TO2MORROW

Magazine on results from the Open Innovation Network 2020

TO2 federatie
De samenwerkende organisaties in toegepast onderzoek

Impact on society 2020 Impact Report

TNO innovation for life | MARIN BETTER SHIPS, BLUE OCEANS | Deltares | WAGENINGEN UNIVERSITY & RESEARCH | nlr Dedicated to innovation in aerospace

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The researcher who asks questions, the ambitious entrepreneur, curious consumers, first-timers - early adapters - they invariably look through specially-focused glasses; the kind of glasses that zoom-in on distanced horizons or a different perspective on old discoveries.
You can associate such a nice view with societal challenges. This results in mission-driven innovation which makes us all benefit. As a society, we reap the benefits of clean, more sustainable and safer applications, and the Netherlands gains competitiveness and earning potential.
Many mission-driven people work at Deltares, MARIN, TNO, Wageningen University & Research and the Royal Netherlands Aerospace Centre (NLR), which together, form a federation known as TO2 institutes. They would be happy to offer you a glimpse. In the past year, many adaptive and rapidly deployable applications have emerged and the pandemic has shown how important that is. I immensely appreciate how the TO2 institutes commit themselves to this.
Wageningen University & Research is working on matching up and analysing corona data from hospitals. Assembled data patterns reveal useful insights and this will increase far more at a later stage if other organisations and self-learning computers join in.
Together with its partners, TNO is developing a heat battery that stores energy by combining water vapour and salt. It is cheaper than conventional batteries and also suitable for domestic use, making it socially promising.
The Royal Netherlands Aerospace Centre is focusing on a hydrogen application for electric flight. In commercial terms, this is both worthwhile and sustainable.
MARIN and Deltares are exploring the motions of the largest type of container ship in extreme conditions in the shallow North Sea. This also generates a lot of immediately useful knowledge for coastguards and captains, useful insights for ship designers, and to determine international shipping routes.
This report covers many more applications, all envisaged by five TO2 institutes, all eye-catching, socially relevant and often surprising.
Allow yourself to be inspired!

Mona Keijzer,
State Secretary for Economic Affairs and Climate

CREDITS
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In the overview below, each of the institutes, who are part of the TO2 federation, summarize their key areas of activity and the key technologies they develop and apply.

The TO2 federation consists of:

WUR

Wageningen University & Research is the joint venture between Wageningen University and Stichting Wageningen Research (foundation). We have more than 5,500 employees and 12,000 students from over 100 countries working in the fields of healthy nutrition and the living environment across the globe, both for governments and for the business community. The mission of Wageningen University & Research is “to explore the potential of nature to improve the quality of life”. Wageningen University & Research's strength not only lies in combining specialised research institutes and the university, but also in collaborations among various natural, technological and social science disciplines. As a result, scientific breakthroughs can quickly be translated into practice and into education. Wageningen Research is part of the TO_2 federation and consists of several research institutes who are active in the themes Food & Biobased Research, Bioveterinary Research, Livestock Research, Marine Research, Economic Research, Environmental Research, Plant Research and Food Safety Research.

MARIN

The Maritime Research Institute Netherlands (MARIN) conducts research into hydrodynamics, maritime (zero-emission) technology and operations with simulations, model testing, true-size measurements and training. MARIN focuses on shipbuilding, shipping, offshore industry and public authorities. To this end, MARIN pays attention to the following social themes in the mission-driven innovation policy: energy transition and sustainability; agriculture, water and food; and safety. Key technologies that receive special attention are artificial intelligence and autonomy & decision support.

Deltares

Deltares is an independent knowledge institute for applied research in the field of water and subsoil. Based on a systematic approach, we work globally on smart innovations and applications for humans, the environment and society.
Deltares has a unique combination of highly qualified employees, innovative key technologies, unique experimental facilities and specialist open source software. As a knowledge institute for applied research, we are successful when our ‘in-depth’ knowledge is redeemed in and for society. Together with our partners, we are going to tackle the social challenges of today and of the future.
From a perspective of water and subsoil, including infrastructure, our work covers four mission areas: Future, Sustainable and Safe deltas, and Resilient infrastructure.
Deltares | Enabling Delta Life

TNO

The Netherlands Organisation for Applied Scientific Research (TNO) has a mission to connect people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. TNO believes in the joint creation of value in economic as well as social terms and, together with partners, focuses on innovations for nine domains: Buildings, Infrastructure & Maritime; Circular Economy and the Environment; Defence, Safety and Security; Energy Transition; Healthy Living; Industry; Information and Communication Technology; Strategic Analysis & Policy; Traffic and Transport.

Developing and making key technologies functional for application, is one of TNO's core activities within these domains. These include photonics, nano- and quantum technology, but also new forms of production, material and chemical technology. Key technologies are characterised by a wide field of application or scope in innovations and sectors. They will radically change the way we live, learn, innovate, work and produce. Key technologies are essential in resolving social challenges, such as safety, energy and care. Key technologies also enable groundbreaking innovations of processes, products and services, and provide a major contribution to the economy, to the emergence of new businesses and new markets, to an increased competitiveness and to bolstering job creation.

NLR

The Royal Netherlands Aerospace Centre (NLR) connects the sciences, business community and government in the Netherlands and internationally. This knowledge organisation conducts applied science research in the market segments: industry, civil aviation, aerospace and defence. NLR's work covers the full spectrum of ‘Research, Development, Test & Evaluation’ (RDT&E). Within the mission-driven innovation policy, NLR’s research focuses on the social themes: energy transition, sustainability and safety. Examples of key technologies that receive special attention are artificial intelligence, augmented/virtual reality, digital twin and state-of-the-art materials (e.g. composites and 3D metal printing).

Innovative strength

against corona

This edition contains some great examples of how the TO2 institutes come up with solutions in a global crisis that affects us all. NLR is conducting a study into corona infections in aircraft cabins. WUR helps to better share data on corona from the care sector. TNO is deploying all its innovative strength and dozens of employees have devised practical innovations to combat the coronavirus. Read more about it in this magazine.

