

TNO innovati  
for life

# THE IMPACT OF TNO

TNO innovation  
for life

PROF. DR. ALEXANDER RINNOOY KAN, CHAIRMAN SER:

“WHEN I SEE TNO IN ACTION,  
I AM AMAZED AND GRATEFUL.  
TNO IS THE MODEL  
**INTERNATIONALLY ORIENTED  
KNOWLEDGE INSTITUTE**”

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# › THE IMPACT OF TNO





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# FOREWORD

Developing knowledge is something you do together. At TNO we do this every day. But working on practicable solutions to complex problems is not something you do on your own. That's why companies, government, authorities and other organisations work a lot with us. And we are keen to work with them.

Effective innovation is what TNO stands for. We develop knowledge not for its own sake but to be used by others. This publication describes 10 examples of how we do this, each one presenting a timeline from knowledge development through public-private partnership and knowledge transfer to ultimate impact. We believe in this co-creation of value in both societal and economic terms.

We focus on societal themes where change or transition is required. Our mission is, and will continue to be, to find the specific areas in which we can best support society and, by doing so, realise the greatest possible impact.

I invite you to join me in looking back at the period 2011–2014 and to be inspired by the work that we have done with our stakeholders. Moreover, I invite you to join us in working on the transitions that concern us today.

*Paul de Krom*  
*Chairman of the TNO Executive Board*

# MAXIMISING THE **POTENTIAL** OF **ALGAE**

## › **KNOWLEDGE DEVELOPMENT**

Within the Sustainable Chemistry and Healthy Living collaboration, TNO has been researching how to optimise the use of micro-algae. Algae contain valuable ingredients, grow rapidly and can be cultivated on infertile soil. So algae can be rightly regarded as the agricultural crop of the future. But to get the high-grade ingredients out of the algae new knowledge is needed.

## › **KNOWLEDGE TRANSFER**

The consortium comprises of De Wit Speciality Oils, Van Wijhe Verf, SABIC (ingredient processors), Bühler (technology provider), Royal HaskoningDHV (engineering) and Algae Food and Fuel AF&F (algae supplier). Together we co-developed the mobile pilot plant VALORIE to test out the production process at a variety of sites. The findings will later be used to scale up to industrial pilots capable of large-scale production.

## › **PUBLIC-PRIVATE PARTNERSHIP**

We have formed a consortium to create a new chain for algae biomass and algae ingredients. Together with its partners TNO has developed vital knowledge at lab scale to open algae in an energy-efficient way so that the individual ingredients such as proteins, oils and carbohydrates can be extracted.



# IMPACT

TNO has produced a technology that is unique to the world. It enables the tough cell walls of algae to be broken without causing damage and therefore allows the valuable contents such as proteins, oils, fats, carbohydrates and other high-grade fractions to be extracted. These ingredients are vital to the food and feed industry as well as for the production of chemical and pharmaceutical (semi-manufactured) products. Over the coming years these companies will be able to produce such ingredients profitably.

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# LESS SALT, SUGAR AND FAT IN FOOD WITH NO LOSS OF QUALITY OR EXTRA COSTS

## › KNOWLEDGE DEVELOPMENT

In collaboration with Food Quality and Production, we have developed scientifically based models to produce healthier food without compromising taste or quality.

We have developed methods that can quickly and effectively determine the quality of the food.

## › PUBLIC-PRIVATE PARTNERSHIP

In the 'Multiple reformulation' project we collaborated with a cluster of seven industrial parties on substantially reducing the salt, sugar and fat content in a range of products.

Together with three industrial partners in the VETlesS project we developed a new production process and improved composition for meat products containing less fat.

With other producers we worked on reducing the sugar content in candy bars and on innovative solutions to reduce salt in soups and sauces by half.

## › KNOWLEDGE TRANSFER

In the EU project HealthBread we worked together with a consortium of the Finnish VTT research centre, the Netherlands Bakery Centre, ingredients suppliers and SMEs to develop innovative, healthy and tasty bread products.

We transferred bakery knowledge in an SME technology cluster to reduce the amount of saturated fatty acids in their products.



# IMPACT

Bread that feels and tastes like white bread but is as healthy as the wholemeal bread we are familiar with in our country. Consumers in southern Europe, who are averse to our sturdy brown bread, seemed to love it. This exceptional scientific achievement by a consortium led by TNO signifies a major contribution to a healthier diet and the reduction of heart and vascular disease, diabetes and obesity. Bakers throughout Europe are already supplying HealthBread and even the US is preparing to launch the product. Research by TNO means that Dutch and international food producers can make healthier products without an increase in the cost price.

