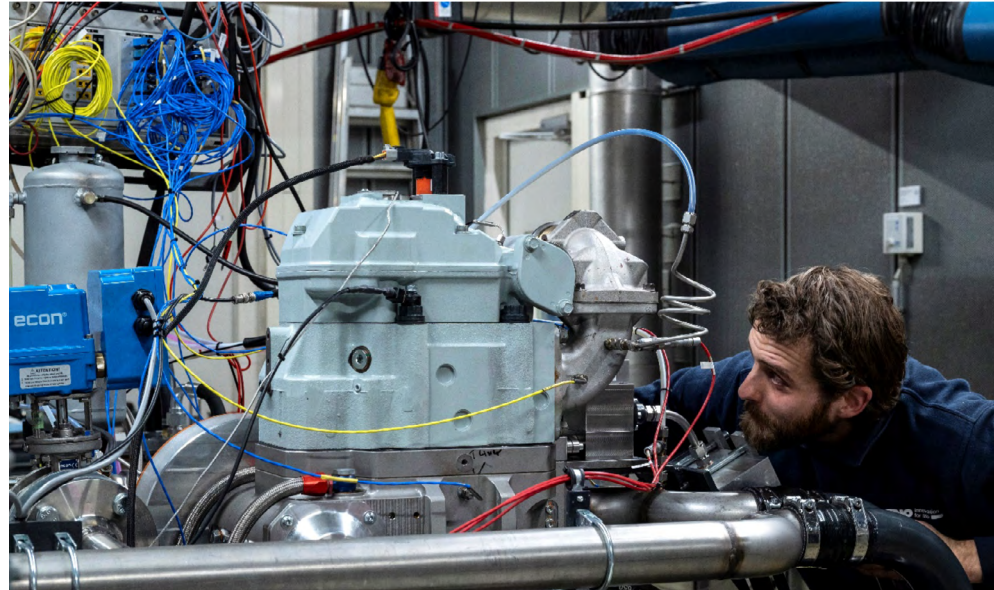
Highlighted research facilities



Quantum Sensing Testbed | TNO

Quantum sensors are sensors in which quantum mechanical effects such as coherence and entanglement are used to convert stimuli into electrical signals. Quantum sensors have practical applications in many areas, ranging from better navigation and radar systems to improved medical detection devices and the ability to observe climate change more accurately.

At TNO, we want to accelerate the process of bringing quantum sensors to market by setting up an open test facility. With support from Quantum Delta NL and in collaboration with TU Delft, we are working on this testbed facility, where universities, companies, and end-users can work together to develop the technology and its applications. [Read more](#)



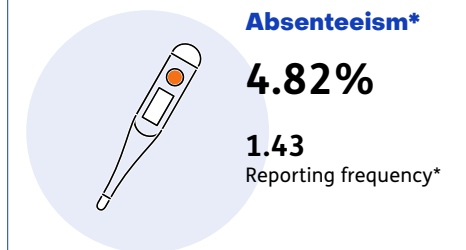
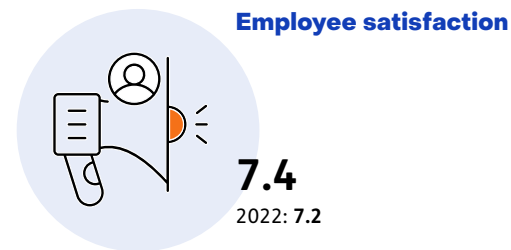
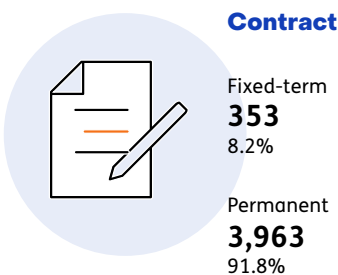
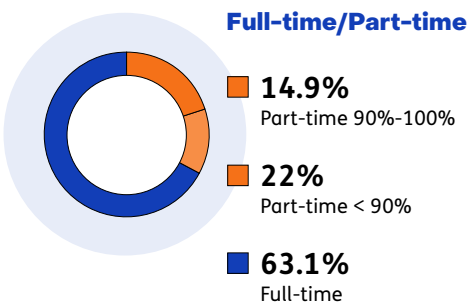
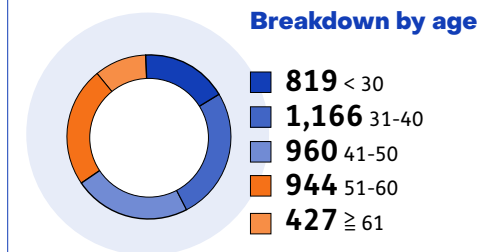
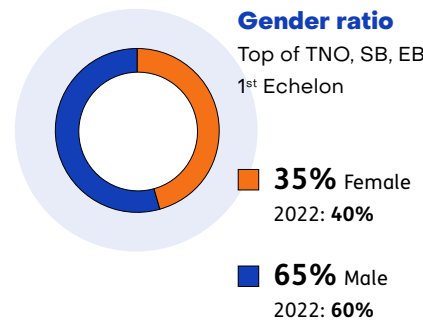
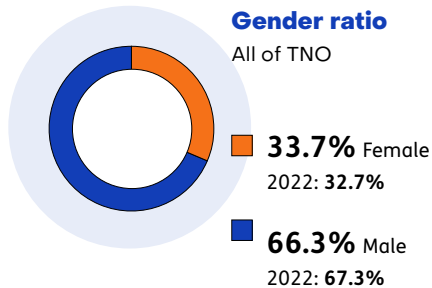
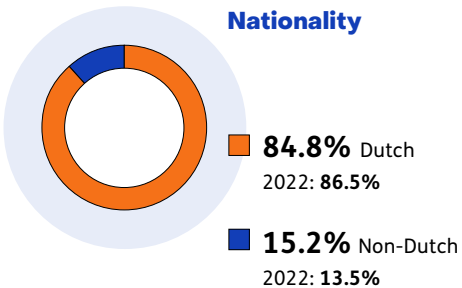
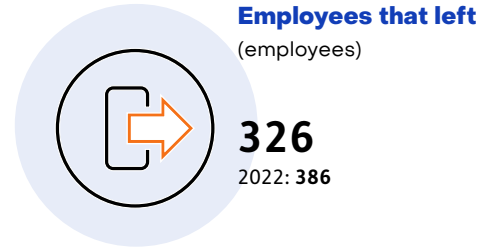
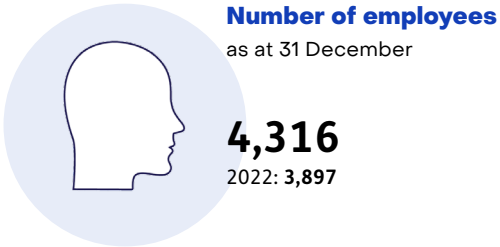
Innovation Centre for Sustainable Powertrains

Energy transition developments in the mobility domain are moving fast, with regard to combustion engines as well as battery and fuel cell technology. TNO's Innovation Centre for Sustainable Powertrains (ICSP) in Helmond offers a unique facility for application-oriented research and testing. These facilities are necessary to strengthen the Netherlands' competitive position in the market for sustainable propulsion technology and vehicles. With two major public-private partnerships, GTD-H and GTD-E, the major Dutch industrial parties and knowledge institutions are taking a big step towards becoming leaders in this field. The ICSP plays a central role in making this happen.

In 2024, the research facilities will undergo a major upgrade to ensure that TNO can help accelerate the industry's transition to more sustainable propulsion technologies, such as H2-ICE, batteries, and fuel cells. The improvements extend the scope of application from heavy road transport to off-road and marine applications.



Home for talent indicators



* In 2023, a limited assurance statement was issued for this KPI by our external auditor. The Appendix explains the definition of this KPI.



Home for talent (human capital)

TNO wants to be a ‘Home for Talent’ for current and future employees.

For us, being a good employer means investing in people. After all, the knowledge and employability of its staff are crucial to TNO’s ability to achieve its strategic goals. TNO therefore also strives for an inclusive culture where everyone feels at home, feels valued and respected, and is given equal opportunities.

Home for talent indicators

In 2023, the proportion of ‘internationals’ (non-Dutch employees) at TNO increased (+1,7%) to 15,2%, and the number of women within the total TNO population rose slightly (+1%) to 33,7%. In contrast, at the top of the organisation, the percentage of women fell again (-5%) to 35%. To ensure gender balance, there is a focus on both the advancement and inflow of women at the top. Within TNO, there are several training courses aimed at career growth specifically for women. And we are also working on policies to lower systematic barriers to women’s advancement. There are also initiatives to introduce women outside the organisation to TNO in a low-threshold way. This creates a valuable network to draw upon in case of vacancies.

In particular, TNO also wants to be a home for young talent – we offer graduates and young professionals the opportunity to grow within TNO. TNO supervised 435 students doing graduation and internship projects in 2023, while 69 (former) TNO interns were recruited to a (starter) position within TNO. A total of 15 new trainees started on the TNO trainee programme in February and September 2023. The two-year programme had a total of 27 trainees at the end of 2023.

Intensifying recruitment

Also in 2023, we paid a lot of attention to recruitment to support the TNO growth objectives. The tight labour market makes it essential to recruit proactively.

Publishing a job posting is often no longer sufficient to reach enough candidates. Extra efforts such as headhunting and deployment of the TNO network (referral programme) often yield that one needle in the haystack. Job applicants today have multiple job options. It is therefore important to pay close attention to a smooth and proper application process. This is how we make a difference for candidates and achieve a lasting match.

Talent development

Setting clear goals, giving and receiving feedback regularly, and discovering and developing talents is central to TNO. This enables us to align personal development, talent, and performance and to allow for customisation.

We encourage employees and managers to discuss personal development regularly, at least once a year, focusing on both individual development and the direction of the department. Various training courses are organised for this purpose. There has also been clearer communication about the various development opportunities available within TNO and the corresponding development programmes and training courses.

Attractiveness as an employer

TNO has a lot to offer to society and the business world. To raise awareness of this, we have launched a new intensive branding campaign TNO-wide, both on TV and online, which has brought TNO a lot of exposure. The aim is to increase TNO’s visibility as an employer and strengthen its image as an attractive employer. Research shows that many people see TNO as an attractive employer, but that there is room for improvement in terms of TNO’s brand awareness. The coming year will therefore see even more focus on profiling TNO as an attractive employer in the labour market.

Employee Engagement Survey

In 2023, 59% of TNO employees participated in the Employee Engagement Survey (EES). On average, they find TNO to be a pleasant and instructive working environment. Employees experience great job satisfaction and challenges in their work. TNO is growing fast. For all new colleagues, a good start at TNO is crucial. The results show that new colleagues are satisfied with the onboarding programme.

Compared to 2022, a very strong increase can be seen in salary and fringe benefits satisfaction. This increase brings us back to the 2021 level. We also see an increase in overall satisfaction (from 7.2 to 7.4 on a ten-point scale) and a decrease in the number of people considering leaving TNO.

The EES also provides insight into the assumed inclusiveness in the workplace as experienced by different groups such as employees with a disability, people with a bi-cultural background or employees who feel part of the LGBTQIA+ community.

Overall, stress-related complaints have increased slightly compared to 2022. In particular, the 25-34 age group deserves attention. For 38% of employees in that age group the results indicate a possible risk of mental and physical issues.

TNO does not stand alone in this; a similar pattern is emerging throughout Dutch society. Not all complaints are therefore related to working at TNO. However, some complaints are. Over the past few years, a lot has been put in place to reduce the symptoms.



TNO employees in the spotlight

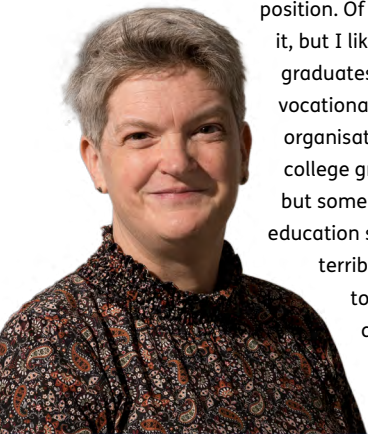
With over 4,300 employees, TNO has a huge diversity of people, with different backgrounds, expertise, and passions. By allowing them to do their work freely and giving them the space to develop themselves and their talents, they can contribute to solutions for a safe, healthy, sustainable, and digital society. Here, we introduce some of TNO’s staff.

Mariët Broxterman

Team Leader of Instrument Manufacturing at Space Systems Engineering

‘Every day, I still feel that they are happy with me, which is very special.’