TNO

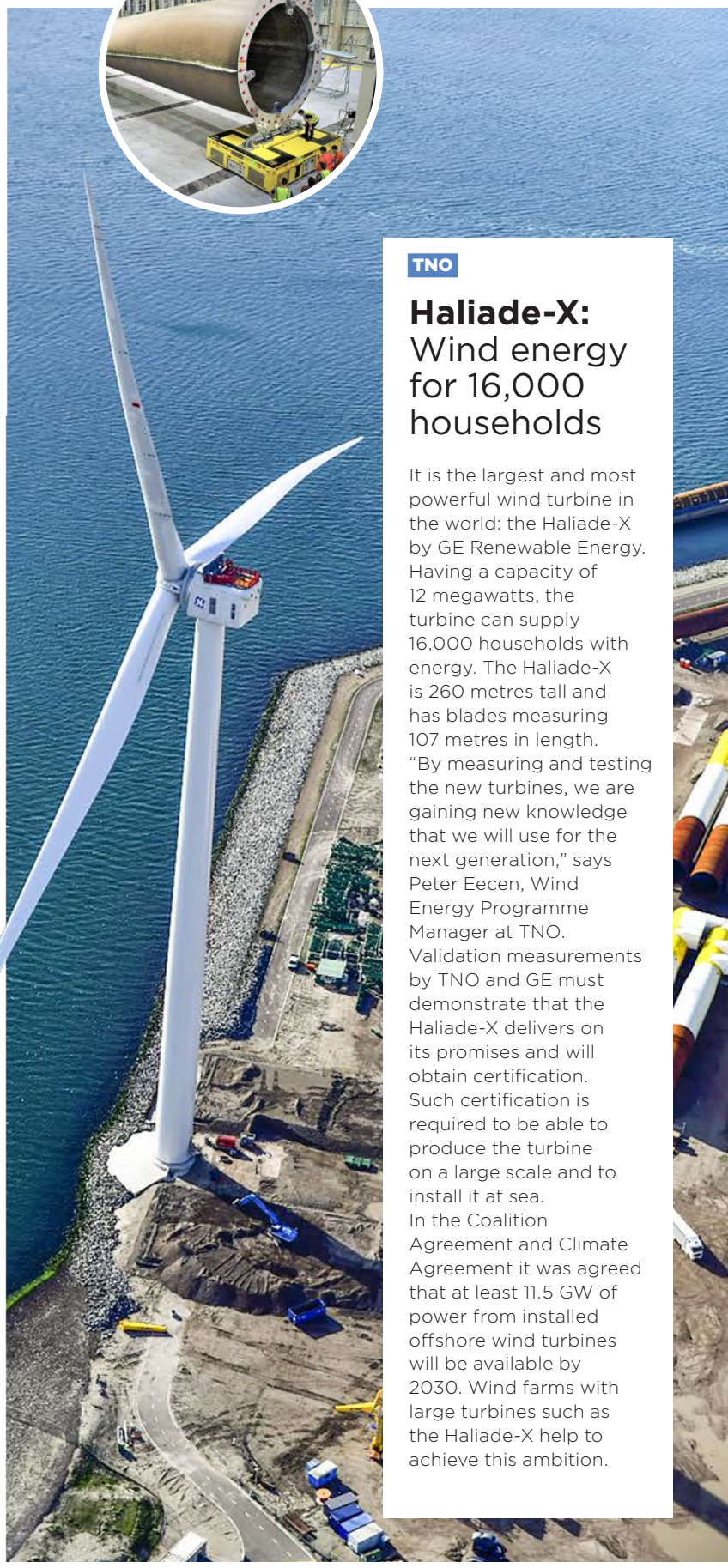
Positive impact on business activity through innovation

TNO effectively has an impact on businesses with whom it works in an innovation process. Growth in added value of companies that TNO has engaged in their research, is estimated to be 14 to 17% higher than companies who also conduct R&D, but not with TNO. This is the most important conclusion of an econometric analysis of the impact that TO2 has on companies.
TNO uses its own data in combination with data from Statistics Netherlands (CBS) on R&D expenditure by companies. By combining this data, a unique dataset has been created, which, for the first time, has enabled the impact of a Dutch TO2 to be investigated using econometric methods.
TO2 institutes are partly financed with public money, which is why they are regularly evaluated externally. That is only fair, says TNO's CEO Paul de Krom. "We do not cultivate knowledge merely for the sake of knowledge, but to arrive at practical applications and to help the Netherlands move forward. Shedding light on our impact is clearly one of our own goals," says De Krom.

NLR

Study into corona infection in aircraft cabins

Onboard aircraft, it is well-nigh impossible to guarantee a distance of one and a half metres between passengers. Following a request from the Ministry of Infrastructure and Water Management to draw up an inventory of HEPA filters in aircraft at Dutch airports, Royal NLR was not yet able to respond to the requirement by July: even though there is a good air filter, what risks are run onboard an aircraft to get infected with SARS-CoV-2?
Consequently, the ministry called for a follow-up study that NLR is conducting together with RIVM (National Institute for Public Health and the Environment). The initial findings of a literature study were published in mid-October. In December 2020, additional results will be known based on measurements and simulations after consultation with national and international experts. This will be performed on two types of aircraft with which passengers are most likely to fly from Schiphol Airport, such as the Boeing 737-800 and 777-300ER.