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Along with the RIVM and Wageningen UR we have gained new insights into consumer acceptance of a healthier range of foods and a change in unhealthy diets.

# FOCUS, **MASS**, PARTNERSHIP

We, the three thousand or so professionals at TNO, work together to solve societal issues, connecting people and knowledge to this end. In this way we create innovations that sustainably boost the competitiveness of business and industry and the wellbeing of society. That is our mission.

Between 2011 and 2014 we focused on seven societal themes, using our knowledge base to generate many innovative solutions, developed largely in public-private partnerships. We have since, partly in view of the declining government funding for applied research, strengthened our focus in five transitions:

- from economic stagnation to growth in the high-tech industry
- from illness and care to health and behaviour
- from a diversity of threats to manageable risks
- from bottlenecks due to urbanisation to dynamic urban regions
- from conventional resources to renewable energy systems ▶



PATENT APPLICATIONS



PATENT FAMILIES



PERCENTAGE OF  
PATENT FAMILIES USED  
EXTERNALLY



**7.325**

NUMBER OF PUBLICATIONS

SCIENTIFIC  
IMPACT  
OF TNO

**69**

**> 20.000**

NUMBER OF CITATIONS

► Of course, we are taking a multidisciplinary approach to the complexity of these transitions. We also believe in the co-creation of value: open innovation, shared research, with parties at home and abroad, governments and authorities, companies from large to small, universities and other knowledge institutions.

The success of this approach is evident in, for example, the Holst Centre, where some 200 people from around thirty different countries and tens of industrial partners work together on sensor technologies and flexible electronics. More recent initiatives in this context include Biorizon in the field of chemistry, Solliance for flexible solar cells, QuTech for quantum computers and the partnership with Wageningen UR in the area of personalised food among other things. ■

TNO EMPLOYEES

**4135**

IN 2011

**3009**

IN 2014



# MORE EFFECTIVE CAMERA SURVEILLANCE IN PUBLIC AREAS

## › PUBLIC-PRIVATE PARTNERSHIP

The EU project TACTICS (2012), in which we are working as coordinator with ten domestic and foreign partners, is geared to detecting terrorist threats and radicalisation.

In the Sight police project (2014) we work on the ad hoc connection of private and public sensors for a better up-to-date picture of safety and security.

In the Surveillance & Security programme we are co-developing a new security concept with the police and marechaussee for objects that may pose a terrorist threat.

TNO works with the National Police, security regions and industry on innovations in the field of real-time intelligence to enable the technology, organisations, process and people to perform as intelligent, flexible networks. This leads to cross-regional alerts, better ways of engaging the public in safety and security and better data-sharing among all those involved.

## › KNOWLEDGE DEVELOPMENT

In the Safety and Security collaboration we have used new video-analysis (VCA) methods to boost safety and security. VCA is the automatic interpretation of video images and we have developed methods to quickly and effectively identify important signals for threats and crisis situations.

Improved operating processes create more up-to-the-minute information that allows the role of the camera operators to become proactive rather than reactive. We are exploring how automatic calibration can help to quickly analyse content and how VCA on bodycam images can make mobile camera surveillance more effective.

## › KNOWLEDGE TRANSFER

The government will be investing substantially in safety and security in the coming years via the National Innovation Agenda on Safety and Security (NIAV). Within this context TNO is focusing, within the field of sensing and sensors, on:

- improving situational awareness:  
mobile, connected, real-time
- emergency centres: Shared Security Operations  
Centre International Zone
- drones: air space control
- urban environment: Smart City programmes



# IMPACT

The early identification of risks, and taking subsequent fast and effective action, is crucial for our safety and security. SMEs are keen to exploit our technological findings. As in a smart (CLVR) surveillance system that operates by image recognition and motion detection developed by two companies. This created interest from a foreign multinational that is now selling the system worldwide. A nice example of how TNO technology developed for defence or the police has found its way in to the civilian world.