‘What still makes working at TNO so special after 23 years? I find the things we make and do incredibly beautiful. And I also really like people. They come in all shapes and sizes here. My education was at senior secondary vocational level. I was extremely lucky to end up in this position. Of course, I also worked hard for it, but I like to make a case for the graduates of senior secondary vocational programmes within our organisation. TNO is mainly about college graduates and academics, but some people simply thrive in the education system while others do terribly well in practice. We need to show that latter group more clearly what opportunities there are for advancement!’



Sharon Prins

Research Manager

‘What really stresses employees out? Different projects, lots of meetings, lots of context-switching.’

‘TNO is like a candy store. There are so many interesting projects! But just as too many sweets make you sick, too much work can give you stress-related symptoms,’ Sharon Prins explains, who is Research Manager for Data Science. She launched Focus Planning in her department. Her colleague Maaïke de Boer suggested having employees work on one project for three weeks. The results so far? ‘Very positive! Employees like working in focus blocks: it gives them more peace of mind and produces better results.’



Saarang Gaggar

Former TNO trainee, now Project Manager for Integrated Vehicle Safety, participated in the Partnership Election 2023

‘Our work and impact on the energy poverty challenge during the Partnership Election makes me proud.’

‘In a team of young TNO professionals, we aimed to help address energy poverty. Eventually, we came up with a multi-disciplinary solution that combines several expertise domains at TNO to allow us to identify the people suffering energy poverty in a privacy-sensitive manner. This solution is now being co-developed with the Municipality of Rotterdam, and has the potential of helping thousands of at-risk households. As someone with an entrepreneurial background, I aspire to help make TNO a more enterprising environment as well. This includes innovating on both - our processes and mindset to place the customers and users at the centre of our innovation process as well as failing fast and frequently.’

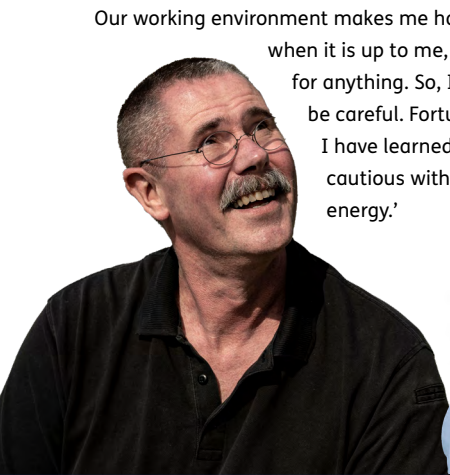


Frank de Wolf
Electronic Defence Researcher

‘A second burnout felt even more embarrassing.’

With no less than two burn-outs, Frank de Wolf was in for a rough time. The first, in an advanced stage, came as a surprise. When the second hit, a colleague convinced him to raise the alarm. When the recent recovery process revealed a diagnosis of ADHD, he finally had the missing piece of the puzzle that allows him to better manage his long-term employability. Frank is grateful for all the support TNO offered him both times. The most important lesson he is still learning: to say no more often.

Frank: ‘For me, TNO is like a candy store. Our working environment makes me happy and when it is up to me, I am up for anything. So, I have to be careful. Fortunately, I have learned to be cautious with my energy.’



Joanne Donkers
Scientist Metabolic Health Research,
Young Excellent Researcher 2023

‘We now have something truly unique for gut health research.’

The Young Excellent Researcher election is an annual TNO tradition to celebrate the outstanding achievements of our young researchers up to the age of 35. In 2023, Joanne received this award because of the unique model of the gut that she developed.

Gut function has a huge impact on a person’s overall health. And yet this highly complex tissue remains difficult and challenging to study.

The model developed by Joanne provides the ultimate set-up to study gut health in the most natural conditions, contributing to research and development of nutrients and drugs that improve our health through the gut.



Mark Boerman
Learning & Development Consultant

‘Experts fight on to the bitter end and do not rest until a problem is solved. I love that.’

Mark has been organising the master class for Senior Scientists since 2005. Mark: ‘There was no TNO programme to develop into a principal scientist. Whether it is about radar, electric motors or hydrogen, it fascinates me immensely that, at some point, experts decide to become a champion in their field. These experts must then develop their own network and communicate in clear language with people with a different expertise or role, such as business developers. Master class participants become more entrepreneurial. At the end of the master class, your mind will have been shaken up and you can move on with fresh zeal.’

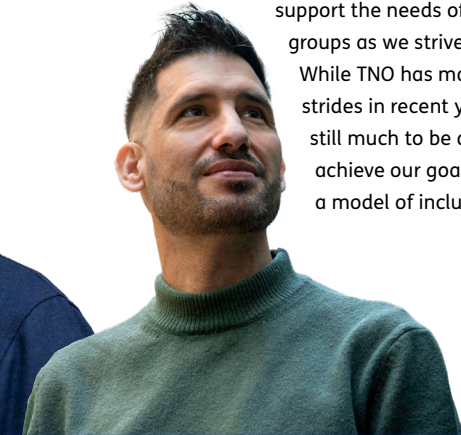


Francesc Sastre Calabuig
Scientist Specialist Materials Solutions, EMT unit, Rainbow@TNO community ambassador

‘My vision is to create a company where everyone feels valued and empowered to be themselves.’

‘As a scientist, I’m dedicated to developing innovative technologies to use renewable energy sources. As a Rainbow TNO ambassador, I actively strive to foster inclusivity within TNO, ensuring that everyone, regardless of their background, feels valued and has equal opportunities. I take pride in TNO’s efforts towards creating a better, greener world. Internally, I’m pleased to see the increasing visibility of diversity and inclusion initiatives over the past few years.

It’s crucial for us to acknowledge and support the needs of minority groups as we strive for inclusivity. While TNO has made significant strides in recent years, there’s still much to be done to achieve our goal of becoming a model of inclusivity.’



Sustainable and responsible business conduct



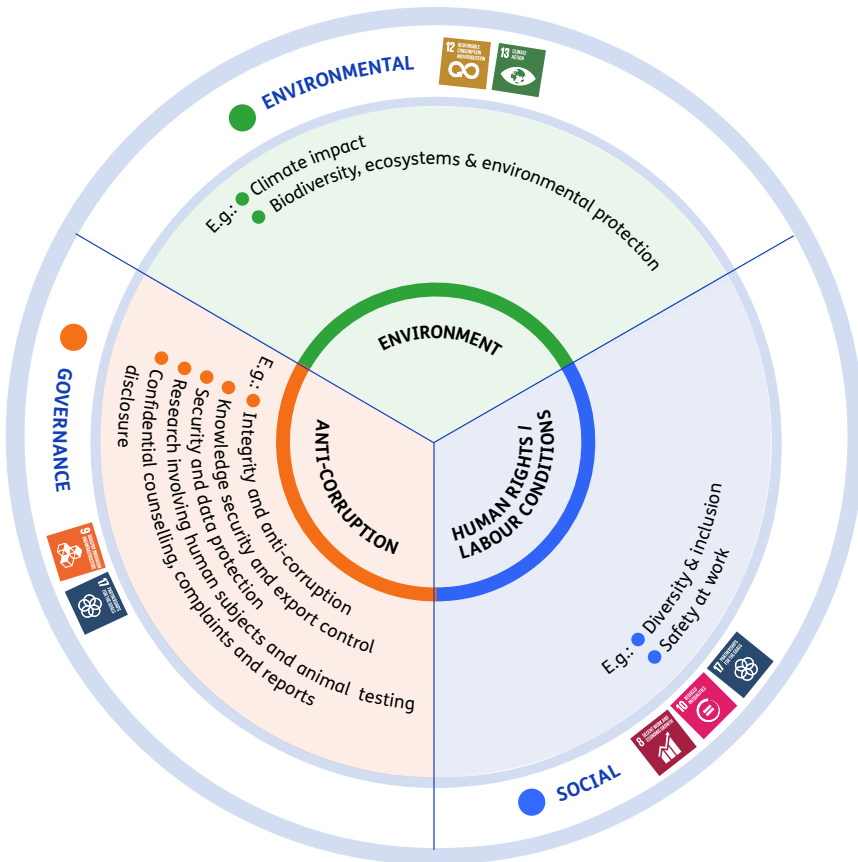
TNO's mission to make demonstrable societal impact is inextricably linked to TNO's own operations. TNO wants to be an organisation that takes its responsibility in line with its mission. TNO does so with a focus on the topics to which we also make our greatest substantive contribution: we practice what we preach.

The key points of TNO's Corporate Social Responsibility (CSR) policy are the following:

- TNO aims to have made its operations climate-neutral by 2040.
- TNO is committed to the United Nations Global Compact (UNGC) and subscribes to the 10 principles of sustainable business practices.
- TNO recognises its supply-chain responsibility towards both suppliers and customers.
- TNO focuses in particular on themes that are in line with its primary process: integrity, energy and sustainability, diversity and inclusion, and working conditions.

Since 2020, TNO has been affiliated with the UNGC, a United Nations pact to convince companies worldwide to adopt sustainable and socially responsible policies and report on their implementation. TNO wants to fulfil its social responsibility and sees the UNGC's ten universal principles of sustainable business practices as an important guide in this respect.

The image shows TNO's priorities for sustainable and responsible operations, clustered according to a classification and linked to Environment, Social and Governance (ESG) topics. These priorities have also been linked to the relevant UNGC principles. Finally, the topics are also linked to the SDGs, the United Nations' sustainability goals.



EcoVadis score

EcoVadis provides sustainability assessments of companies based on four themes (the environment, labour and human rights, ethics, and responsible and sustainable procurement), each with a maximum score of 100. The overall assessment consists of the average on the four themes, based on policy and other documentation supplied. This documentation is reviewed by international experts. In the previous audit, TNO turned its progress on sustainable and responsible operations into a substantial increase from 38 points (2020) to 48 points in 2022. With this result, TNO has scored above average in the 'Scientific Research and Development' sector and reached the 'Bronze level'. In particular, much has been improved on the theme of sustainable procurement, but there was also progress on the themes of the environment and labour and human rights. TNO wants to continue to improve its score, in line with its social objectives.





Supply chain responsibility

TNO recognises its supply chain responsibility towards suppliers and customers. This is also specifically included in our CSR policy. Our suppliers and partners play an important role in achieving our ambitions and the success of TNO. The Supplier Code of Conduct was drafted in 2023 and will be implemented in 2024. The principles of the United Nations Global Compact (UNGC) form the basis of this Supplier Code of Conduct.

Procurement is an important part of the business chain to achieve results, both in supporting research projects and in core business operations. TNO embraces the principles of responsible and sustainable procurement and has enshrined them in its procurement policy. The natural moments of tenders are increasingly being used to integrate CSR issues into business operations. To strengthen collaboration along the supply chain, the Procurement department has established key performance indicators (KPIs), which we will integrate into our procurement process in 2024.

We have also implemented the Ambition Web methodology, developed by the PIANOo public procurement expertise centre, part of the Ministry of Economic Affairs and Climate Policy. This methodology is used in all European tenders to translate our CSR ambitions into specifications, wishes, and requirements. We have applied the methodology in such fields as garden and grounds maintenance, end-of-year gifts, and cleaning services, paying extra attention to Energy & Climate, Biodiversity, Diversity & Inclusion, Working Conditions, and Circularity.

In 2023, we considered how to record and concretely apply acting with integrity and due diligence in collaboration with our business relations. We will continue this process in 2024.



Environment (natural capital)

TNO takes responsibility for its use of natural resources. Every year we report our carbon footprint to provide insight into TNO's impact on the climate. We also show what steps we are taking in terms of local environmental protection, natural ecosystems, and biodiversity.

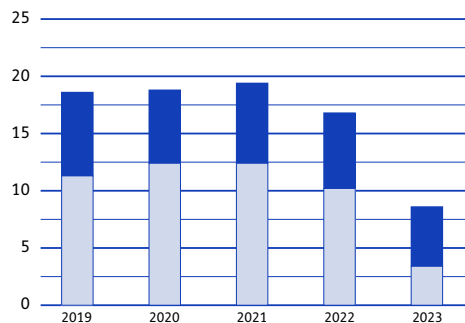
Climate impact

TNO takes responsibility for direct, indirect and chain emissions of greenhouse gases resulting from its business activities. Our ambition is to have climate-neutral operations by 2040 at the latest. To measure progress and make adjustments, the carbon footprint is determined annually in line with the Greenhouse Gas (GHG) protocol. This is done in accordance with our [calculation method](#), which was updated in 2023.

For the year 2023, TNO's total carbon footprint was 178 kilotonnes CO₂-eq, a small increase compared to the footprint in the base year 2019.