TNO

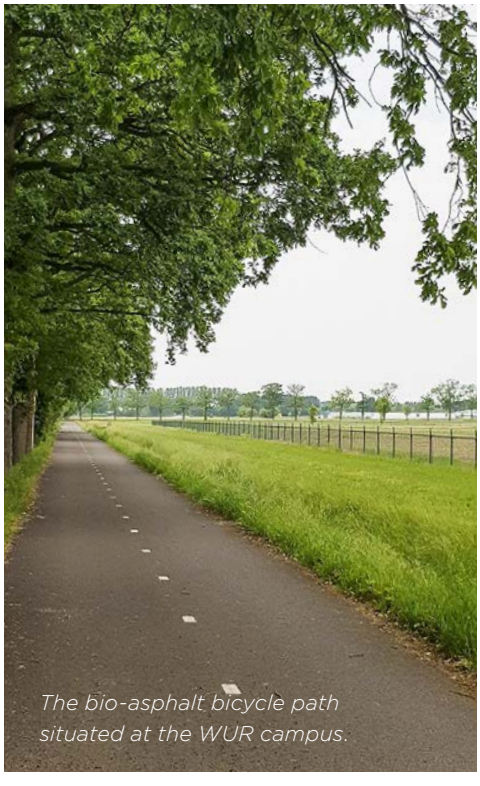
Haliade-X: Wind energy for 16,000 households

It is the largest and most powerful wind turbine in the world: the Haliade-X by GE Renewable Energy. Having a capacity of 12 megawatts, the turbine can supply 16,000 households with energy. The Haliade-X is 260 metres tall and has blades measuring 107 metres in length.
"By measuring and testing the new turbines, we are gaining new knowledge that we will use for the next generation," says Peter Eecen, Wind Energy Programme Manager at TNO.
Validation measurements by TNO and GE must demonstrate that the Haliade-X delivers on its promises and will obtain certification. Such certification is required to be able to produce the turbine on a large scale and to install it at sea.
In the Coalition Agreement and Climate Agreement it was agreed that at least 11.5 GW of power from installed offshore wind turbines will be available by 2030. Wind farms with large turbines such as the Haliade-X help to achieve this ambition.

WUR

Bio-asphalt based on lignin

WUR is taking the lead in the Netherlands to substitute bitumen (a component part of crude oil) in asphalt on a large scale with a natural binder lignin. This is happening in the TKI project CHAPLIN, which works with partners in the asphalt production chain. Bitumen is used in the asphalt mixture as a binding agent to bind the other components such as crushed stone, sand and filler. “By substituting half of the bitumen with lignin, fewer fossil raw material is needed and CO_2 is captured via the lignin for a longer period of time. That saves 20% of emissions,” says WUR's Richard Gosselink. Lignin can also be produced at lower temperatures than bitumen, so less energy is needed.
The partners in the TKI project CHAPLIN want to encourage the use of lignin as a raw material for asphalt in the coming years. “In this project we will further test this technology with other types of lignin in Dutch biomass residual flows, such as wood, straw and grass. In addition, we are exploring how to integrate lignin asphalt after use into the recycling process of the asphalt sector.”



The bio-asphalt bicycle path situated at the WUR campus.

MARIN

The Atmosphere measures pressure and aerosols

MARIN has had an autoclave ‘The Atmosphere’ since 2019.
An autoclave is a vessel in which researchers can control temperature, pressure, gas composition, humidity and circulation of gases and liquids. Autoclaves can be found in many laboratories, but never has one been built that can monitor the ambient conditions so precisely over such a wide range.
This enables MARIN to support the maritime sector with knowledge to develop liquefied natural gas (LNG) tanks. The international shipping organisation wants to emit 50% less CO_2 by 2050. The transition from fuel oil to natural gas is a first step. At sea, natural gas is best transported in liquid form by cooling it to -162 °C. In the future, new alternative fuels (gases and liquids) will be added and these will require further research.
However, this calls for tanks with special insulation systems.
In The Atmosphere, a prototype of the tank has been tested under various operating conditions.
This has greatly accelerated the development of the tank. Usage is versatile, because universities, institutes and companies in the Netherlands can also make use of The Atmosphere, for example, for testing processing equipment, basic research in biophysics and for research into the spread of aerosols.

Problem: if energy generation is totally renewable in a couple of years, large-scale storage of energy will be necessary. However, wind energy and solar power are difficult or costly to store.

TO2 Solution: together with TU Eindhoven, TNO have developed a heat battery based on water vapour and salt for the storage of loss-free energy.

Impact: this TNO heat battery is a breakthrough for energy storage. It is much cheaper and more environmentally friendly than electric batteries and is easily scalable for individual homes, blocks of houses or complexes of apartments, neighbourhoods or even bigger.