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# SENSORS MEAN **SIGNIFICANT SAVINGS** ON BRIDGE MAINTENANCE

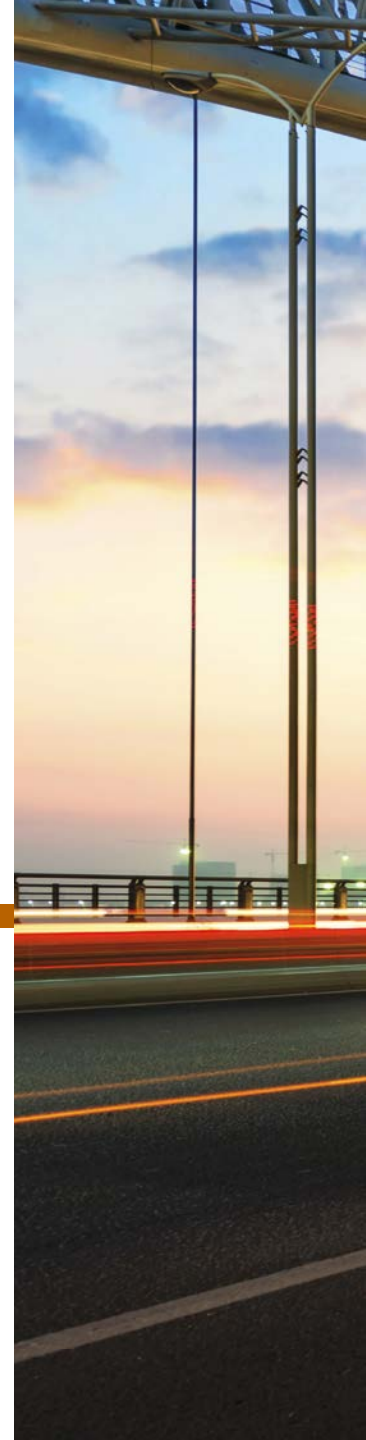
## › KNOWLEDGE TRANSFER

The world's smartest bridge: in collaboration with the partnership Sustainable Building and Directorate-General for Public Works and Water Management (Rijkswaterstaat). This was the pilot for the rollout of the monitoring and modelling of the Van Brienenoord bridge in Rotterdam. Collaboration contracts with local authorities on the basis of the results of the Van Brienenoord bridge pilot.

## › KNOWLEDGE DEVELOPMENT

TNO develops methods and technologies that reduce the maintenance costs of our infrastructure throughout its lifetime. One of the ways to do this is through much more precise planning of bridge maintenance.

In the Sensors Enabling Technology Programme (ETP) we have developed a new way of collecting information through the smart use of sensor technology. In the Modelling ETP we worked on predicting the behaviour of the bridge on the basis of monitoring parts of the bridge using highly sensitive sensors. Special calculation models can determine where and when problems will occur in the structure before they actually do.





# IMPACT

Thanks to a new method developed by TNO the Dutch government will be able to make significant maintenance saving on bridges, viaducts and locks.

Sensors enable the precise calculation for how long these structures can be safely used, thereby avoiding unnecessary early replacement or renovation.

The Dutch companies involved have good opportunities to export this technology because similar needs exist abroad.

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EUROPEAN COMMISSIONAR NEELIE KROES:

“THE CURRENT WAY RESEARCH AND INNOVATION IS FUNDED IS NOT ALIGNED WITH MANY SMALL COMPANIES AND RESEARCH TEAMS. LOCAL DIGITAL AGENDAS BRING EUROPE CLOSER. WE GET A LOT OF SUPPORT FROM INNOVATIVE REGIONS LOOKING FOR CONNECTIONS WITH AND POSSIBILITIES TO LEARN FROM, AS WELL AS SHARE WITH, OTHER REGIONS AND CITIES IN EUROPE. IN THIS RESPECT THE **PROVINCE OF FRIESLAND** HAS TAKEN THE LEAD **TOGETHER WITH TNO**”



52 PROFESSOR



15 LECTURER

# THE NETHERLANDS AND TNO

The Netherlands is among the world's elite when it comes to trade and industry. But it is not a position to be taken for granted. Innovation is crucial to keeping it. This challenge is central to Dutch innovation policy. A policy that has selected five societal themes and nine top sectors.

Since the start we have had an active role in all top sectors and generate valuable contributions in close collaboration with industry, government and other knowledge institutions, ensuring that the 'triple helix' creates innovative solutions that can strengthen our economy and society.

We work together with the other applied research institutions in the Federation T02: Marin, Deltares, National Aerospace Centre (NLR), Agricultural Research Centre (DLO) and Energy research Centre of the Netherlands (ECN).

We also work with research and education institutions such as universities and institutes of higher education. We cluster strengths to accelerate innovations; each with its own focus and complementary to the collaboration. Knowledge sharing and the efficient use of each other's facilities and capacities are things we do on a daily basis.