CO₂ emissions scope 1 and 2

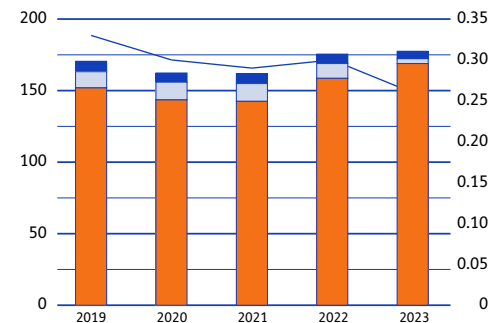
(ktonnes CO₂)



■ Scope 1
■ Scope 2

CO₂ emissions scope 1, 2, and 3

(ktonnes CO₂)



■ Scope 1 ■ Scope 3
■ Scope 2 --Carbon emissions / € revenue

TNO's direct and indirect emissions are down solidly compared to 2019. With a reduction in Scope 1 (-29%) and Scope 2 (-70%), at the end of 2023, we are well on track to meeting the 'TNO Climate Neutral 2040' target.

Scope 3 emissions have increased by 11% compared to 2019. This is partly due to the calculation method used. This calculation method is still largely based on procurement expenditure and international statistical databases. It does not include an inflation adjustment.

Carbon emissions in three scopes & definition of climate neutral

TNO reports its carbon emissions in line with the GHG Protocol. Emissions can be broken down into three scopes, with various targets:

- Scope 1: direct emissions from TNO's own operations (fuel for company vehicles and gas consumption in buildings).
- Scope 2: indirect emissions from TNO's own operations (electricity and heat consumption in buildings).
- Scope 3: indirect emissions from other activities in the supply chain (business travel, commuting, and the procurement of goods and services, such as materials, transport, waste processing, etc.).

TNO's definition of and approach to climate-neutral operations

TNO's ambition is to be climate neutral by 2040 at the latest. TNO has an absolute reduction target for direct and indirect emissions (Scopes 1 and 2) of net zero carbon emissions by 2040. To avoid an unwanted shift of emissions to the supply chain (Scope 3), a relative reduction target per euro of revenue has been set: the total carbon footprint per euro of revenue, expressed as a five-year average, must be reduced.

To achieve net zero emissions, current carbon emissions will have to be reduced to an absolute minimum. After that, if there are residual emissions that cannot be reduced or made sustainable, these residual emissions will be removed from the atmosphere by means of 'negative' carbon emissions.

However, the largest component of the increase can be traced to the growth of TNO's core business. Absolute carbon emissions rose along with revenue, but at a slower rate. Emissions per euro of revenue are down 22% compared to 2019 to 0.26 kg. Relative to the number of employees, relative carbon emissions decreased by 16% from 55.4 to 46.5 tonnes per FTE.

Direct and indirect emissions (Scope 1 and Scope 2)

At the end of 2023, TNO is well on its way to achieving the 'TNO Climate Neutral 2040' target. In the area of travel, since 2022, only all-electric lease cars are issued and an all-electric fleet is a step closer. TNO's direct process emissions in the laboratories are highly dependent on specific research projects. The biggest reduction is in energy savings in TNO's buildings and facilities. To this end, we endorsed the Dutch Green Building Council's (DGBC) Paris Proof Commitment in 2020 with the aim of reducing energy consumption by two-thirds by 2040 compared to 2015.

To improve the sustainability of our accommodation portfolio, four major sustainability projects have been delivered in 2023. In addition, last year, specifically for sustainability, we made final investment decisions worth €8.2 million.

In 2023, TNO installed solar panels on the roofs of two sites. In addition, policies regarding making rental locations more sustainable have been adopted. A direct effect of this is the amount of renewable electricity used at these locations. This rose from 38% in 2022 to 89% in 2023. The effect of this major step is clearly reflected in the Scope 2 emissions figures.

TNO's energy consumption shows a sharp decrease (-14%) in 2023. Compared to 2022, 760,000 m³ less natural gas was used, 1,656 MWh less electricity was consumed, and 425 GJ less district heating was needed. Generation by TNO's own solar panels has further increased to 588 MWh in 2023. The efficiency of TNO's buildings was 303 kWh/m² usable area (LFA). This clearly shows the character of the TNO real estate portfolio, with many energy-intensive laboratories.

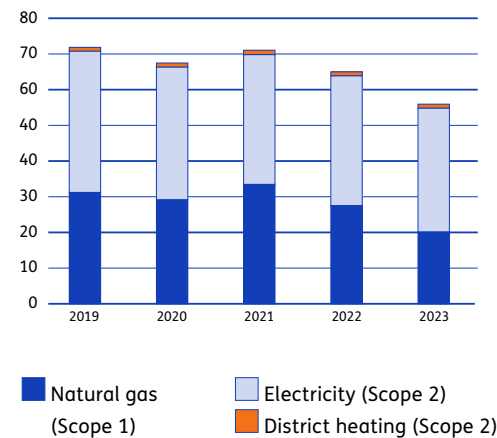
In line with the GHG protocol, both location-method and market-method emissions are reported for TNO's Scope 2 emissions. The location method looks at the carbon emissions of the local energy mix. Under this method, an organisation can only influence electricity consumption.

The market method includes the purchase of renewable electricity (certificates) in addition to consumption figures. TNO has been using the market method as a basis since 2023, but reports both numbers.

TNO's location-based Scope 2 emissions for 2023 are 12.9 ktonnes, compared to 16.7 ktonnes in 2022. This is a decrease of 24%, which was brought about by the energy-saving measures we have taken and the fact that the electricity mix in the Netherlands has become more sustainable.

Energy consumption

(GWh)



Chain emissions (Scope 3)

Chain emissions span several categories, with laboratories, the hiring of research and staff, and buildings accounting for about 80% of chain emissions.

The absolute increase in TNO's chain emissions last year (+8% compared to 2022) was largely driven by our revenue growth. As a result, procurement expenditure also increased sharply. In addition, TNO is growing extremely fast in terms of staff. Both these factors are particularly visible in the increase in hired (temporary) staff, the increase in purchased research services (hiring of research and personnel), and the increase in lab-related emissions. These three components go to the heart of our research and are growing fast.



To achieve an absolute reduction of TNO's chain emissions in the long term, we are developing policies for this and taking additional measures. This goes hand in hand with drawing up measures and policies for circular operations.

Emissions (in kilotonnes)	2019	2020	2021	2022	2023
Combustion of natural gas	6.0	5.6	6.5	5.9	3.7
Direct lab emissions (CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs, SFe, NF ₃)	0.0	0.0	0.0	0.0	0.3
Lease cars	1.3	0.7	0.6	0.7	0.5
TNO vehicles	0.0	0.0	0.0	0.0	0.0
Total Scope 1*					4.5
Energy & Fuels (Scope 3)**					0.8
Total Scope 1 (for historical reference)**	7.3	6.4	7.0	6.6	5.2
Energy, Electricity (market method)	10.1	11.2	11.0	9.2	1.4
Energy, Heat	1.1	1.2	1.3	0.8	0.7
Lease cars, Electricity	0.0	0.1	0.2	0.2	0.2
Total Scope 2 (market method)*					2.3
Energy & Fuels (Scope 3)**					1.0
Total Scope 2 (for historical reference)**	11.3	12.4	12.4	10.3	3.4
Energy, Electricity (location method)***	16.4	17.7	17.3	15.6	10.2
Energy, Heat	1.1	1.2	1.3	0.8	0.7
Lease cars, Electricity	0.0	0.1	0.2	0.2	0.2
Total Scope 2 (location method)*					11.1
Energy & Fuels (Scope 3) location method)**/**					1.8
Total Scope 1 & 2 (for historical reference)**	19	19	19	17	8.6

Emissions (in kilotonnes)	2019	2020	2021	2022	2023
Mobility	18.7	14.0	11.7	15.5	12.2
Buildings	28.2	31.3	31.3	36.5	36.8
Offices	9.7	9.5	8.9	13.6	13.9
Labs	39.2	39.8	42.4	43.5	49.4
Printed Matter and Client Relations	4.9	3.9	4.2	5.7	6.5
Hiring of Research and Personnel	47.6	42.9	41.7	39.9	45.5
Facilities, Waste, and Water	3.7	2.0	2.4	3.9	4.7
Total Scope 3	151.9	143.5	142.5	158.6	168.9
Total Scope 1, 2 & 3	170.5	162.3	161.9	175.5	177.5
CO₂ per € Revenue	0.33	0.30	0.29	0.30	0.26
CO₂ per FTE	55.4	50.0	49.4	51.5	46.5

* In 2023, a limited assurance statement was issued for these figures by EY.

** Historically, TNO has always categorised well-to-wheel emissions under Scope 1 & 2 emissions. In line with the GHG Protocol, in 2023 this is broken down between tank-to-wheel (Scope 1 & 2) and well-to-tank (Scope 3). For historical comparison, itemised Scope 3 category Energy & Fuels is shown in the table under Scope 1 and 2.

*** The location method is included in the table for transparency purposes but does not add up as TNO uses the market method as a basis.

The decrease in emissions from mobility (-22% compared to 2022) is mainly the result of the introduction of a new mobility policy from 1 January 2023. The policy is based on three pillars: flexibility, vitality, and sustainability. Key measures of the policy include full reimbursement for public transport, no air travel for distances below 700 km, and a carbon charge (€100/tonne CO₂) on top of the ticket price of air travel. Besides, hybrid working has remained the norm at TNO following the corona pandemic.

As part of the policy, TNO joined the Dutch 'Coalitie Anders Reizen' in 2021. This is a collective of 70 companies that want to reduce business mobility emissions with a target reduction of 50% per FTE by 2030 compared to 2016. TNO has now achieved a 60% reduction per FTE. Flying remains a focus and in the coming years we will study to what extent behavioural change can contribute to further reductions.



To improve data quality, measurement methodology improvements have been implemented for a number of categories (waste, water, and mobility) in 2023. With the legislation that has been introduced, data quality is expected to improve significantly in the coming years. Improving measurement methodology and data quality will require continuous attention in the coming years.

CO₂ compensation

Since 2022, TNO has offset 100% of Scope 1 and 2 carbon emissions for all locations through Gold Standard Verified Emission Rights (VERs). Compensation for all air travel was added in 2023. Given the turbulence in the carbon offset market over the past year, we have set aside relevant budgets. The necessary tender for this compensation continues through 2024.

Biodiversity, ecosystems, and environmental protection

At TNO, we ensure the fair and equitable use of genetic materials for research and knowledge purposes and the protection of biodiversity and ecosystems. Some of the genetic materials used by TNO for research are qualified as 'genetic resources' under the Nagoya Protocol. This protocol lays down rules for the use of genetic resources, aimed at the fair and equitable sharing of the benefits arising from the use of these resources. We regularly assess the effectiveness of the Nagoya policy and update it when necessary.

Looking at our own operations, we feel that as the landowner of various locations, we are responsible for the flora and fauna present. At TNO's Ypenburg location in The Hague, for example. This campus is located in a natural environment that is also home to a population of deer. In the management vision for the site, completed in 2023, we emphasised green and water management, with additional focus on biodiversity and the natural ecosystem. Water management in particular determines the development of the flora and fauna in this area to a great extent. Nature compensation is the norm if felling, building or filling up is required anywhere at the location.

Furthermore, TNO started a partnership with BijZaak, a company dedicated to biodiversity and local pollination, in 2023. TNO has placed beehives on the roof of one of its locations in Delft. We are exploring whether this is possible at other locations.

ESG dilemma - Environment

As part of TNO's ambition to be climate neutral by 2040, we are putting solar panels on all suitable roofs at TNO locations. Around the time of supplier selection for solar panels, it was discovered that cases of forced labour had been identified in chains of solar panel manufacturers worldwide. Manufacturers who could offer more transparency about their chains were significantly more expensive. The increased certainty of ruling out human rights violations in the chain was ultimately the deciding factor in the choice.

A choice was made for Energyra solar panels. Energyra is a Dutch solar panel manufacturer which mainly uses European suppliers. An additional advantage is that these are locally produced panels, reducing the carbon footprint. For TNO, it is an additional bonus to be using these panels because Energyra developed them using innovative TNO technology. By using metal wrap-through back contacts, a 5-7% higher yield can be achieved. It is nice to see this innovation, developed in part by TNO, reflected in our business operations: we practice what we preach.



Social

TNO is committed to equal relations with its employees based on mutual added value. We want to promote a safe, healthy, and connected way of working, aimed at sustainable deployability of employees. TNO is also committed to diverse and inclusive employment. We want to provide a workplace where everyone feels at home and has equal opportunities to develop. Finally, TNO recognises its responsibility in the chain, setting ESG requirements for suppliers of products and services, for example.