Heat battery for energy storage

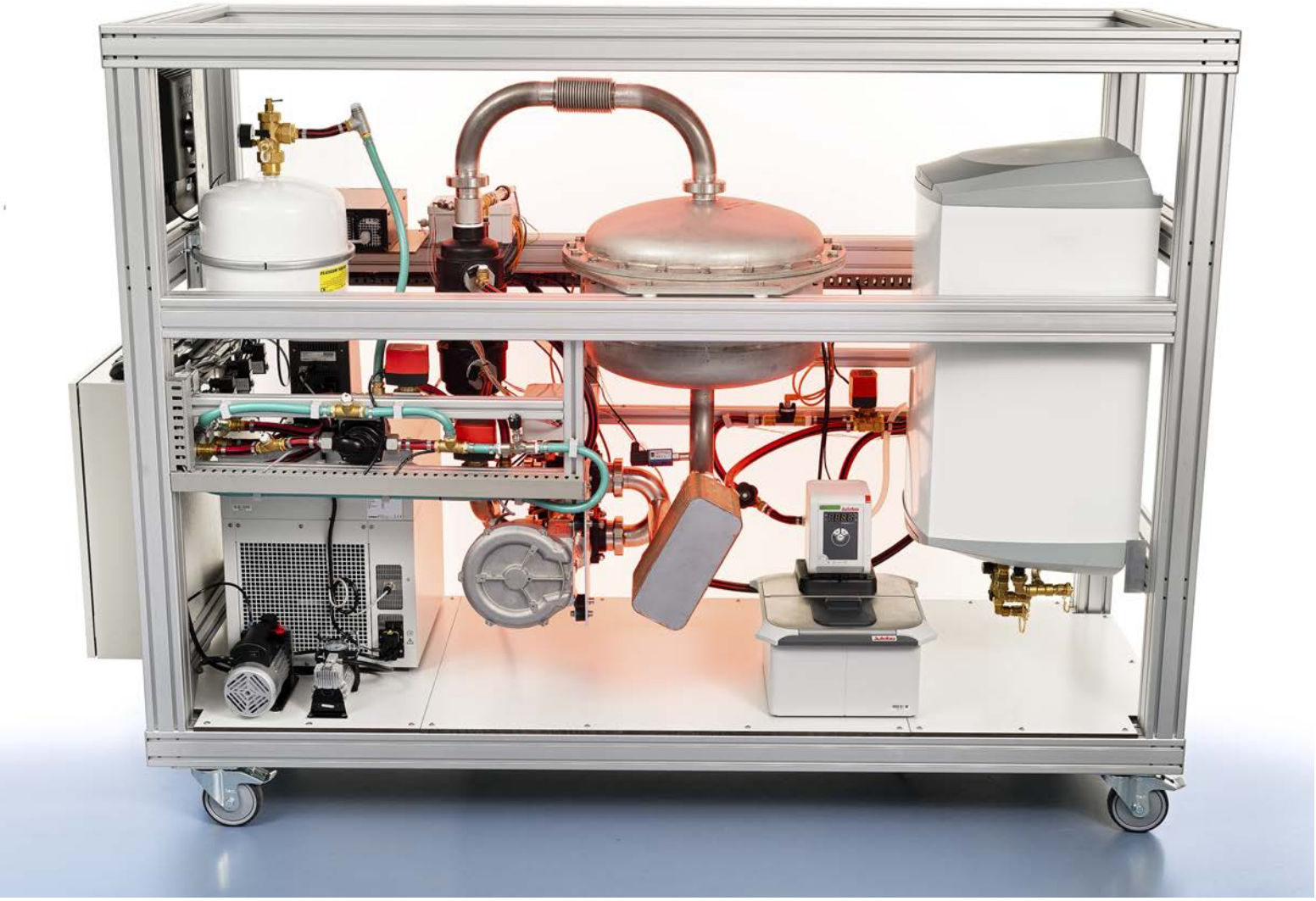
TNO

Together with TU Eindhoven, TNO have developed a heat battery based on water vapour and salt, for the storage of loss-free and compact energy. This method enables efficient heat storage for each house or complex of apartments.

The supply of renewable solar power and wind energy is uncertain. Wind farms or solar panels do not provide continuous energy, because the wind doesn't blow and the sun doesn't shine every day. To make more efficient use of these renewable sources, energy storage is paramount. “This extra capacity can be used to bridge periods when there is no solar power and wind energy. This additional power will reduce peak loads on the electricity mains at times of high demand or supply and balance the grid better or make it more flexible,” says Professor Olaf Adan of TNO.

Water vapour and salt

TNO and TU Eindhoven developed a heat battery that works on water vapour and a salt hydrate. By combining these two components, new salt crystals emerge. This process releases heat. When you bring heat back into the system, like the energy of solar panels, water and salt separate again and the salt crystal retains the heat. As long as you keep both components separated, that energy is stored loss-free. “The challenge was to create a suitable salt composition that continues to function with repeated (multi-cyclic) use. Stable in all aspects,” says Adan. “That has proven to be successful. We expect the battery to last for at least 20 years if it is fully charged and discharged once a month, but it is likely to last much longer. We basically



use potassium carbonate. This is a common salt and easy to produce. It is made by binding potassium hydroxide with CO_2. So you put CO_2 into it, but the material is very easy to recycle or reuse." Aside from this storage material, a device (the battery) is needed. A new principle was developed for this purpose, consisting of four components: a fan, heat exchanger, evaporator/condenser and a reactor vessel. Adan: "The first three components are existing, mature technologies and can therefore be built, albeit with some modifications." The cost of the stored energy is at least ten times lower than the cost of electrical storage systems, like the Tesla Powerwall.

The results are so promising that TNO and TU Eindhoven, in collaboration with their Dutch industrial partners, will establish a company to produce the heat battery on a large scale. Initially, there will be pilots in Eindhoven, the South of France and Poland. "That is where we will develop the battery – the size of a refrigerator for an average home – in various combinations with renewable energy systems," says Adan. He expects the heat battery will be introduced into the market in 4 years' time. ■

Who: TNO and TU Eindhoven.
Duration: development of the heat battery has taken 10 years, but the technology has improved considerably over the last 3 years.
Budget: grants of €7 million from the European Union and €3 million from private/public organisations.
Follow-up: further research will be conducted on the integration and control of the heat battery with various systems, such as the electricity mains, heat grid, solar collectors and heat pump.

Flying on hydrogen

Problem: commercial aviation accounts for about 3% of global carbon emissions. Before the corona crisis, aviation grew substantially and there were few obvious reduction methods. In order to achieve the targets of the Climate Agreement by 2050 – carbon emissions must reduce by half – the sector needs to improve sustainability. However, electric flight is restricted, particularly due to the necessary energy storage in heavy batteries.

TO2 Solution: NLR conducts technical research into hybrid electric flight. The electric-powered two-seater aircraft by Pipistrel Velis Electro is given a hydrogen tank to be able to fly longer than only on batteries.

Impact: by conducting research into hydrogen in combination with electric flight, NLR contributes to important innovations and research into sustainability of commercial aviation. Moreover, these innovations and this research can also be applied in sectors other than aviation.

NLR, TNO

How can we use hydrogen to fly cleaner? Martin Nagelsmit, Programme Manager of electric flight at Royal NLR, is exploring various possibilities to reduce the climatic impact of aviation.