Our more than fifty professors bridge academic and applied research, bringing the knowledge of TNO to their department and, vice versa, bringing knowledge back to TNO. The fifty or so lecturers at institutes of higher education take a similar approach. ►

SIMON BAMBACH, MSc  
CEO VDL ENABLING TECHNOLOGIES GROUP:

“HOW DO YOU TURN BASIC TECHNOLOGIES INTO SOMETHING THAT WORKS? YOU CAN'T REALLY DO WITHOUT INSTITUTIONS LIKE TNO ... WE DO BUSINESS WITH TNO IN A LOT OF FIELDS AND APART FROM **GOOD RESULTS** THAT GENERATES **NEW INCENTIVES**”

DRS. DICK SCHOOF, NATIONAL COORDINATOR  
FOR COUNTERTERRORISM AND SECURITY:

“NEW, INCREASINGLY COMPLEX SECURITY ISSUES  
ARISE CONSTANTLY. WE WORK WITH TNO IN A  
VARIETY OF PROGRAMMES. TNO IS ONE OF OUR  
**KEY KNOWLEDGE PARTNERS**”

► Apart from the role we play in the focal areas of the top sectors and societal themes, we perform specific tasks for a number of government ministries. These are defence research for the Ministry of Defence, deciphering information on the Dutch subsurface for the ministries of Economic Affairs and Infrastructure and the Environment and improving job participation for the Ministry of Social Affairs and Employment.

Finally, we create new employment opportunities with TNO Companies B.V. by launching innovations in the form of startups and valorising knowledge through issuing licences. Here, too, we seek collaboration, as in the close relationship with YES!Delft, a TU Delft incubator. ■



**308**  
UNIVERSITIES  
(NL)

NUMBER OF  
PATENTS



**409**  
TNO

## PATENTS AND LICENCES

The final step in the innovation funnel is commercialisation of research and knowledge. For instance, by selling patents and encouraging entrepreneurship. The patents of TNO protect knowledge and products. These days a patent seldom protects against violation. It is more pertinent to have patent families on strategically relevant knowledge positions.

Many of TNO's patents are used by other parties in the form of licences, from startups and SMEs through to large companies. The percentage of patents used by companies in this way grew substantially during the last strategy period.

## ORIGIN OF OUR REVENUE

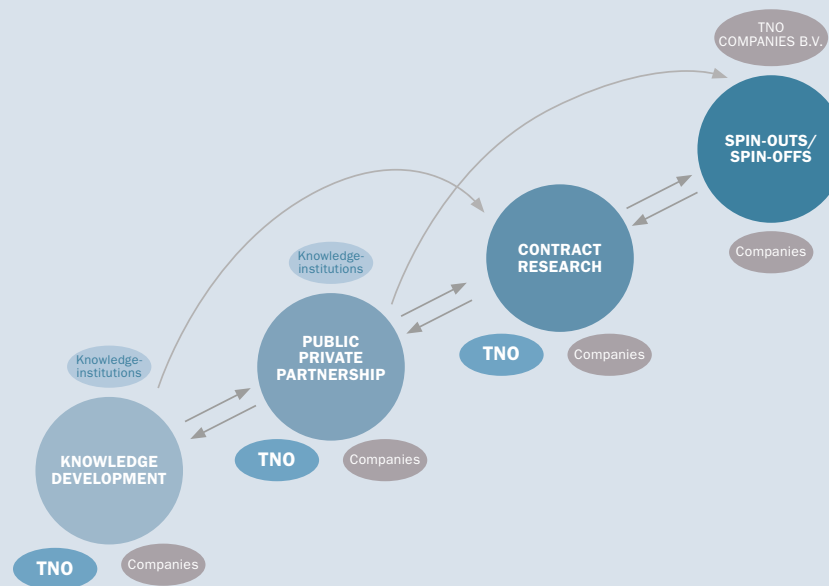
Knowledge development is responsible for around a third of our revenue. Inspired by demands from industry and government, we develop and maintain a broad and deep knowledge base for the Netherlands. A similar proportion of our revenue comes from knowledge developed with and partly funded by industry and government. We undertake these collaborative programmes in our demand-driven programmes and this contributes to our knowledge base. The immediate aim of these programmes is to boost the competitiveness of industries in the top sectors and support government policy.

The final third of our revenue derives from contract research where we solve problems for industry, government and other organisations insofar as these come within our selected themes. TNO also enables the exploitation of knowledge by around forty companies within TNO Companies B.V.