Diversity & Inclusion

TNO wants to be a place where everyone feels at home and comfortable to be themselves. An organisation where everyone is given equal possibilities to participate and develop. By bringing together diverse talents and perspectives, TNO strengthens its innovation power. 2023 was the second year of the TNO Diversity & Inclusion (D&I) Strategy 2022-2025. This year's focus was on equal opportunities. The aim is to structurally analyse and improve processes to strengthen equal career opportunities. To this end, the development of a two-way mentoring programme was launched, linking TNO employees to learn from each other's experiences. The programme is expected to be rolled out in early 2024. Furthermore, an action plan was developed to improve gender balance in TNO's scientific leadership. Interventions in the plan focus on recruitment, development, and retention. Further implementation will take place in 2024.

On Thursday 15 June 2023, TNO signed the Declaration of Amsterdam. This is a statement of intent by Workplace Pride, the international foundation for LGBTQIA+ inclusion at work. TNO thus underlines the importance, both moral and practical, of an inclusive workplace and organisation. Greater inclusion also reduces absence and turnover of innovative talent.

There are four TNO employee-led D&I networks: Women@TNO, Cultural and International Diversity@TNO, Rainbow@TNO, and Neurodiversity@TNO. Furthermore, a week-long celebration of diversity and inclusion was held for the third time in October 2023, with workshops and events at various locations. The year 2024 is dedicated to the theme of 'Diverse and Inclusive Collaboration'. Through this, we aim to foster collaboration among diverse talents and learn to reap the benefits of diversity.



In the presence of the Rainbow@TNO community and Michiel Kolman (left), co-chair of Workplace Pride, Tjark Tjin-A-Tsoi (right) signed the declaration.



Safety at work

TNO believes it is important for employees to work safely. We have therefore undertaken several initiatives to contribute to this in 2023.

In the area of safe and healthy working, TNO has adjusted its ambition in 2023. Henceforth, our prevention policy will focus even more on preventing long-term effects of, for example, chemicals, noise, and psychosocial workload. The safety culture needs to become stronger through more leadership and exemplary behaviour by management. Employees should also give each other feedback in the case of risky operations.

In 2023, the new Additional Risk Inventory and Evaluation (ARIE) from the Dutch Working Conditions Act came into force. This obligation applies to three TNO locations because they work with flammable, explosive or toxic substances. These locations are prepared for the strict requirements imposed by the ARIE obligation.

TNO wants employees to report dangerous situations and incidents, because these are learning opportunities. The number of reports in 2023 was slightly lower than in 2022, with an increase in the total number of employees.

In 2023, reports were followed up promptly and accurately in 98% of cases.

TNO conducts structured incident investigations into the causes of serious incidents and dangerous situations. In 2023, investigations were launched into six incidents. One such incident was also reported to the Dutch Labour Inspectorate. An employee slipped on a puddle of drilling oil and broke his elbow. A major cause of this incident was that the room had not been adequately cleaned after maintenance work, nor released properly. The work permit procedure at these locations was obviously tightened up after the incident, with more attention paid to a tidy workplace before starting work.

ESG dilemma – Social

The TNO organisation is becoming increasingly international, with more and more foreign employees and clients. This means that the use of the English language is also increasing. To ensure that international colleagues feel engaged and can do their jobs well, the English Fit for Purpose policy was established in 2021 with guidelines on when to use English or Dutch. This presents some dilemmas. Some clients and projects require employees to be proficient in Dutch.

In addition, there are Dutch employees who struggle with the English language. Balancing between different perspectives and demands is tricky. Moreover, last year it was found that the policy is interpreted and applied differently in different parts of the organisation. So, in 2024, we will pay more attention to language and the resulting dilemmas.

Social Personnel Fund TNO

The Social Personnel Fund TNO (SPF) was established in 1951. The fund is an independent foundation that supports participants in need of financial assistance, while maintaining complete privacy. In addition to providing loans and donations, e.g. for a holiday, and offering a financial coach, the SPF launched a campaign in 2023 to help members reduce their energy costs: the HR window film campaign. This has provided nearly 700 participants with a double pack of HR film.

It can be difficult for people to ask for help. Therefore, in 2023, some threshold-increasing application forms were abolished and awareness of the SPF was raised. Focus remains on threshold-reducing actions and the incentive to recruit as many TNO employees and retired TNO employees as possible as members to contribute to the fund. In 2023, 1,672 TNO employees and 1,179 retired TNO employees were members of the SPF. The aim is to increase this number significantly in 2024.



Governance

TNO aims to live up to the highest standards of integrity in its operations. This forms the basis of our licence to operate. Integrity is in our employees' DNA and is enshrined in the TNO code.

Integrity and anti-corruption

Research integrity is very important for independent, high-quality applied scientific research. TNO has committed itself to the Netherlands Code of Conduct for Research Integrity (NCCRI). An internal audit of the implementation of the NCCRI was completed in 2023. In response to the findings of this audit, improvements will be made to governance, prioritisation, and demonstrable compliance with the code of conduct. The external evaluation of the NCCRI was also launched in 2023, in which TNO will participate.

The TNO code is the basis for our social and business integrity. It is an integral part of TNO's terms and conditions of employment, and all TNO employees must be familiar with the code and act in accordance with it. Furthermore, all TNO employees must report their ancillary positions that are relevant to TNO each year. The 2023 Employee Engagement Survey showed that the majority of employees know the TNO code well (average score of 5.6 on a seven-point scale) and also consider, based on their experience, employees at TNO to act with integrity (average score of 5.9 on a seven-point scale).

In addition, there is an ongoing dialogue with management on issues such as conflicts of interest and corruption risks. As part of anti-corruption, measures have been taken to raise awareness about the risk of bribery and corruption. This was done through an online training course developed for a specific target group within the organisation.

Research involving human subjects and animal testing

TNO's work also covers research involving human subjects and research for which personal data are collected. Some of this research is subject to the Medical Research Involving Human Subjects Act ('WMO') and is reviewed by an external medical research ethics committee. The part that is not subject to the Act is reviewed by TNO's Internal Review Board. In 2023, this Board reviewed 134 proposals. The internal review is itself evaluated annually and the results are reported to the CEO.

TNO conducts biomedical research with a view to improving human health. TNO's ambition is to keep animal testing to an absolute minimum. Wherever testing is unavoidable, TNO does its utmost to carry out the research involved in a meaningful way, using as few animals and causing as little distress as possible. In doing so, TNO follows the Three Rs policy: replacing animal testing with non-animal innovations, reducing the number of laboratory animals, and refining animal testing.

This policy ensures that the results translate well to humans and that the tests cause as little distress to the animals as possible. To carry out animal testing, TNO has obtained several project licences, which were granted by the Central Authority for Scientific Procedures on Animals (CCD) after external review by an independent Animal Tests Committee (DEC). TNO also has its own Animal Welfare Department, which is responsible for internal oversight, reviews, advice, and policy in the area of animal welfare in animal testing and laboratory animals.

Confidential counselling

Since 2012, TNO has had a group of confidential counsellors. They support all employees who encounter and report undesirable behaviour to them. Our confidential counsellors are a reflection of society and have diverse backgrounds and profiles. The confidential counselling team has 15 members. In addition, two external confidential counsellors are available from the occupational health and safety service Beter.

The Central Confidential Counsellor is responsible for coordinating the group of confidential counsellors and – in collaboration with HR – advising in complex cases. Three new confidential counsellors were appointed by the Executive Board in 2023. In the past year, the confidential counsellors were approached 57 times. Around 30% of the meetings were more in the nature of conversations between colleagues and, in around 70%, the person was approached as a confidential counsellor. In 10 situations, colleagues received more long-term guidance from a confidential counsellor or a confidential counsellor was approached jointly by several colleagues.

Complaints

TNO has an Internal Complaints Procedure, an External Complaints Procedure, and a system for addressing cases in which wrongdoing is suspected. In 2023, three complaints were submitted based on TNO's External Complaints Procedure. These complaints have been settled. TNO's Internal Complaints Procedure was not invoked in 2023. There were no complaints from our procurement chains in 2023.



Reports

At the beginning of 2023, the handling of two reports from the previous year was still ongoing. For one of them, after preliminary investigation, it was decided not to investigate the matter further. It involved a suspected conflict of interest that was addressed by the organisation in a timely manner to avoid an actual conflict of interest.

The Integrity Reporting Centre commissioned further external investigation into the second report. This was reported to the Executive Board and managers in October 2023. The investigation found no integrity violations affecting the public interest. However, areas for improvement were identified with regard to internal communication and behaviour among colleagues. We took advantage of this report to review the process of reporting within TNO and update the Regulations governing the suspicion of wrongdoing at TNO.

Disclosure

In 2023, TNO prepared for future developments under the new Open Government Act ('WOO', replacing the Government Information (Public Access) Act). Through process optimisation, TNO aims to handle all issues involved effectively and efficiently.

In 2023, 55 requests were received under the Open Government Act. Of these, five were addressed directly to TNO, and 50 involved a request for the opinion of another administrative body. This is an increase compared to 2022. All requests were dealt with in accordance with the statutory requirements. On two occasions in 2023, an objection was raised against a primary decision by TNO. In one case, an objection was lodged against a TNO decision on a complaint. In 2023, three appeal cases were pending in relation to an appeal that had been lodged previously against a TNO decision on a complaint.

Security

As in 2022, security awareness was a major focus at TNO in 2023. TNO employees in positions involving confidentiality and contact with classified information are required to complete in-depth security awareness training. They do this through a digital programme.

In 2023, all new employees in positions involving confidentiality will be required to complete what is known as Declaration of No Objection training in their first week of work. This training makes them aware, immediately upon entering, of the important role they play within TNO and the risks and measures involved.

In addition, sessions specifically for TNO employees with a Declaration of No Objection were held this year in collaboration with the Military Intelligence and Security Service. These sessions zoomed in on current threats, classical espionage, and social engineering. All this contributed to an increase in security awareness among TNO employees and the resilience of TNO in 2023.

Data protection

In 2023, we made significant progress on some of the work we started in 2022. The privacy regulations for personnel data and the digitisation of review applications to the Internal Review Board are examples of this. Both projects are expected to be completed in early 2024.

Up to January 2024, 11 data breaches have been reported, three of which resulted in a report to the Dutch Data Protection Authority (DPA). The DPA requested further information from TNO in response to one report. This information was provided and did not lead to any further questions or further investigation by the regulator. There has been a marked decrease in data breach reports compared to 2022, when 14 data breaches were reported internally and four were reported to the Data Protection Authority. Six GDPR requests were filed in 2023. These were dealt with within the stipulated timeframe.

Knowledge security and export control

In 2023, as in 2022, there was a strong focus on knowledge security. This year, at the request of the Ministry of Education, Culture, and Science and the Ministry of Economic Affairs and Climate Policy, TNO conducted an inventory of sensitive knowledge and technology areas within the organisation. This survey not only provided feedback on the list of sensitive knowledge and technology areas yet to be determined by the two ministries, but also mapped out where these areas are located within the organisation. This provides a good starting point for further action.

While both ministries were working on the final list of sensitive areas of knowledge and technology and the implementation of a screening act, TNO – in collaboration with Export Control and Corporate Legal & Compliance – provided some customised advice. Another question that was examined was whether we need to take additional measures within our organisation to keep our knowledge and information safe.

TNO acts in accordance with sanction and export control legislation. Compliance is embedded through the TNO Export Control Internal Compliance Programme (EC ICP). We regularly review the effectiveness of the EC ICP and update it where necessary.

Healthy financial management

Financial indicators (consolidated result)

(in millions of €)

TNO consolidated result	2023	2022	2021
Operating income	702.4	608	572.5
Revenue	687.8	590.7	559.9
Other operating income	14.6	17.3	12.6
Revenue breakdown			
Market revenue	348.0	292	291.2
State funding	339.8	298.7	268.7
Costs			
Operating expenses	692.9	610.3	546.9
Personnel costs	455.0	392.6	362.4
Impairments	0.4	1.1	-
Net result	16.4	0.5	45.4
<i>Result from participating interests</i>	2.5	1.3	26.7
Cash flow for the financial year	-2.0	-21.5	38.8
Capital			
Operating capital invested	445.9	435.8	418.3
Equity	391.2	374.8	374.3
Solvency ratio	52%	48%	49%
Assets			
Tangible fixed assets	241.9	233.4	219.9
Investments in tangible fixed assets	45.4	56.5	44.1

Employees (effective)	2023	2022	2021
Number of TNO organisation employees (average FTE)	3,809	3,461	3,278
Number of group company employees (average FTE)	2	2	2
Total number of employees (average FTE)	3,811	3,463	3,280
Number of TNO Organisation employees (FTE at year-end)	3,982	3,595	3,337
Number of group company employees (FTE at year-end)	2	2	2
Total number of employees (FTE at year-end)	3,984	3,597	3,339



Sound financial foundation

TNO's legal remit is to ensure the maintenance of an appropriate knowledge base infrastructure. This is only possible with a structurally sound financial foundation and through effective operational management. Additional funding from the national government has played an important role in this since 2017. For the next strategy period, our ambition to boost investments and ensure sound operational management will be as strong as ever, with the aim of accelerating the progress of societal transitions. **Revenue** is an indicator of our contribution to a specific important societal issue. An **operating profit** is a requirement for healthy financial management, to provide a buffer for setbacks and also to create scope for investment in innovation. Our **equity** enables us to accelerate our investments in knowledge and facilities. Proper **risk management** enables TNO's management to weigh up risks in order to achieve its strategic objectives.