Electric flight could be the answer to flight shame. In the years ahead, the Netherlands wants to develop further in the field of hybrid-electric flight, which combines an electric motor with a combustion engine. In February 2019, the Draft Sustainable Aviation Agreement was adopted. This gave 26 parties in the aviation sector the go-ahead to flesh out the National Hybrid-Electric Flight Action Programme (AHEV). The government, business community, knowledge centres and educational institutes are jointly working on achieving the ambitions for commercial aviation, general aviation (civil aviation with the exception of scheduled and charter flights) and ground-based operations at airports.

Up to 500 kilometres

The target for 2030, is to undertake flights with hybrid-electric aircraft for lessons and sightseeing, which lays the foundation for transporting several passengers by hybrid-electric aircraft over distances of up to 500 kilometres. By 2050, carbon emissions must be reduced by half in comparison to the emissions in 2005. The ultimate long-term goal is zero-emission flight by 2070. “This ambitious goal cannot be achieved by only keeping one solution in mind,” says Martin Nagelsmit, who researches multiple tracks alongside each other. “First of all, there's electric flight, but that has many limitations; you need a heavy battery. With the knowledge of today, at most you can travel short distances in small aeroplanes.” Secondly, there is the possibility of using hydrogen power. Hydrogen can be converted into electricity or combusted immediately, releasing water vapour. A third option is to use a different type of fuel. Biokerosene made from used cooking oil or synthetic hydrogen-based kerosene.

The electric aircraft Pipistrel

Research is also being conducted into building energy-efficient aircraft, with lighter materials for example.

Pipistrel Velis Electro

NLR is testing hybrid-electric flight step-by-step at the Living Lab Electric Flight, because it must, of course, meet all safety requirements. Last year, the first step was flying with a drone on hydrogen. This autumn, NLR continued the tests by flying longer and further with a bigger drone. At the end of September, NLR received an electric-powered aircraft: the Pipistrel Velis Electro. The aim is to convert this electric two-seater aircraft and to equip it with a Range Extender and hydrogen tank, allowing a longer flight of more than 50 minutes and making it suitable as a flight trainer for pilots in training. The technical side is not the only challenge, this is followed by certification. Nagelsmit: "Supposing that flying on hydrogen is possible, then this aircraft must be certified. There are no certification standards for this at the moment. How would we then comply with all safety regulations?"

Hydrogen tank

NLR also has a wide range of choices when it comes to installing a hydrogen tank, because hydrogen comes in both gas and liquid form. To compress gaseous hydrogen at high pressure, a strong tank is required. If a smaller volume of liquid hydrogen needs to be stored, a temperature of -253 °C is required. This requires a tank that can withstand low temperatures. Nagelsmit: "Unfortunately, hydrogen has a large volume." Hydrogen is not as ideal as it sounds yet. "In addition, the emission of water vapour high in the atmosphere may have a warming effect. This must still be examined further. Hydrogen is not ideal for aviation yet."

NLR is researching solutions to reduce the impact of aviation on climate. Nagelsmit: "It calls for out-of-the-box thinking." The biggest culprit of carbon emissions are intercontinental flights. That's because lots of fuel must be carried. A stopover to refuel for the second part of the flight could be a smart move to keep within carbon emission limits. Or refuelling in the air, as is done by Defence with military aircraft.

Good move

"Of course, there are pessimists who say that there will never be an electric Boeing 747, but if you can fly electrically-powered for a thousand kilometres with 19 people in the future, and pilots can complete their training without emissions, then that is a good move. By conducting research in the Living Lab, we contribute to important innovations and research into the sustainability of commercial aviation." Besides, systems developed for aviation often find applications outside the sector and vice versa. ■

Who: NLR, University of Technology Delft, TNO, University of Twente, Ministry of Defence, DroneHub Groningen, RHIA, DEAC, AeroDelft.
Duration: until 2030.
Budget: €500,000 per year.
Follow-up: zero-emission flight is the ultimate long-term goal in 2070.

Problem: there is an enormous need for housing. It is estimated that the housing shortage will reach more than 400,000 homes in 2025. Furthermore, the existing housing stock must quickly become more sustainable in order to reduce energy consumption.

TO2 Solution: TNO shares knowledge about sustainability in the building industry with construction companies and homeowners and supports the transition to a circular building industry. This includes projects such as the prefabrication of (parts of) housing, the application of Cross Laminated Timber and the development of durable future-proof frames.

Impact: it leads to significantly reduced carbon emissions, in which both the production of building materials and prefabrication of timber houses reduces the construction time.

TNO

Wood expert Jan de Jong welcomes the fact that more attention is being paid to the construction of wooden houses in the Netherlands. Together with his TNO colleagues and with companies in the building industry's chain, he ensures that knowledge and innovation in timber construction is placed where it belongs, in the construction industry.

The right timber in the right place

By having the proper know-how, it is possible to complete a habitable wooden house within five days. De Jong: "Timber construction requires a good deal of knowledge, you need to know which timber can be applied where. By sharing our expertise in timber construction, we encourage innovation in a sector that is almost entirely focused on stone and concrete. We do this in close cooperation with the builders."

Smart frames

An example of such cooperation lies in the development of the frame of the future. A frame made of composite timber that is durable, circular, energy-efficient and maintenance-free. The latter is achieved by a clever design: on the outside – the part most affected by weather – there is less timber than on the inside. Unlike the customized frames that contractors currently use in construction, it is cheaper and easier to produce this frame in a series. TNO also encourages the construction of timber houses by using Cross-Laminated Timber (CLT). CLT panels comprise three or more glued layers of cross-bonded timber. In a factory these are cut to size, including cut-outs for windows and doors. These wooden panels form the basis for prefabricated houses that are built and habitable within a few days.