## SPIN-OUTS/SPIN-OFFS

TNO Companies B.V. commercialises and exploits the knowledge developed by TNO that no longer fits within the TNO portfolio and whose opportunities are improved in a private setting. In this way TNO 'bridges' innovation and valorisation via risk-bearing connections with industry and venture capitalists. The 40 or so companies held by TNO Companies B.V. had a joint gross revenue of 113 million euros\* at the end of 2014.

\* This is the consolidated revenue of the group companies in which TNO has a holding of 50% or more.



# CO2 CAPTURE, TRANSPORT AND STORAGE

## › KNOWLEDGE DEVELOPMENT

Many CCS (Carbon Capture and Storage) research programmes are limited to laboratory or pilot scale, or individual topics. The TNO coordinated programme, CATO2, has therefore been organised as a comprehensive demand-driven research project in which we combine fundamental research performed at ten universities with practical support for industrial pilots and demonstration projects.

## › KNOWLEDGE TRANSFER

CATO2 is the national research programme for Capture and Storage. Knowledge transfer is done through the organisation of workshops, participation in conferences and a website containing technical scientific information where, apart from the research results, arguments from supporters and opponents can be found. Each year CATO2 organises a CCS event, published newsletters, popular scientific publications and helps the government formulate policy.

## › PUBLIC-PRIVATE PARTNERSHIP

In the CATO2 programme some 40 parties (research institutions, industry, NGOs, SMEs and government) are collaborating closely on the basis of public-private funding. Thanks to the broad composition, this has led not only to valuable knowledge but also to major societal value and solutions in tangible solutions, such as ROAD, the Rotterdam Storage Capture Demo.



# IMPACT

CATO2 has led to new insights into and the effective reduction of the risks associated with the capture, transport and storage of CO<sub>2</sub>. In addition, newly developed methods for capture lead to significant cost savings (>25%). On the basis of the research into subsurface storage the first storage permit has been granted under the European CCS Directive.

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# CONVERTING **BIG DATA** FROM SENSOR NETWORKS INTO **SMART DATA**

## › **PUBLIC-PRIVATE PARTNERSHIP**

Collaboration with knowledge, private and public partners has enabled us to develop the data integration as well as data distribution, with successful application in different domains.

A striking example was the EU Urban Flood programme, led by TNO, which was ranked as excellent by the European Commission.

Within the programme Smart Dairy Farming sensor technology and big data are being used to give dairy farmers better recommendations concerning aspects like rearing young cattle and the fertility of dairy cows.

The STOOP co-funding project is geared to big data applications in the mains management of gas and water transport companies.

## › **KNOWLEDGE TRANSFER**

In 2015 TNO transferred the operation of part of the Anysense™ technology to the company Prime Data, which will continue the development in its Smart Data proposition. This means data enrichment by linking up to (scientific) models and open datafiles, making the data available for visualisations and predictions.

## › **KNOWLEDGE DEVELOPMENT**

We have been researching integration, standardisation and real-time analysis of data from sensor networks, focusing on the visualisation and presentation of the data and creating an ecosystem.



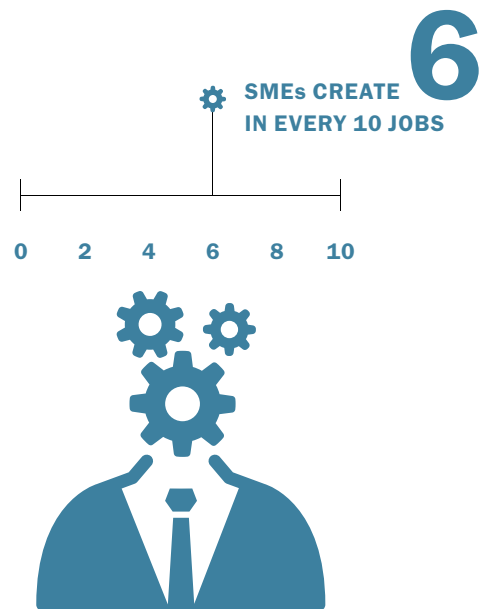
# IMPACT

Converting big data into smart data, or collecting, enriching and deciphering real-time data from large-scale sensor networks to generate information that can be used for domains like mobility, logistics, industry and energy.

This TNO technology now enables dikes to be intelligently monitored, for example, and the traffic intensity to be measured in the Amsterdam waterways using sensors. While this is happening now in our country, Dutch companies have used the technology to make products that are ready for and are sold in markets on the other side of the world. As in China where an intelligent monitoring system for dike monitoring has been placed along the Yellow River. The technology is also an important building block for Smart Industry and Smart Cities.