Revenue

For the purpose of developing, applying, and disseminating knowledge, TNO obtains its funding from a number of sources. Performing research in projects generates (net) revenue. These sources of funding are:

- **Institutional funding:** funds made available by the Dutch government (through the Ministry of Economic Affairs and Climate Policy as coordinating ministry) for developing, applying and disseminating knowledge for the purpose of resolving societal issues, giving support regarding government tasks and policy, and enhancing the innovative strength and competitive position of the Netherlands. The Early Research Programmes (fundamental knowledge development to strengthen TNO's own knowledge base) and Demand-Driven Programmes, among others, are funded in this way. In 2023, €202 million of acquired institutional funding was spent on research (2022: €190 million).
- **Programme funding:** earmarked funds from various ministries. Each ministry involved indicates the topic or subject for which these funds should be used. An important and special part of this is the task-related funding for carrying out delegated knowledge-intensive, statutory public tasks for the Ministry of Defence and the Geological Survey of the Netherlands. In 2023, €138 million of programme funding provided by ministries was converted into research by TNO (2022: €109 million).
- **Competitive funding:** contributions from partners in collaborative projects that TNO acquires on a competitive basis, such as EU projects and large-scale public-private partnerships (Shared Research). Partner contributions to collaborative projects totalled €133 million in 2023 (2022: €97 million). In these projects, TNO matches these contributions with institutional funding or programme funding.
- **Contract funding:** fully external public or private funding for Contract Research, which TNO obtains by making offers and winning contracts. The content of the contract is tailored to the client's needs, but with TNO remaining alert to the uniqueness of the contribution. In 2023, contract research worth €215 million was carried out (2022: €194 million).

All funding, much of which is long-term, is used to implement projects and is therefore accounted for as revenue. TNO has the duty to use the state funding it receives as effectively as possible and to achieve the right balance between this income (programme and institutional funding) and third-party contributions (competitive and contract funding). The relationship between these two sources of income is expressed by what is called the multiplier: total revenue divided by the amount of state funding. In 2023, the average ratio of public funding to market revenue was €1.00 to €1.02 (2022: €1.00 to €0.98).

TNO seeks contributions from third parties to maintain and renew its knowledge base, in addition to the funding it receives from the government. The ratio in relation to state funding varies by research area, but should result in a multiplier of between 2 and 3 on average. Too low a multiplier would mean that public and private partners, as well as clients, do not find TNO research relevant enough to invest in it. However, too high a multiplier implies that the portfolio activities might be 'mature' by now and could be left wholly or partly to other parties (such as commercial parties). Continuing to achieve a multiplier of between 2 and 3 will prove challenging in the next few years, as private investment in the Netherlands is not growing strongly and companies are using 'corporate venturing' as an alternative to in-house R&D. Moreover, the National Growth Fund allows companies, with government grants and their own in-kind contribution, to collaborate with knowledge institutions. This ensures that instead of innovating directly in collaboration with TNO, companies can participate in the National Growth Fund and thus collaborate and innovate indirectly. To assess the effective use of state funding, TNO therefore not only wants to look at expenditure by third parties at TNO, but also at the expenditure by third parties in projects such as the National Growth Fund, in which TNO participates, and at the value creation of its spin-offs.

Since 2017, the Technology Transfer programme has focused on transferring technology developed by TNO to the market by granting licences and/or setting up new companies (spin-offs and carve-outs). This programme is funded by TNO itself and aims to become 'revolving' over time. Three new spin-offs were set up in 2023 (2022: 5). As at 31 December 2023, 41 TNO spin-offs had been created from the Tech Transfer programme. The total value of these companies is €331.5 million and the spin-offs have provided 631 jobs. In 2023, €66 million in funding was raised by these spin-offs.

Operating result

Revenue was up €97.1 million, rising to €687.8 million in 2023 (2022: €590.7 million). Other operating income totalled €14.6 million in 2023, which was €2.7 million lower than in 2022 (€17.3 million). Total operating expenses increased by €82.6 million to €692.9 million in 2023 (2022: €610.3 million). This produced an operating profit before interest, participating interests, and taxes of €9.5 million (2022: operating loss of €2.3 million).



Operating expenses consist of direct project costs, personnel expenses, depreciation, impairments, and other operating expenses. Direct project costs increased by €7.0 million to €79.5 million as a result of growth in revenue. Personnel costs increased by €62.4 million in 2023. Of these personnel costs, €54 million went to higher wages and salaries, including for pension and social insurance contributions, as well as for changes in personnel provisions. This rise can be attributed to the increase in staffing in 2023, as well as the organic growth in salaries of 3.75% + a €200 gross (flat increase) per month as of 1 January 2023. Other personnel expenses increased by €8.4 million, mainly due to higher commuting expenses and higher hiring costs. Depreciation increased by €2.0 million in 2023 to €25.7 million. In 2023, impairments amounting to €0.4 million were recorded mainly on fixed technical installations due to relocations. Other operating expenses increased by €12.0 million to €132.3 million mainly due to higher accommodation costs, growth in software and licence costs, and an increase in outsourced work. These cost increases are offset by reductions in changes in provisions and other expenses.

Net financial income increased by €8.6 million in 2023 to a positive €9.0 million (2022: €0.4 million positive) due to the rise in interest rates.

In 2023, we expect a corporate income tax expense of €4.6 million (2022: €1.1 million gain). The corporate income tax returns to the end of 2021 have been finalised by the Dutch Tax and Customs Administration.

In 2023, there were no significant value changes in our participating interests, leaving a result of €2.5 million (2022: €1.3 million). As a result of the above, a net result of €16.4 million (2022: €0.5 million) remains.

Equity

Of TNO's equity totalling €391.2 million at the end of 2023, €144.9 million relates to TNO's research for the Dutch Ministry of Defence. The allocated reserve for the new housing for Defence fell by €1.5 million in 2023 and amounted to €28.5 million at the end of 2023. This reduction is due to additions to this allocated reserve of €10.0 million and withdrawals based on investments of €11.5 million. The statutory reserve, containing non-distributable profits from participation by group companies, increased by €3.3 million.

Taken together, the above movements and the positive result of €16.4 million lead to a €14.6 million increase in the general reserve. The general reserve has grown sharply over the past few years as a result of the sale of participating interests. In coordination with the Ministry of Economic Affairs and Climate Policy, it will be used for strategic investments in research and innovation.

Liquid assets

At the end of 2023, the balance of liquid assets stood at €350.2 million (against €352.2 million at the end of 2022). The reduction in liquid assets of €2.0 million in 2023 has several causes, which are explained in more detail below:

- On balance, tangible fixed assets were up by €8.5 million. At €44.6 million (including investments of €4.0 million financed from the 'climate envelope' and €4.0 million obtained through state funding), the investment level was above the depreciation charges of €25.7 million.
- Working capital increased by €1.1 million. Current receivables increased by €13.3 million due to more projects in progress and more prepaid items such as rent and service contracts. This working capital decrease was offset by an increase in current liabilities of €14.4 million, mainly unused leave, taxes, and social security charges.
- Long-term liabilities show a net decrease of €4.3 million. This decrease is largely due to regular depreciation in the investment resources.
- The positive net result, including the result of participating interests of €16.4 million and other balance sheet movements of €3.3 million, made a positive contribution of €19.7 million to net liquid assets at the end of 2023.

Of the liquid assets, an amount of €52.5 million (2022: €52.6 million) was reserved for public funding yet to be provided on the one hand and for the settlement of funds received in advance in the context of coordinated partnerships on the other. An amount of €28.5 million in liquid assets was also set aside for future investments in housing for defence research.

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 2024 investment budget totals around €62.9 million, which is €32.4 million more than the depreciation charges.

Solvency

The solvency ratio was 52% in 2023, almost equal to the level of 51% at the end of 2022.



In control statement

The Executive Board considers that internal controls and risk management with regard to finance, privacy, information services, export control, and sanctions are properly designed and proved to be sufficiently effective during 2023. There are 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 legislation and regulations can be ruled out.

Finance

Objective	Risks	Controls
Reliable and sound financial management	Control information unreliable	<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 reviews, 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.
	Incorrect financial accounting	Process- and data-oriented checks to guarantee accuracy, timeliness, and completeness of the financial data reported.
	Unlawful 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. 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

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 checks on 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.
	Failure to demonstrate GDPR compliance	<ol style="list-style-type: none"> 1. TNO has a detailed GDPR step-by-step plan in which personal data are handled with the utmost care. 2. Data breach protocol: TNO has a protocol for reporting data breaches and learning from incidents. 3. Rights under the GDPR: TNO gives information about data processing on the website and provides the possibility of exercising rights. 4. TNO has records of data processing operations. 5. TNO has a privacy policy and related regulations. IT measures are described in the TNO security policy. 6. TNO concludes GDPR contracts with partners and suppliers with which personal data are exchanged, using Standard Contractual Clauses of the European Commission.

Information Services

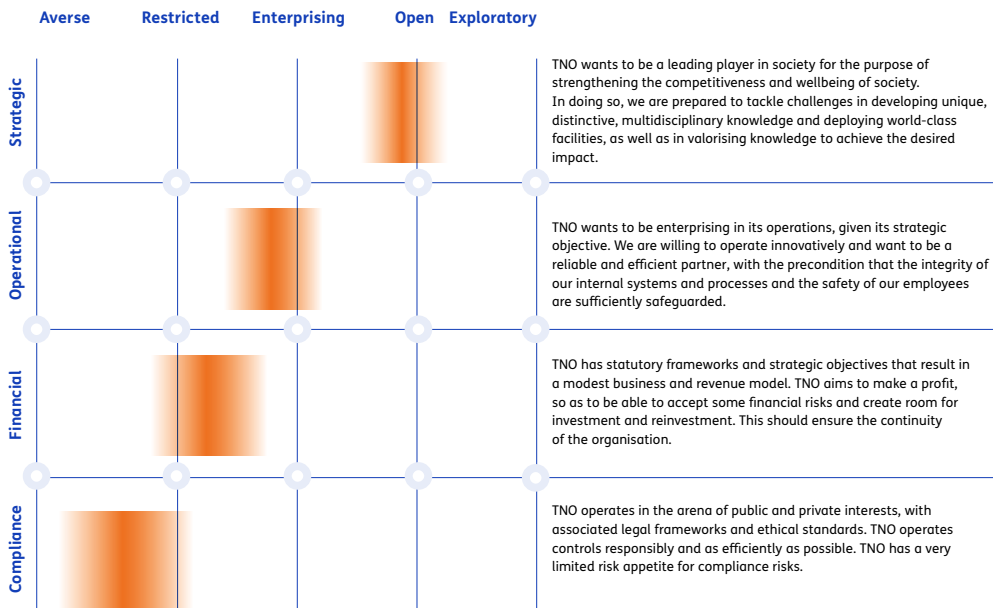
Safeguarding the availability, integrity, and confidentiality of IT services	Outsourced information provision does not meet reliability and continuity requirements	An ISAE 3402 statement is submitted annually by the implementing organisation (issued by an independent auditing body) on the design, existence, and operation of the control framework associated with the contracted services.
	Internal control processes not up to standard	The Information Security Management System (ISMS) is operational. ISO 27001 certification of the ISMS is ongoing and Information Services is expected to be ISO27001 certified by Q1 2024.

Risk management

TNO wants to protect its legitimacy and continuity, to be able to achieve its strategic goals. To this end, we carry out risk management in which we weigh up both the opportunities and risks. The Executive Board is responsible for developing, implementing, and monitoring TNO's comprehensive risk management and control system.

Risk appetite in 2023

TNO's risk appetite is related to its objectives and to the unique nature of TNO as a Research and Technology Organisation (RTO). It is about creating the right assessment frameworks and addressing the question whether risks can be reduced, consciously accepted, or avoided. We describe TNO's risk appetite as follows:



TNO-wide risk analysis for 2023

TNO's Executive Board identified the following five risks as strategic risks for 2023. These risks emerged in an ongoing consultation process between the Executive Board and the Managing Directors. This process is part of the 2023 budget process.