Reuse

The greatest benefit of timber construction is durability. Timber construction causes fewer carbon emissions and trees (wood) naturally store CO_2. As long as trees are not burned, the CO_2 is not released either. By felling and replanting new coniferous forests, the stock of timber does not run out and wood can also be reused. Jan: "Solid, by reusing old beams to make new ones. Wood chips form the basis for chipboard. Woodworking adhesive can be made with wood dust or lignin. What remains is good biofuel. Currently 90% of scrap timber disappears into furnaces." TNO also oversees the transition to reuse wood in the building industry.

As the Netherlands has few forests and is therefore restricted in its own timber production, TNO is working on the development of more circular renewable alternatives, such as cross-laminated timber made of waste wood. "If we want to be circular by 2050, we must now re-use all building materials and pave the way for standardisation of timber construction. We must ensure that the right timber ends up in the right place." ■

Who: TNO together with partners (architects, contractors, housing corporations and municipalities).
Duration: frame of the future runs until 2024.
Budget: it differs per project, for the frame of the future €600,000 - €1,200,000.
Follow-up: replacement of customized frame with the frame of the future.

Working on reliable heating

Houses in the suburb of Hoog Dalem are heated with aquathermal energy.

Problem: the Netherlands wants to stop using gas to reduce carbon emissions. Sustainable heat grids are an alternative for heating homes and buildings. This means they are an important link in achieving the objectives of the Climate Agreement and in reducing carbon emissions. Such collective systems must be reliable, renewable and affordable. Collaboration from the entire heat chain is needed to achieve acceleration and an upscaling for renewable heat grids.

TO2 Solution: the heat collective WarmingUP is an innovative joint venture. Here, parties from the entire heat chain are developing new know-how, forms of collaboration and financing. TNO and Deltares make an important contribution to this. For instance, they cleverly combine renewable heat sources within the same heat grid and work on large-scale heat storage systems that are needed in such a renewable heat grid.

Impact: the results help to make the upscaling possible from 340,000 connected homes in 2018 to 1,100,000 connections in 2030. The use of renewable sources leads to substantial carbon emission reductions, system and process innovations, and the coherent designing of heat grids leads to efficiency gains.

Deltares, TNO

By 2050, all Dutch homes must stop using gas in order to meet the Climate Agreement objectives. We must heat millions of homes differently, for example using geothermal energy, which requires new infrastructures and rules. Deltares, TNO and KWR are working on the puzzle together with parties in the heat supply sector.

A heat grid is a type of centralised heating: there is a heat source somewhere in the neighbourhood – a centralised 'boiler' – and the hot water flows through pipes from the source to the houses. Most heat grids are still relatively small and supply heat for a single new-build district. At present, the Netherlands has large-scale heat grids in about 17 cities; together they heat 300,000 homes (***Warmtemonitor 2019*** [Heat Monitor]).

Collective heat systems

Heating more than a million homes by 2030 through 'grids', calls for a different way of thinking: ranging from small heat grids to collective heating systems. These are complex structures that must be able to extract heat from the water and subsoil, store it and supply it to individual houses. The sources – aquathermal energy and geothermal energy – have different temperatures and volumes. This is a technical challenge for its transportation and storage. Gerda Lenselink, Strategic Advisor at Deltares: "Adapting existing buildings is a huge undertaking. We need to scale up, make it more sustainable and reduce costs if we want to achieve the carbon emission reduction of the Paris climate targets."

Joint progress

In the past, companies, individuals and the government have worked separately on pieces of the solution. All the chain links in the heat sector have now been brought together in the WarmingUP project: from heat suppliers to municipalities and water boards. TNO has taken the lead in the WarmingUP collective, which also comprises the research institutes Deltares and KWR and 35 participants. TNO coordinates the smart management of heat grids, geothermal energy and socially oriented integration of heat grids. KWR coordinates the research into high temperature heat storage capabilities. Deltares focuses on the construction of large-scale infrastructures and aquathermal energy. WarmingUP ensures that all new information reaches the right parties, so that they can immediately apply the findings in practice. For example, Deltares has identified how much heat from aquathermal energy can be gained where and at what price it can be supplied. The potential calculations have now also been included in models by the Netherlands Environmental Assessment Agency. Lenselink: "Aquathermal energy is only a seriously renewable alternative if you can calculate its potential in a certain neighbourhood."

Affordable and reliable

Aside from the technical aspects, attention is also paid to the socially oriented side of heat grids, she says. "Not every location has the same resources. How do we ensure that it is affordable and acceptable to the end user? How are municipalities, housing corporations and heat suppliers are able to make it attractive to opt for a collective heating system? WarmingUP forges the connections so that we can organise this together." ■

Who: Deltares, TNO and KWR collaborate with 35 participants: heat suppliers and grid companies, the water and soil energy sector, municipalities, provinces, universities, colleges and test locations.
Duration: 2020-2022.
Budget: €19 million.
Follow-up: via new tenders for Mission-driven Research, Development and Innovation and the Renewable Energy Production Incentive Scheme. Read more on www.warmingup.info.

Combating on farms

Problem: freshwater shortage due to dry summers in the Netherlands is detrimental to agriculture.

TO2 Solution: regional scan freshwater measures, co-developed by Deltares, provides an insight into the costs and benefits of freshwater measures on farms. For example, water managers can advise farmers on smart measures that help to store rainwater. This makes farmers less dependent on surface water or groundwater.

Impact: the tool provides an overview of possible effects, costs and benefits of agricultural drought measures. This will result in a better substantiation of the area process in the region and policy at national level.

Deltares, WUR

Freshwater is indispensable for agriculture and, by extension, the food supply. The past few years have been increasingly dryer. Fortunately, there are various possibilities for farmers to store freshwater from rainfall and to use it more efficiently. Where does which measure work best? The Deltares Regional scan Freshwater measures offer an insight.