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# PARTNER FOR SMEs



SMEs are the engine that drives our economy, creating six in every ten jobs and good for 60 of every 100 euros earned in business and industry. And knowledge is what drives innovation, certainly in the SME sector. This is precisely why TNO is active in many ways for and with SMEs. Because we believe in successful innovation through collaboration between entrepreneurs and our technology experts to develop new products and improve existing ones. We aim to make Dutch SMEs more innovative. And so help boost the economy and jobs.

For SMEs who are actively innovative, we organised the tenth edition of 'Technology seeks entrepreneur' in 2014, an event that was attended by hundreds of SMEs. We presented the exceptional findings we had developed and which we want to see commercialised by entrepreneurs. In this way SME entrepreneurs succeed in getting various new products and services into the market each year on the basis of TNO technology.

We also give them the opportunity to get to know new technology, something this group of SMEs may not otherwise so easily come into contact with. Furthermore, in sixteen episodes of the TV programme Dutch Entrepreneurs Club on RTL7, TNO enabled a wide audience to find out about these special TNO technologies that have been used and commercialised by entrepreneurs. These vary from making hamburgers out of beet waste to helping the police combat criminals via a special app.

TNO also works closely with SME Netherlands, affiliated sector associations, the Chamber of Commerce, the Netherlands Enterprise Agency and individual companies. That also produces many breakthrough innovations.

TNO has the most active SME programme of all Dutch knowledge institutions. We have a special SME team that supports entrepreneurs to make a success of their innovation. TNO-wide there hundreds of TNO experts actively working for SMEs every day. Each year we do more than three thousand assignments for and with SMEs. Now almost a quarter of all our assignments come from SMEs. ■

MARTIJN VERBEEK OF BLITTS:

“THE BLITTS STARTUP IN THE HAGUE SAVES CITIZENS AND MUNICIPALITIES MONEY AND WORRIES IN APPLYING FOR PERMITS FOR SIMPLE RENOVATIONS BY PROCESSING THE APPLICATIONS ONLINE. I GOT THE TIP BY PAYING A VISIT TO TNO’S **TECHNOLOGY SEEKS ENTREPRENEUR**. THEY HAD DEVELOPED SOMETHING VERY CLOSE TO AN IDEA THAT WAS IN MY HEAD. DURING THE COMPANY’S DEVELOPMENT, TNO PEOPLE COLLABORATED VERY ACTIVELY AND CAME ALONG WITH GREAT IDEAS”

# HIGHER PARTICIPATION AND SELF-SUFFICIENCY FOR RESIDENTS WITH COMPLEX OR MULTIPLE PROBLEMS

## › KNOWLEDGE DEVELOPMENT

In collaboration with Work and Health we have developed and produced an integrated approach for triage, transit and intensive counselling (case management). New insights have been gained into the effectiveness of the approach through measuring the effects and evaluating the process.

## › KNOWLEDGE TRANSFER

The integrated approach diagnostic tool has been made transferable for use in other municipalities (distributing knowledge of the self-sufficiency matrix). The business case model and shared benefit modelling are now being used in Amsterdam (IJ office), The Hague (Parnassia), Utrecht (ROS) and Hardenberg (Vital Vechtdal).

The integrated approach is an innovative example for providers, municipalities (VSW living lab) and health insurers ('parel' project Achmea). In the EU it is known as 'innovative integrated care' (action group B3, EIP/AHA).

## › PUBLIC-PRIVATE PARTNERSHIP

We have developed an information system with the insurer Achmea and the municipality of Amsterdam for the operational implementation of an integrated approach. For care professionals we have made a training programme and a serious game to teach them how to use this approach.

TNO has developed an entirely new business case and model that enable a better distribution of income and expenditure among care providers, insurers and municipalities. We have also created innovative administrative and operational collaboration between the providers of care and wellbeing.



# IMPACT

We have developed an innovative, integrated approach to care and demonstrated that within half a year it improves the self-sufficiency among citizens with complex or multiple problems. And, an equally pertinent point: the investments pay for themselves within three years. The 'Beter Samen in Noord' (Better Together in the North) living lab has come up with an innovative concept for the cost-effective implementation of shifting youth care, long-term care and the schemes for re-integration and modified work to municipalities (3d operation). Which means that the parties concerned kill three birds with one stone: better service to citizens, a healthier population and lower costs of care and wellbeing (triple target).