	Risk description	Owner
1	The risk of TNO receiving negative publicity, e.g. due to an incorrect TNO report, causing reputational damage.	CEO
2	The risk that due to insufficient focus, portfolio renewal will lag, thus lowering customer satisfaction.	CEO
3	The risk of insufficient public funding being available as a result of political decision-making, thus not achieving the desired impact objective.	CEO
4	The risk of insufficient funding being available to invest in the high-tech facilities, thereby failing to achieve the desired impact objective.	COO
5	The risk that talented employees cannot be recruited in sufficient numbers, are not motivated or cannot sufficiently be retained by the organisation.	COO

Throughout 2023, the Executive Board reviewed these risks and mitigation measures on a quarterly basis. It was concluded that the measures contributed to risk mitigation. We also assessed what new risks have emerged during 2023. These risks have been recognised and addressed.

No major shortcomings were identified in the way the current risk management and control system functions. This is confirmed in the internal and external audit reports we received in 2023.



Report of the Supervisory Board



At the end of 2023, the Supervisory Board consisted of (from left to right) Baptist Coopmans, Hester Bijl, Gijs de Vries, Louise Verheij van Wijk, Marko Hekker, Peter van Laarhoven, and Jolanda Lamse-Minderhoud.

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

Topics

In a general sense, the Supervisory Board has overseen the policy pursued by TNO in 2023. A number of significant issues are examined in more detail below.

Composition of the Executive Board

CSO Peter Werkhoven, in close consultation with the Supervisory Board, decided to step down as member of the Executive Board for personal reasons from 1 January 2023. The Supervisory Board expresses its thanks to Peter Werkhoven. As a result of his departure from the Executive Board, the composition of the Executive Board was reviewed. In consultation with the Executive Board and after coordination with the Ministry of Economic Affairs and Climate Policy, it was decided to reduce the number of Executive Board members to three. The key portfolio elements from the previous CSO position were given to the CEO.

Integrated management

In 2023, a key change is the transition to more integrated governance within TNO. This includes the integrated unit plans drawn up last year. These plans focus on ambitions based on propositions and describe how they will be shaped jointly by the units in close collaboration between market, knowledge, and operations. The Supervisory Board took note of these integrated unit plans in a special meeting with the Managing Directors and the Executive Board and is excited about the important transition initiated by TNO. This change will help create a faster, more agile, and more entrepreneurial and healthy organisation to address the major challenges in safety, sustainability, health, and digitalisation facing our society. To properly shape this integrated management, the organisational structure within the two largest units, Defence, Safety & Security and Energy & Materials Transition, has been changed. With this change, integrality is placed at a lower level in the unit (division), which has improved the manageability, agility, and scalability of these units. This organisational change went smoothly. The Supervisory Board is positive about the move towards the formation of the Executive Committee (ExCo), which has given integrated management an extra boost.

Strategy

In early 2023, a summary of TNO's strategy was published that tightened its priorities, including TNO's core tasks, demonstrable impact of innovations, valorisation, and implementation in society. Several key components of this were discussed with Supervisory Board last year, including the Customer Excellence and Vital Organisation strategic change programmes, the SME strategy, and TNO's valorisation policy. The Supervisory Board welcomes this tightening and TNO's increasing visibility on relevant social issues.



Knowledge position

Once every four years, the technology portfolio of each unit undergoes a Knowledge Position Audit (KPA), conducted by an external committee. The Quality Committee discussed the results of the Knowledge Position Audit of the Healthy Living & Work unit that took place in early 2023. It was also discussed how the KPA methodology will be changed from 2024 to better reflect the character and objectives of TNO.

Staff

With the allocation of national growth funds and the increase in the defence budget, the intake of new employees and retention of existing employees is a top priority. The Supervisory Board is pleased that TNO managed to hire around 740 new employees in 2023 and also managed to limit outflow. The highly successful TNO brand and work campaign entitled 'This is our time' certainly contributed to this.

Over the past year, the Supervisory Board put various aspects of human resources policy such as vitality, diversity & inclusion, and social safety on the agenda of its meetings. Delegations of staff and the Supervisory Board also met during working visits to various locations. From this, a picture emerges of an organisation in motion, with more focus on a number of priorities, attention to the agility and decisiveness of the organisation, and a good handling of the growth in the number of employees including monitoring retention. The tender for cleaning services was approved, as was the approach to the New Pension System and the relocation of routine Accelerator Mass Spectrometry activities. Furthermore, the acquisition of the remaining stake in VSL, National Metrology Institute, was finalised in early 2024 after careful coordination with the Ministry of Economic Affairs and Climate Policy.

Compliance, audit, and risk management

The Supervisory and Executive Boards regularly discuss TNO's compliance with various laws and regulations. 2023 also saw a reassessment of the audit function within TNO, which was discussed with the Supervisory Board's Audit Committee on several occasions resulting in an adequate Internal Audit Charter and a risk-based audit plan. A review of the risk management policy within TNO also took place in 2023.

In addition, in 2023, specific attention was given to the migration of the current SAP ECC/SRM environment to S/4HANA.

Revised organisational regulations

In 2023, TNO's organisational regulations were fully updated. The TNO Organisational Regulations are based on the TNO Act and the Corporate Governance Code. These regulations detail the composition, tasks, and responsibilities of the Executive Board, the Supervisory Board, and the Defence Research Council and set out how the Executive Board, Supervisory Board, and Defence Research Council relate to each other. The changes were prompted, on the one hand, by the introduction of the divisional structure in the aforementioned unit and the integrated management in all units from 2024. On the other hand, updating is due to advancing insight and amended laws and regulations, in particular the new 2022 version of the Corporate Governance Code. The new regulations came into force on 1 January 2024.

Finance

On 15 March 2023 the Supervisory Board approved the 2022 financial statements and on 13 December 2023 it approved the budget for 2024. EY, which came out on top in the 2022 tender for audit services, conducted the annual audit in 2023.

Performance of the Supervisory Board and evaluation of the Executive Board

The Supervisory Board keeps track of developments in relevant areas through the Audit Committee, the Quality Committee, as well as the Selection and Remuneration Committee. In addition to the Executive Board, the Supervisory Board also obtains information during meetings by inviting experts from within the organisation. Furthermore, as indicated above, periodic working visits are made and the Supervisory Board held lunch meetings with TNO employees. A Supervisory Board delegation also attended two consultation meetings between the Executive Board and the Works Council. The Executive Board informs the Supervisory Board periodically with an adequate overview that includes relevant management information. The same applies to progress information on the Technology Transfer programme. The members of the Supervisory Board briefly discuss the meetings in advance and also regularly reflect on their own performance and evaluation aspects between meetings. There is a supervision agenda that formulates priorities for supervision and there is an annual focus on the education of Supervisory Board and Executive Board members. 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 greatly appreciates the decisive way in which the important changes have taken place and the good result that was achieved in 2023. It is great to see how the TNO

organisation is growing and flourishing and how the employees, as ‘real time setters’, are putting flesh on numerous innovations that contribute to increasing the earning capacity of the Netherlands.

Composition of the Supervisory Board and its committees

The three permanent Supervisory Board committees were composed as follows in 2023:

	Audit Committee	Quality committee	Selection and Remuneration Committee
Gijs de Vries			Member
Peter van Laarhoven			Chair
Hester Bijl		Chair	
Baptiest Coopmans	Member		
Marko Hekkert		Member	
Jolanda Lamse-Minderhoud	Chair		
Louise Verheij van Wijk	Member		Member

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 Dutch Corporate Governance Code, were satisfied.

Meetings

The Supervisory Board met on seven occasions in 2023. The Audit Committee met four times and the Selection and Remuneration Committee and the Quality Committee both met twice in 2023. Outside the meetings, there was contact between the committees as necessary. Representatives from the Supervisory Board attended two Works Council meetings. Furthermore, the Supervisory Board 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 2023 was as follows:

	SB meetings	Committee meetings
Gijs de Vries (chair of SB)	7 (of 7)	2 (of 2)
Peter van Laarhoven (vice chair of SB)	6 (of 7)	2 (of 2)
Hester Bijl	7 (of 7)	2 (of 2)
Baptiest Coopmans	7 (of 7)	4 (of 4)
Marko Hekkert	7 (of 7)	2 (of 2)
Jolanda Lamse-Minderhoud	7 (of 7)	4 (of 4)
Louise Verheij van Wijk	7 (of 7)	6 (of 6)

Report of the Council for Defence Research



At the end of 2023, the Council for Defence Research consisted of (from left to right) Marc Gazenbeek (Ministry of Defence), Hendrik-Jan van Veen (TNO), Ad van de Sande (Ministry of Defence), Auke Venema (Ministry of Defence), Maarten Tossings (TNO, chair), and Harold Bousché (TNO, secretary).

The global security situation has deteriorated rapidly in recent years. The wars in Ukraine and the Middle East and the rising tension in the Far East show that security cannot be taken for granted. Geopolitical relations are changing and this also directly affects Europe's prosperity and economy. In a European context, strategic autonomy and threats to undersea infrastructure have become more prominent on the agenda in 2023.

Technology and innovation are increasingly making a difference to our ability to win the wars of today and tomorrow. The Dutch Ministry of Defence will therefore significantly strengthen its innovative capacity in the coming years. This will be done in close collaboration with industry and knowledge institutions, as well as with allies and other partners. The Innovation & Research Implementation Agenda published by the Ministry of Defence in November 2022 serves as the main guideline in this regard. Growing investment by the Ministry of Defence is having a positive impact on the scope and innovative nature of defence research and opportunities for national and international collaboration. For this reason, 2023 was another good year for defence research.

TNO has the role of 'home laboratory' for the Ministry of Defence and therefore practises science and innovation at the frontline. Collaboration between the Ministry of Defence and TNO has been intense since 1947. Every day, we collaborate with knowledge partners and industry so that military and security professionals of the Netherlands and its allies have state-of-the-art equipment and the best possible information position, guidance, and preparation. TNO focuses not only on technological solutions, but also emphatically on (improvements in) skills, methods, and processes based on a system approach.

Defence research at TNO is mainly concentrated within the Defence, Security & Safety (DSS) unit, one of TNO's six units. This unit has grown significantly in 2023: staff size by 13 per cent to almost 900 FTEs and revenue by 23 per cent to €174 million. This growth is reflected in all types of research for the Ministry of Defence.

The most important are the target funding programmes to maintain the knowledge base for the long term and, in addition, the engagements to support the Ministry of Defence's Materiel and IT Command (COMMIT) with the rapidly increasing portfolio of materiel projects. There has also been an increase in the assignments from the armed forces.

The Council for Defence Research sets the policy to be pursued with regard to defence research at TNO. The Council met six times in 2023. There are two new members. Hendrik-Jan van Veen, as successor to Marja Eijkman, was appointed Managing Director of the DSS unit in early 2023 after agreement by the Council and thus became a member of the Council. In addition, Major General André Steur was succeeded by Rear Admiral Ad van de Sande as Director of Operational Policy and Plans of the Ministry of Defence and as Council member.



The team of directors of the DSS unit is assisted by a Strategic Advisory Council. The composition of this Strategic Advisory Council remained unchanged in 2023. The Strategic Advisory Council met twice in 2023 under the chairmanship of Prof. Beatrice de Graaf.

When he took office in February 2023, the new Managing Director was tasked by the Executive Board and the Council for Defence Research with adapting the organisation and management of the unit to cope with major growth, working out and establishing a more integrated form of planning and management, as well as building a culture in which togetherness, supportive leadership, respect for each other, and inclusiveness are central. An intensive process was undertaken during the year in close collaboration with the Ministry of Defence to flesh out this assignment. This resulted in a decision to introduce a division structure starting 1 January 2024, the appointment of a new team of directors, as well as an integrated unit plan for 2024.

To monitor and account annually for the relationship between knowledge areas, staff capacity, and budget in times of growth, the Ministry of Defence, TNO, NLR, and MARIN have revived the Defence Knowledge Portfolio Review. This follows the elaboration of the Innovation & Research Implementation Agenda mentioned earlier.

The Ministry of Defence and TNO – in line with one of the priorities set by the Council for Defence Research for 2023 – have partnered with regard to national and international innovation and R&D programmes such as the National Growth Fund, the Mission-driven Top Sectors and Innovation Policy, bilateral collaborations with other countries, and the European Defence Fund (EDF). Together, we constantly seek opportunities to better leverage the Ministry of Defence's research investments through the use of new instruments. A major achievement in this context was the conditional allocation of €102 million from the National Growth Fund for the Polaris proposal submitted by a consortium led by Thales Netherlands, the Ministry of Defence, and TNO. The EDF also saw results, with 13 of the 17 proposals co-submitted by TNO being honoured in 2023. Furthermore, in the first round of the Ministry of Economic Affairs and Climate Policy's Applied Research Facilities arrangement, a proposal by DSS to develop its own open large language model, GPT NL, was approved.