The KNMI (Royal Netherlands Meteorological Institute) has drawn up climate scenarios for the future. In terms of drought, they outline two possibilities: either it stays the same or it leads to more drought. In agriculture, dry periods already cause crop damage. The 'high' areas of the Netherlands, such as Brabant, Gelderland and Overijssel, are the first to notice it, says Joost Delsman of Deltares. "It is much easier to channel water to the low polders in the west. Yet, in 2018, they also suffered from water shortages owing to the low level of the Rhine."

Less dependent

Drought is devastating for production on farms, and hence the supply of food. The good news is that farmers are able to take various measures that can retain groundwater and surface water for longer. That makes them less dependent on direct rainfall. "Raising ditch beds, farm weirs that work like dams, drip irrigation instead of spraying, or storing freshwater in the soil," Delsman sums up a few examples. What works in one place is not equally effective everywhere. That depends on spatial factors: is there a lot of salt in the soil? Is a farm situated in a stream valley or on high sandy soil? Since they are expensive adaptations, it is important to have the most feasible picture of costs and benefits prior to construction. That is how the Regional scan Freshwater measures came about. Delsman: "This tool provides an insight into the costs of measures and which effect the water boards can expect from them in their region. Water managers can use this to advise local farmers on how to increase freshwater availability as efficiently and cheaply as possible."

Prototype in the polder

Researchers started on a prototype for the Anna Paulowna polder (North Holland) and De Raam at Grave (North Brabant). Delsman: "We examined which measures could reduce crop damage at these places.

dry summers

That differs for each soil, groundwater level and crop type. We translated the results in financial terms. We also looked whether the results of the Regional scan were in line with other studies that had already been done locally."
This showed that the prototype provided useful information, but only for those specific locations. In North Holland, it was particularly interesting for bulb growers to store freshwater in the soil. In De Raam few measures defeat the common irrigation installations. That means that water managers have a considerable task there. The tool also appeared to be difficult to use. In the second phase, a pilot in Chaamse Beken and Twello, a lot of work was done on the user-friendliness and national application. Delsman: "The problem of drought is happening throughout the Netherlands, so it makes sense to include several areas and even to calculate at a national level."

Interactive chart

The improvements have been successful. Delsman: "An interactive chart can be used by water managers, where they can click on certain measures or packages to see what the costs and benefits are, without increasing water demand. They are also able to see what happens, for example, when 20% of the farmers take measures. What is then the most cost-effective combination? Aspects such as quality of life or what something looks like in the environment, are aspects that users must weigh up for themselves in their decision."
Water managers can use this information to have well-informed discussions with farmers in their region. In the end, it is the farmers who decide whether or not to take a measure. So, why exactly are water managers taken as the starting point and not the farmers themselves? Delsman: "Initially we look at it from a wider perspective to calculate the impact of measures on a large scale. The next step is local, which requires a lot of specific knowledge about a farm as well as a visit to the farmer or detailed local research. By initially looking broadly, it is possible to calculate whether it makes sense to concentrate measures in certain areas or even provinces, so that other areas can also benefit from them."

Delta programme

The new Regional scan has already been used in the Delta Programme to calculate the impact of freshwater measures on a national scale. This showed that agricultural measures are viable in specific areas, but certainly not everywhere. This means that it is essential to link such measures to other policy themes, for example, flooding. If a measure achieves benefits in different areas, then that would be more cost-effective.

The next step is to teach water managers across the Netherlands how to work with the tool. Delsman: "Knowledge is already far more accessible, but it is important to learn to interpret the results properly. In this, Deltares, KWR and two Wageningen institutes are supervising the water boards." ■

Who: Deltares, KWR, Wageningen Environmental Research, Wageningen Economic Research and engineering firm Acacia Water, the Foundation for Applied Water Research (STOWA) – the knowledge centre for the water boards, the Ministry of Infrastructure and Water Management, the Delta Water Board in Brabant, the IJsselmeer Freshwater region, the Freshwater supply in East Netherlands and the water catchment area of the Meuse river.
Duration: 2016 – 2020.
Budget: €400,000.
Follow-up: distribute the tool to all water boards and teach users to interpret the results.

Challenge: less food in the wheelie bin

Problem: millions of kilos of food go to waste each year in the Netherlands. Food waste is everywhere: after harvesting, during storage and transportation, in supermarkets and restaurants and by consumers at home. This is not only a waste of good food, but also of all the raw materials, water and energy needed for its production and transportation. This has consequences for the environment and climate, and approximately 6% of all greenhouse gas emissions can be prevented by reducing food waste.

TO2 Solution: WUR researches how to prevent or reduce food waste and to reuse residual flows. For example, researchers at Wageningen are working on measuring and monitoring raw material efficiency and waste. They do so on a national level, at each link in the chain, by sector and for individual companies.

Impact: WUR's research and its catalyst function could reduce food waste by half in 2030. This makes an important contribution to a future-proof food system (more food security, fewer adverse effects on climate). For the Netherlands, this means that every year a million tons of food commodities with the highest possible quality can additionally be used within the food chain.

WUR

Nobody wants to throw away food, yet it happens on a large scale. Together with consumers, businesses and public authorities, scientists at Wageningen want to reduce food waste by half by 2030. What obstacles do they encounter?

The inhabitants of the Netherlands waste about a quarter of all the food. We incinerate about 60% of the wasted food. It is such a waste of billions of euros and of the raw materials, water and energy used, says Sanne Stroosnijder of Food & Biobased Research at Wageningen University & Research. The Stichting Samen tegen Voedselverspilling (a foundation to jointly combat food waste), which is an 'ecosystem' of companies, organisations, consumers and public authorities, wants to be the global leader. This means that every year a million tons of food commodities can additionally be used within the food chain in a high-grade way.

A hundred parties

As an independent knowledge partner, WUR has been inspiring more than a hundred parties, from small start-ups to large corporations. WUR measures and monitors waste on a national level by sector and maps out opportunities for improvement, for example in the hospitality industry. Stroosnijder: "The Food Waste Challenge showed how restaurants can reduce waste by one-fifth using simple interventions." A well-known hotel chain even achieved a 70% reduction. That's how WUR likes it. "Ultimately, it's the companies, public authorities and consumers who make all the difference."