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# DUTCH TRIPLE HELIX LEADS THE WORLD IN **RADAR RESEARCH** AND APPLICATIONS

## › KNOWLEDGE DEVELOPMENT

The programme for cooperation with the defence industry (DGI) is specifically geared to topics in the two HTSM Roadmaps: Security and Components and Circuits. This mainly concerns activities in the field of active sensors.

Platform Nederland Radarland was established by Thales Nederland, TNO, TU Delft and the ministries of Economic Affairs and Defence to maintain the leading position of the Netherlands in the field of research and development for radars.

D-RACE, the Dutch Radar Centre of Expertise is a strategic collaboration between Thales Nederland and TNO, focusing on accelerated innovation, which involves a variety of companies, including many specialist SMEs. The technology knowledge base generates demonstrable spill-over effects to other economic sectors.

The activities are aligned with the Strategic Research Agendas of the European Defence Agency (EDA), something that will become increasingly the case in the future with the ECSEL and CATRENE Joint Undertakings of the EU.

## › KNOWLEDGE TRANSFER

To reinforce the HTSM Roadmaps the programme has made specific acquisitions for foreign contract research, in addition to national technology projects (NTP) for the Ministry of Defence together with Dutch industry and SMEs. Other activities were the licensing of the IP created for monolithic microwave integrated circuits (MMIC), among others, a field in which TNO is world leader.

Platform Nederland Radarland acts as the knowledge arena and ecosystem for the DGI demand-driven programme. A related proposal, in part by the Ministry of Economic Affairs, aims to extend this to 'Sensors for Security'.

There is now a healthy basis for future growth through structural participation in the EU Joint Technology Initiatives (JTI) ECSEL and CATRENE, and through contracts with the Dutch defence industry.



# IMPACT

The new patrol vessels of the Royal Netherlands Navy that have been operating since 2012 are equipped with a unique, innovative mast that fully integrates all radars, antennas and electro-optical sensors. The same mast can be found on the JJS Karel Doorman that was launched in 2015. The mast is the result of cooperation in the triple helix of Defence, TNO and Thales that adds to the leading knowledge and market position of the Dutch radar industry, which is acknowledged all over the world.

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## RESEARCH CONSORTIA

TNO works in hundreds of national and international research programmes for the joint development of knowledge.

### 7th EU framework programme (± 400 projects)

- Own contribution TNO: **95 million**
- EU contribution: **195 million**
- R&D value: **3 billion**

# EXCELLING INTERNATIONALLY

TNO's playing field is neither the Netherlands nor Europe but the world. Which is why our three thousand experts are in constant touch with the elite of their fields. We are also internationally active by exploiting opportunities abroad together with Dutch industry. These activities mean that we help make the Netherlands an attractive international living lab in which foreign companies and knowledge institutions are keen to locate.

“OUR RELATIONSHIP WITH TNO IS INVALUABLE. SPACE IS A DIFFICULT, HIGH-GRADE TECHNOLOGICAL FIELD OF WORK IN WHICH WE TAKE GREAT RISKS. TO MANAGE THOSE RISKS WE NEED **THE BEST EXPERTISE** WE CAN GET”

Our offices in Qatar and on Aruba are not only bases from where we do research with local government and industry and international companies but they also form a hub with growth markets in the Middle East and South America respectively.

TNO makes effective use of the European research programmes FP7 and its successor, Horizon 2020, to strengthen its knowledge base. The European Union wants Horizon 2020 to boost Europe's competitiveness by inviting industry and the knowledge infrastructure to co-create solutions to the societal issues that confront the whole of Europe. We are the only European knowledge institution to be a participant in all five existing Knowledge and Innovation Communities: Climate KIC, EIT ICT Labs, KIC InnoEnergy, Raw Materials, Innovation for Healthy Living and Active Ageing. Moreover, TNO is involved in the development of the KICs Food4Future and Added Value Manufacturing. We see this as a unique illustration of our capacity to innovate and connect at a European level.

Our role in the international playing field is also shaped by the top foreign researchers we attract. Although the number of core expertise areas at TNO is declining, the knowledge level is rising in those areas we need it. Our success in this respect is evident from an external audit that put twelve of our expertise groups among the international elite. ■

# REDUCING TRAFFIC JAMS ON DUTCH ROADS

## › KNOWLEDGE DEVELOPMENT

Through collaboration and early technology programmes (ETP) we have gained insight into the creation of shockwave traffic jams and have shown how cooperative technology (vehicle-vehicle and vehicle-infrastructure communication) can reduce them.