Internationally, TNO has intensified active collaboration with nine countries inside and outside Europe in 2023, together with the Ministry of Defence. In addition, TNO is very active in the NATO Science & Technology Organisation (STO). In light of the growing threat to undersea infrastructure, the Ministry of Defence established a Seabed Security Experimentation Centre (SeaSEC) within the Northern European Northern Naval Capability Cooperation (NNCC) in December 2023, hosted by TNO.

Under the Mission-driven Top Sectors and Innovation Policy, industry, knowledge institutions, and the government together signed the new Knowledge and Innovation Covenant (KIC) 2024-2027 in early November 2023. To align activities, KIC partners work together through eight Knowledge and Innovation Agendas (KIA), including the KIA Security. For this KIA, five missions have been defined under the leadership of the Ministry of Defence and the Ministry of Justice and Security, which call for (applied) innovations and help guide defence research.

In November, Defence Minister Kasja Ollongren visited the DSS unit. It was a successful visit with a great deal of focus on our involvement in current developments (such as Ukraine) and collaboration with industry partners. The latter will increasingly expand in the coming period, due to increased necessity (production security of ammunition and weapon systems) as well as intensifying industrial policy. Another important event to present the results of TNO's defence research was COMMIT's multi-day Purple Nectar event in September 2023.

There were a number of developments in the area of real estate and research facilities in 2023. After many years of preparation, the new construction started for the laboratory for CBRN (chemical, biological, radiological, and nuclear protection) research at The Hague Ypenburg location. The proposed lease of part of the Oude Waalsdorperweg location in The Hague to the Military Intelligence and Security Service is final. The growth and also the changing type of experiments have implications for the need for space and experimental facilities. The Council for Defence Research approved the first three related plans and requested the development of a 'real estate and facilities growth plan' that would provide an integrated understanding of medium- and long-term real estate and facilities needs.

In conclusion: 2023 was another good year for defence research at TNO. Worrying geopolitical developments are giving further impetus to defence research. We are in a period of growth. In the good relationship between the Ministry of Defence and TNO, which is based on trust that constantly needs to be maintained, predictability is important to each side. With the plans announced nationally and in the European context for Defence and for innovation in general, TNO is in an excellent position to further deepen this collaboration in the coming years.

On behalf of the Council for Defence Research,

Maarten Tossings, chair



Composition of the Executive Board, Supervisory Board, CDR, and Strategic Advisory Councils

Composition of the Executive Board

Distribution of portfolios on the Executive Board

CEO:

- External positioning and profiling of TNO, strategy, corporate governance, point of contact for the Supervisory Board and Works Council, scientific integrity, strategic advisory boards, marketing, communication and public affairs, human resources, internal audit, integrity
- Chair of Executive Board, Chair of Integrity Advisory Board and Diversity & Inclusion Board

COO:

- Operations of units, real estate & facilities, information services, operational excellence & auditing, security, investment in research facilities, corporate social responsibility
- Chair of CDR, Chair of Investment Board, member of CSR Board

CFO:

- Planning & control, financial policy & reporting, risk management, procurement, business intelligence, legal & compliance, valorisation, tech transfer & IP, market strategy, point of contact for TNO Pension Fund Foundation and Supervisory Board Audit Committee
- Chair of Governance, Risk & Compliance Advisory Board, Tech Transfer Board

Dr T.B.P.M. (Tjark) Tjin-A-Tsoi, Chair/CEO (1966)

Since 01-06-2022.

Executive and supervisory positions:

- Executive Board member, Federatie van Samenwerkende Organisaties in het Toegepast Onderzoek (Federation of Applied Research Institutes, TO2)
- Member, Zuid-Holland Economic Board
- Supervisory Board member, Vrije Universiteit Amsterdam (VU)
- Supervisory Board member, PreWonen
- Supervisory Board member, Dutch National Opera & Ballet
- Member, 'Raad van Nesteliers' (Advisory Council), Royal Netherlands Marechaussee
- Member, Royal Holland Society of Sciences and Humanities
- Member, Netherlands Academy for Technology and Innovation (ACTI)

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

Since 15-03-2019.

Executive and supervisory positions:

- Board member, The Netherlands Industries for Defence & Security (NIDV)
- Member of the Executive Committee, NIDV Naval Construction Cluster (NMC)
- Board member, Stichting Maritiem Kenniscentrum (MKC) (Centre for Maritime Expertise)
- Board member, Dcypher
- Chair, Digital Task Force, Zuid-Holland Economic Board
- Supervisory Board member, Holland Metrology
- Supervisory Board member, Stichting Bibliotheek Krimpenerwaard (Krimpenerwaard Library Foundation)

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

Since 01-05-2021.

Executive and supervisory positions:

- Non-executive director, Toxys BV
- Supervisory Board member, Audit Committee chair, and Remuneration Committee member, Acta Marine Holding BV
- Advisory Board member, Top Woman of the Year Foundation
- Supervisory Board member, Biotech Booster BV (from 15-12-2023)

Dr W.C.A. (Aloys) Maas, Secretary (1967)

Since 01-01-2018.



Composition of the Supervisory Board

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

Since 01-07-2019; first term runs until 01-07-2024.

Professional activities outside TNO:

- Chair of the Supervisory Board, Erasmus University Medical Center Rotterdam (until 31-12-2023)
- 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 Foundation) (until 01-07-2023)
- Chairman of the Supervisory Board of Slachtofferhulp Nederland (Victim Support Services Netherlands) and Perspectief Herstelbemiddeling (Perspective Restorative Mediation) (from 01-07-2023)
- Chair of the Board, National Monument Camp Amersfoort Foundation
- Coach, Executive Sherpa Coaching/Mind&Health

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

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

Professional activities outside TNO:

- Chair of the Supervisory Board, CQM (until March 2023)
- Chair of the Supervisory Board, Port of Moerdijk
- Chair of the Supervisory Board, Arnhem and Nijmegen University of Applied Sciences Foundation
- Vice-Chair of the Supervisory Board, CB Logistics
- Member of the Supervisory Board, H&S Group
- Vice-Chair, the Netherlands National Commission for UNESCO
- Chair of the Supervisory Board, Dutch Touring Opera
- Member of the Board, Association of University Supervisors (since 01-08-2023)

Prof. H. (Hester) Bijl (1970)

Since 01-09-2018; first term runs until 01-09-2023.

Professional activities outside TNO:

- Rector Magnificus, Executive Board, Leiden University
- Professor of Numerical Mathematics, Mathematical Institute, Leiden University
- Board member, Leiden Bio Science Park Foundation
- Supervisory Board member, Impuls Zeeland

Mr J.B.P. (Baptiest) Coopmans (1965)

Since 01-02-2021; first term runs until 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
- Supervisory Board member, Royal FrieslandCampina (since 13-12-2022)

Prof. M.P. (Marko) Hekkert (1971)

Since: 01-05-2022, first term runs until 01-05-2027.

Professional activities outside TNO:

- Director, Netherlands Environmental Assessment Agency (PBL)
- Professor of Dynamics of Innovation Systems, Copernicus Institute of Sustainable Development, Utrecht University

Ms J.D. (Jolanda) Lamse-Minderhoud RA (1969)

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

Professional activities outside TNO:

- Partner, PricewaterhouseCoopers (until 01-07-2023)
- Supervisory Board member, Wildlife Justice Commission (until 15-07-2023)
- Member of the Board of Management, PwC Digital Technology Services B.V. (until 01-07-2023)
- Interim director, Stichting Cultuureducatie Dordrecht (from 22-01-2024)
- Supervisory Board member, Amphia Ziekenhuis (from 01-03-2024)

Ms L. (Louise) Verheij van Wijk (1964)

Since 01-10-2019; first term runs until 01-10-2024.

Professional activities outside TNO:

- Chair of the Supervisory Board, Star-shl
- Interim CEO, JoyinCare Group
- Chair of the Supervisory Board, MRI Centre
- Member, IT & Innovation Think Tank of the Netherlands Comprehensive Cancer Organisation (IKNL)

Dr W.C.A. (Aloys) Maas, Secretary (1967)

Since 01-01-2018

All members are Dutch nationals.



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

Rear Admiral A. (Ad) van de Sande

Member, Ministry of Defence, Directorate-General of Policy, Director of Operational Policy and Plans

Dr H.A.H.C. (Hendrik-Jan) van Veen

Member, TNO, Managing Director TNO Defence, Safety & Security

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

List of SAC members as at 31 December 2023

Unit	Mr/ms	Name	Company	Department
Defence, Safety & Security	Ms	Prof. B.A. de Graaf	Utrecht University	Faculty Professor of Humanities, Dep. of History & Art History and History of International Relations
	Ms	Lieutenant General E.F. Boekholt-O'Sullivan	Ministry of Defence	Directorate-General for Policy, Deputy Director-General
	Ms	I.C. Bryan	Dutch Institute for Vulnerability Disclosure (DIVD)	Chair of the Board
	Mr	J.C. Dicke	Ministry of Economic Affairs and Climate Policy	Commissioner of Military Production
	Mr	Major General J.P.L. Duckers	Ministry of Defence	Army Command, Deputy Army Commander (PCLAS)
	Mr	H.G. Geveke	National Police	Board Member
	Ms	Prof. E. Giebels	University of Twente	Professor of Social Psychology of Conflict and Safety
	Mr	G.A. Kuiper	Ministry of Defence	Directorate General for Policy, Strategy Director, Policy Development and Innovation
	Mr	H.J.J. Lenferink	Province of Gelderland	Acting King's Commissioner
	Mr	Prof. E.R. Muller	Leiden University	Dean, Faculty of Governance and Global Affairs/Administrator and Professor of Safety, Security and Law, Leiden University, Campus The Hague
	Mr	Commodore (ret) Prof. F.P.B. Osinga	Ministry of Defence, Leiden University – Institute of Security and Global Affairs	Professor of War Studies
	Mr	L. Roffel	Thales Nederland	Chief Technical Officer
	Ms	H.M.J. Somsen	Ministry of Justice and Security, NCTV	Deputy NCTV and Director of Cyber Security and Nation-State Actor Threats
	Energy & Materials Transition	Mr	T.J.A. Wagenaar	
Mr		Prof. K. Blok	Delft University of Technology	
Mr		O.F. de Bont	Renewi	CEO
Ms		Prof. H.C. de Coninck	Eindhoven University of Technology	Professor of Socio-Technical Innovation and Climate Change
Mr		M.E. Galjee	HyCC	Managing Director
Mr		M. Heijdra	Ministry of Economic Affairs and Climate Policy	Directorate General for Energy, Deputy Director General for Climate & Energy
Mr		J.W. van Hoogstraten	EBN	Managing Director
Mr		R. Miesen	RWE Generation	CEO
Ms		J.C.M. Sap		Supervisory Board member + Chair of social impact team
Mr		W.N. Schouten	BNR	Director, Impact Economy Foundation/BNR
Mr		Y. Sebregts	Shell Global Solutions International B.V.	Executive Vice President Innovation R&D
Mr		Prof. G. van der Steenhoven	Ministry of the Interior and Kingdom Relations (Senior Civil Service) and University of Twente	Advisor to the Ministry of the Interior and Kingdom Relations, Part-time professor UT
Mr		R. van Tilburg	Natuur & Milieu	
Ms		J.C.V. Vaessen	Chemistry NL	Chair, Chemicals Top Sector
Ms		L. de Vries		Climate ambassador and vice president of the Young Climate Movement
Mr		M. Waas	Nobian	Director/VP R&D, Technology and Sustainability
Mr	Prof. E. Worrell	Utrecht University (Copernicus Institute of Sustainable Development)		



Unit	Mr/ms	Name	Company	Department
Healthy Living & Work	Mr	Dr E.E.W. Bruins		Chair AWTI, independent consultant
	Mr	J.P.H. Daems	CNV trade union federation	Board member
	Mr	Prof. A.J. van Gool	Radboud UMC	Professor of Personalised Healthcare
	Ms	M.E.Y. Koster	Janssen-Cilag B.V.	Lead Strategic Alliances & Sustainable Business Strategy Netherlands
	Ms	N. Meijer	De Buitenboordmotor	Co-founder
	Mr	T.A.J. Oostrom	Dutch Kidney Foundation (Nierstichting)	Director
	Ms	Dr V.C.M. Timmerhuis	ZonMw	Managing Director
High Tech Industry	Mr	M.H. Hendrikse	Holland High Tech	Figurehead of the High-Tech Systems & Materials Top Sector (HTSM)
	Mr	Prof. F.P.T. Baaijens	Eindhoven University of Technology (TU/e)	Full Professor of Soft Tissue Biomechanics and Tissue Engineering
	Ms	B.L.J.M. van Dijk-van de Reijt Msc	The Brabant Development Agency (BOM)	Managing Director
	Mr	M. Geraets	NXP Semiconductors Netherlands B.V.	Executive Director
	Mr	S. Hamminga	Robin Radar Systems B.V.	CEO
	Mr	Dr H. van Houten		
	Mr	Dr P.J. Nieuwenhuizen	Enerkem	Vice President Technology Strategy & Deployment
	Mr	R. Postma	Airbus Defence and Space Netherlands B.V.	CEO
	Ms	Prof. B. Redlich	Felix Laboratory Nijmegen/Radboud University	Director
	Mr	Prof. G. van der Steenhoven	Ministry of the Interior and Kingdom Relations (Senior Civil Service) and University of Twente	Advisor to the Ministry of the Interior and Kingdom Relations, Part-time professor UT
ICT, Strategy & Policy	Mr	H.G. Tappel	Bronkhorst High-Tech B.V.	Managing Director
	Ms	S. van Heukelom-Verhage	Pels Rijcken	Chair of the Board
	Ms	Prof. N.M.P. Bocken	Maastricht University	Maastricht Sustainability Institute (MSI)
	Ms	M. Demmers MBA	Natuur & Milieu	Managing Director
	Mr	Prof. M.L.P. Groenleer	Tilburg University	Scientific director of Tilburg Center for Regional Law and Governance (TiREG)
	Mr	S.B. Luitjens		
Mobility & Built Environment	Mr	Prof. M.R. van Steen	University of Twente	Scientific Director
	Mr	J.H. Dronkers	Ministry of Infrastructure and Water Management	Secretary-General
	Mr	C.F. Eggink	HeartWork	Co-founder
	Mr	B. Janssen	Deltalinq	Managing Director
	Ms	C. Kremer	Vereniging Eigen Huis	Director
	Ms	N. van 't Riet-Visser	DB Cargo NL	CEO
	Mr	B.P. Smolders	Heijmans	Director of Infra
	Mr	F. Vermeulen BA	Municipality of Wageningen	Mayor
	Mr	R.P. van Wingerden MBA	Strukton, Topteam Logistiek, among others	CEO
Mr	Prof. R. Zuidwijk	Rotterdam School of Management, EUR	Professor of Global Supply Chains and Ports	



GRI table

Statement of use: TNO has not reported the quoted information in this GRI table for the period 1 January 2023 to 31 December 2023 in reference to or in accordance with GRI standards. However, this table has been prepared in the spirit of GRI's guidelines.

GRI 1 used: Foundation 2021

GRI Standard	Disclosure	Location
GRI 2: General Disclosures 2021	2-1	Organisational details Table of contents – About this report Stakeholders
	2-2	Entities included in the organisation's sustainability reporting Table of contents – About this report
	2-3	Reporting period, frequency, and contact point Table of contents – About this report Publication details
	2-5	External assurance Auditor's report
	2-6	Activities, value chain, and other business relationships Stakeholders Value creation Strategy – Mission and vision Strategy – Core tasks Strategy – Small and medium-sized enterprises Strategy – Time-to-market Strategy – Strategic programmes
	2-7	Employees TNO key figures Home for talent indicators
2-9	Governance structure and composition Operations – Organisational structure Report of the Supervisory Board Report of the Council for Defence Research Composition of the Executive Board, Supervisory Board, CDR, and Strategic Advisory Councils	
2-22	Statement on sustainable development strategy Preface by the CEO Value creation Strategy – Mission and vision Strategy – Stakeholders Strategy – Impact Sustainable and responsible operations	

GRI Standard	Disclosure	Location
	2-23	Policy commitments Sustainable and responsible operations
	2-26	Mechanisms for seeking advice and raising concerns Sustainable and responsible operations – Governance
	2-29	Approach to stakeholder engagement Stakeholders Strategy – Stakeholders Composition of the Executive Board, Supervisory Board, CDR, and Strategic Advisory Councils
GRI 3: Material Topics 2021	3-1	Process to determine material topics Strategy – Stakeholders
	3-2	List of material topics Strategy – Stakeholders
GRI 301: Energy 2016	302-1	Energy consumption within the organisation Sustainable and responsible operations – Environment
	302-3	Energy intensity Sustainable and responsible operations – Environment
	302-4	Reduction of energy consumption Sustainable and responsible operations – Environment
	305-1	Direct (Scope 1) GHG emissions Sustainable and responsible operations – Environment
	305-2	Energy indirect (Scope 2) GHG emissions Sustainable and responsible operations – Environment
	305-3	Other indirect (Scope 3) GHG emissions Sustainable and responsible operations – Environment
	305-4	GHG emissions intensity Sustainable and responsible operations – Environment
	305-5	Reduction of GHG emissions Sustainable and responsible operations – Environment
GRI 401: Employment 2016	401-1	New employee hires and employee turnover Operations – Home for talent Operations – Home for talent indicators
GRI 405: Diversity and Equal Opportunity 2016	405-1	Diversity of governance bodies and employees Operations – Home for talent Operations – Home for talent indicators



Limited assurance report of the independent auditor on selected indicators

To: the Executive Board of Nederlandse Organisatie voor Toegepast-natuurwetenschappelijk onderzoek

Our conclusion

We have performed a limited assurance engagement on selected indicators in the accompanying annual report for the year 2023 of Nederlandse Organisatie voor Toegepast-natuurwetenschappelijk onderzoek (hereinafter: TNO) at The Hague.

Based on our procedures performed and the assurance information obtained, nothing has come to our attention that causes us to believe that the selected indicators are not prepared, in all material respects, in accordance with the applicable criteria as included in the section 'Criteria'.

The selected indicators concern:

- Carbon footprint (scope 1 and 2 as included on page 49 (and marked with an “**”))
- Number of FTE Workforce (as included on page 4)
- Absenteeism rate (as included on page 41)
- Absenteeism reporting frequency (as included on page 41)
- Number of Patent families (as included on page 4)
- Number of Premier depots (as included on page 4)
- Number of Professors and professors of applied science (as included on page 4)
- Number of Publications and proceedings (as included on page 4)

Basis for our conclusion

We have performed our limited assurance engagement on the selected indicators in accordance with Dutch law, including Dutch Standard 3000A 'Assurance-opdrachten anders dan opdrachten tot controle of beoordeling van historische financiële informatie (attest-opdrachten)' (Assurance engagements other than audits or reviews of historical financial information (attestation engagements)). Our responsibilities in this regard are further described in the section 'Our responsibilities for the assurance engagement on the selected indicators' of our report.

We are independent of TNO in accordance with the “Verordening inzake de onafhankelijkheid van accountants bij assurance-opdrachten” (ViO, Code of Ethics for Professional Accountants, a regulation with respect to independence). This includes that we do not perform any activities that could result in a conflict of interest with our independent assurance engagement. Furthermore, we have complied with the “Verordening gedrags- en beroepsregels accountants” (VGBA, Dutch Code of Ethics for Professional Accountants).

We believe that the assurance evidence we have obtained is sufficient and appropriate to provide a basis for our conclusion.

Criteria

The criteria applied for the preparation of the selected indicators are the criteria developed by TNO and are disclosed on pages 74 of the 2023 annual report. The comparability of selected indicators between entities and over time may be affected by the absence of a uniform practice on which to draw, to evaluate and measure this information. This allows for the application of different, but acceptable, measurement techniques.

Consequently, the selected indicators need to be read and understood together with the criteria applied.

Corresponding information not assured

The selected indicators for the period 2019 up to 2022 have not been part of an assurance engagement. Consequently, the corresponding selected indicators and thereto related disclosures for the period 2019 up to 2022 are not assured. Our conclusion is not modified in respect of this matter.



Limitations to the scope of our assurance engagement

Our assurance engagement is restricted to the selected indicators. We have not performed assurance procedures on any other information as included in the annual report in light of this engagement.

The references to external sources or websites are not part of our assurance engagement on the selected indicators. We therefore do not provide assurance on this information.

Our conclusion is not modified in respect of these matters.

Responsibilities of the Executive Board and the Supervisory Board for the selected indicators

The Executive Board is responsible for the preparation of the selected indicators in accordance with the criteria as included in the section “Criteria”. The Executive Board is also responsible for selecting and applying the criteria and for determining that these criteria are suitable for the legitimate information needs of the intended users, considering applicable law and regulations related to reporting. The choices made by the Executive Board regarding the scope of the selected indicators and the reporting policy are summarized on page 74 of the 2023 annual report.

Furthermore, the Executive Board is responsible for such internal control as it determines is necessary to enable the preparation of the selected indicators that are free from material misstatement, whether due to fraud or error.

The Supervisory Board is responsible for overseeing the reporting process of the selected indicators of TNO.

Our responsibilities for the assurance engagement on the selected indicators

Our responsibility is to plan and perform the assurance engagement in a manner that allows us to obtain sufficient and appropriate assurance evidence for our conclusion.

Our assurance engagement is aimed to obtain a limited level of assurance to determine the plausibility of the selected indicators. The procedures vary in nature and timing from, and are less in extent, than for a reasonable assurance engagement. The level of assurance obtained in a limited assurance engagement is therefore substantially less than the assurance that is obtained when a reasonable assurance engagement is performed.

We apply the ‘Nadere voorschriften kwaliteitssystemen’ (NVKS, regulations for quality management systems) and accordingly maintain a comprehensive system of quality management including documented policies and procedures regarding compliance with ethical requirements, professional standards and other relevant legal and regulatory requirements.

Our assurance engagement included amongst others:

- performing an analysis of the external environment and obtaining an understanding of the sector, insight into relevant sustainability themes and issues and the characteristics of the company as far as relevant to the selected indicators;
- evaluating the appropriateness of the criteria applied, their consistent application and related disclosures on the selected indicators. This includes the evaluation of the reasonableness of estimates made by the Executive Board;
- obtaining through inquiries a general understanding of the internal control environment, the reporting processes, the information systems and the entity’s risk assessment process relevant to the preparation of the selected indicators, without obtaining assurance information about the implementation or testing the operating effectiveness of controls;



- identifying areas of the selected indicators where misleading or unbalanced information or a material misstatement, whether due to fraud or error, is likely to arise. Designing and performing further assurance procedures aimed at determining the plausibility of the selected indicators responsive to this risk analysis. These procedures consisted amongst others of:
 - making inquiries of the Executive Board and/or relevant staff responsible for the sustainability strategy, policy and results relating to the selected indicators;
 - Interviewing relevant staff responsible for providing the information for, carrying out controls on, and consolidating the data in the selected indicators;
 - obtaining assurance evidence that the selected indicators reconcile with underlying records of TNO;
 - reviewing, on a limited sample basis, relevant internal and external documentation
 - considering the data and trends;
- reading the information in the 2023 annual report that is not included in the scope of our assurance engagement to identify material inconsistencies, if any, with the selected indicators;
- considering whether the selected indicators are presented and disclosed free from material misstatement in accordance with the criteria applied.

Amsterdam, 14 March 2024

Ernst & Young Accountants LLP

signed by R.T.H. Wortelboer



Appendix

List of definitions

A number of KPIs have been reviewed by our auditor EY. EY's conclusion on these KPIs is included under 'Statement on other information included in the annual report'. The definitions used for these KPIs are given below.

Carbon footprint (scope 1-2)

The definition we use conforms to the Greenhouse Gas Protocol. A more detailed explanation of our calculation method can be found [here](#).

Scope 1: direct emissions from TNO's own operations (including direct lab emissions, fuel for vehicles, and gas consumption in buildings).

Scope 2: indirect emissions from TNO's own operations (including energy consumption such as heat and electricity).

FTE workforce

The equivalent number of TNO employees and hires with full-time employment contracts (40 hours) at the end of December.

Absenteeism rate and reporting frequency

Absenteeism rate: the total number of sick days of TNO employees (adjusted for FTE percentage and disability percentage) as a percentage of the total number of calendar days (adjusted for FTE percentage) of the total number of TNO employees.

Reporting frequency: the number of unique sickness reports (one report per 28-day sickness period) divided by the number of calendar days (adjusted for FTE percentage) of the number of TNO employees.

Patent families and premier depot

Patent family: a collection of patent applications and/or granted patents filed in different countries for the same invention as at the end of December.

Premier depot: the number of first patent applications filed for an invention in the relevant year.

Professors and professors of applied science

The number of TNO employees with professorships and/or professorships of applied science at the end of December.

Publications and proceedings

The number of peer-reviewed publications in scientific journals and number of proceedings at the end of December. Later delivered publications from previous years that were not reported earlier are counted in the year of delivery. Proceedings are a published report of a scientific conference, congress, symposium or other (similar) meeting.



Publication details

Would you like to know more about TNO?
Do you have any questions after reading
this report or do you have any ideas?
Please contact us at
info@tno.nl

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TNO, Marketing & Communications

Design and production

CF Report, Amsterdam

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