TNO has developed an algorithm for vehicles and infrastructure to effectively and robustly suppress shockwaves by pro-actively warning the driver and actively intervening in the vehicle, supported by communication technology and Cooperative Adaptive Cruise Control (C-ACC).

## › PUBLIC-PRIVATE PARTNERSHIP

Together with partners like the Eindhoven City Region (SRE), the municipality of Helmond, the Province of North Brabant and the Ministry of Infrastructure and the Environment, TNO has developed a vehicle platform that uses smart recommendations to improve the traffic flow and reduce fuel consumption (CO<sub>2</sub>). Communication technology, whereby vehicles, the infrastructure and other information sources inform each other, is at the heart of this application. In that respect we held tests for half a year among commuters on both motorways and the underlying road network. TNO also contributed knowledge and expertise, such as algorithms, to the Infrastructure and the Environment programme 'Beter Benutten' (better utilisation) and the A58 motorway project in collaboration with market parties, both major international players and Dutch SMEs.

## › KNOWLEDGE TRANSFER

TNO investigated the top ten traffic jams in the Netherlands and subdivided them into type and thus the key causal factor. Our knowledge transfer via the DITCM test centre concerning new business models and technology offers SMEs opportunities to conquer new markets. We have demonstrated the potential of the cooperative self-driving car and gave a demo of Cooperative Adaptive Cruise Control (CACC) with the Minister of Infrastructure and the Environment on the A10 motorway in Amsterdam.

We are also proud of our input to Talking Traffic, explicitly named after the Ministry of Economic Affairs National Icons 2014 jury report, a product of the top sectors HTSM and Logistics along with the affiliated market parties and knowledge institutions.





# IMPACT

The cooperative self-driving car improves traffic flow on both motorways and the underlying road network, reduces CO<sub>2</sub> emissions and makes traffic safer.

The pilot projects on a number of roads in the Netherlands show that we can solve the traffic jam problems in the Netherlands using cooperative technology.

This breakthrough has been achieved by TNO in collaboration with market and knowledge partners, government and the end user. We have thus become a model for other countries in finding smart solutions to mobility problems.

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# SMART MATCHING OF DEMAND AND SUPPLY OF ENERGY

## › KNOWLEDGE TRANSFER

In THE EU project EcoGrid (2011–2014), to which TNO brought in its specific knowledge, PowerMatcher was scaled up to manage the energy of around 2,000 homes on the Danish island of Bornholm. PowerMatcher fully complies with expectations here and demonstrates the potential of the strong international consortium.

Couperus (2011–2013) is the first living lab project that uses the unique properties of PowerMatcher for easy upscaling. In 2012 the operation of the heat pumps in 300 apartments of a housing complex in The Hague was matched to the energy network. The energy supplier and network manager save money this way and the consumer profits from a lower energy bill.

## › KNOWLEDGE DEVELOPMENT

From 2004 ECN has been researching multi-agent operating systems for renewable electricity production. This led to the PowerMatcher concept: matching demand and supply. TNO took this concept, developing and testing it further since 2011. In 2013 one of the initiators of PowerMatcher within TNO, Koen Kok, gained his doctorate with the thesis 'The PowerMatcher: Smart Coordination for the Smart Electricity Grid'.

## › PUBLIC-PRIVATE PARTNERSHIP

Together with a wide range of parties in the energy world and knowledge institutions, TNO developed the PowerMatching City application gradually between 2009 and 2014. In 2012 some 40 homes in the Groningen district of Hoogkerk were fully connected to the smart grid. PowerMatcher manages all the appliances and energy applications like heating, air-conditioning, washing machines, cooling and electric vehicles. PowerMatching City is a first in being a real-life, smart grid experiment.





# IMPACT

PowerMatching City is the world's first demonstration project in which a smart grid has been used in practice.

This is a major boost to the use of renewable energy sources such as the sun and wind towards the ultimate goal of Smart Energy Cities. Moreover, studies reveal that the application of such smart systems in the consumer market can signify savings of between one and three and a half billion euros. PowerMatcher has two applications in the global UN Sustainable 100 list of the most important sustainable solutions.

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## » COLOPHON

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TO CREATE INNOVATIONS THAT SUSTAINABLY  
STRENGTHEN THE COMPETITIVENESS  
OF INDUSTRY AND THE WELLBEING OF SOCIETY

› QUESTIONS?

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