According to Sanne Stroosnijder, the three main obstacles are:

1. Where food waste is concerned, consumers are a factor that should not be underestimated, although a sustainable behaviour change is challenging. "Often people are not even aware of how much they throw away." The Waste-free Week, which the foundation organised together with the Food Centre in September, must bring about change with extra attention for the shelf life of products (and the difference between the 'sell by' and 'use by' expiry date).
2. At companies, food waste is often hidden in their operations: procurement, storage, waste disposal. A benchmark makes it clear that one supermarket wastes a lot of bread, while another has to focus more on fruit and vegetables. As such, businesses with similar problems could learn from each other. "We quantify all waste not only in kilograms and euros, but also in terms of nutrient loss and carbon emissions."
3. The most chronic are systemic changes. That actually calls for cooperation in the chain, for example between the hospitality establishment and the supplier. Are companies willing to share data and experiences and make new commitments? "Sometimes a small adjustment in the planning already has a major effect." ■

Who: WUR and a consortium of a hundred large and small businesses, public authorities, knowledge institutes and consumers.
Duration: the foundation against food waste was founded in December 2018 with 25 parties. Since then that number has quadrupled.
Budget: €900,000 per year for monitoring, knowledge vouchers, rules of play and management.
Follow-up: after 2021, continue with innovations and solutions, especially for the above-mentioned obstacles.

Problem: the North Sea is becoming increasingly crowded with wind farms, solar panels and shipping. Maintaining safety for shipping, the environment and infrastructure is an ever-increasing challenge in a complex international context.

TO2 Solution: by using data analysis of traffic flows and quantitative and qualitative risk analyses, MARIN provides an insight into the safety level and impact of, for example, new wind farms or autonomous ships. In addition, together with TNO and Deltares, MARIN researches possible safety precautions.

Impact: MARIN's research provides detailed and shared knowledge of safety, both for shipping and the marine ecosystem. To this, TNO and Deltares have added knowledge about safety precautions which, together, is a prerequisite for continued, well-founded and proactive offshore economic growth.

Orderly offshore traffic

MARIN, TNO, Deltares

Wind turbines, solar panels, seaweed farms and shipping – the North Sea is getting more and more crowded. MARIN analyses traffic flows to ensure that ships, the environment and infrastructure stay protected. Together with TNO and Deltares, the institute is researching precautionary measures to prevent collisions and environmental damage.

In the Netherlands' part of the North Sea there are constantly 150 merchant ships en route. Those ships are becoming increasingly bigger and transport more and more goods, including hazardous substances. Moreover, there are leisure and fishing boats and an increasing number of working vessels. Add to this the growing number of wind farms with wind turbines, solar panels or seaweed farms.
Traffic safety on the North Sea is an ever-increasing challenge, says Yvonne Koldenhof of MARIN. "It is an offshore highway straight through an industrial area at sea. The offshore highway is narrower on both sides and there is less space to make a detour. Although a vehicle with engine problems would stop immediately, the motion of a ship is continuous."

Risk trends

The coastguard monitors ships in real time and comes into action where necessary. Since 2005, it shares data of ship movements with MARIN. Researchers use calculation models and economic forecasting models to see how the traffic situation changes, for example because of additional wind farms or autonomously piloted ships. Koldenhof: "In the past, ships were merely counted. Nowadays we know exactly how they sail and where they cross paths with one another. That provides an insight into possible risks and potentially hazardous traffic situations."
Important research involves the consequences of a possible collision between a ship and a wind turbine: can wind turbines withstand a collision, can a crew leave the ship, and what is the chance of hazardous substances leaking? In conjunction with MARIN, TNO is calculating the load on and strength of wind turbines and ships. Deltares then analyses the spread and, using the ecological knowledge of NIOZ, for example, it maps the environmental aspects of increasing crowdedness on the North Sea.

Safety precautions

When the first wind farms were built, they did not take the environment into account. In the meanwhile, there is a comprehensive approach in which the government proactively designates construction areas to realise 1,200 wind turbines by 2030. Koldenhof: "Fortunately, because of this, the chance of ships colliding with each other does not increase significantly. However, an increase is expected in the number of ships drifting against or sailing into a wind turbine. We are still researching the consequences of this."
Potential safety precautions are: more active shore-based monitoring, a different layout or illumination of new wind farms, or emergency towing vessels; tugboats that help a ship in distress. Koldenhof: "Knowledge of the traffic situation is essential for Dutch national and international frameworks for traffic safety. The North Sea does not stop at the border." ■

Who: MARIN, TNO and Deltares.
Duration: ongoing, since 2013.
Budget: €200,000 – €500,000 annually.
Follow-up: action plan, monitoring, research programme Offshore Wind and putting the Maritime Safety Policy Framework into effect.

Nature is glad to help

WUR, Deltares

Once, island dwellers placed dams made of poles and branches in the Wadden Sea to break the wave motion. Nowadays, jointly with Deltares and business partners, scientists at Wageningen are applying this ancient technique for recovery of the mangroves on Java (Indonesia). A matter of building with nature, which prevents the coastline from disappearing.

Problem: the north coast of Java (Indonesia) is suffering from massive coastal erosion and flooding caused by mangrove deforestation, unsustainable aquaculture and groundwater abstraction.

TO2 Solution: Wageningen Marine Research and Deltares have partnered in an innovative coastal recovery project that works with 'soft' small-scale structural interventions (permeable dams) that restore mangroves. These have been copied from the ancient Dutch technique of breaking the wave motion of the Wadden Sea. This prevents flooding and coastal erosion. The mangroves are returning and the cultivation of shrimp is possible again.

Impact: it leads to recovery of the ecological and economic resilience of 20 kilometres of coastal area, which can be expanded with local resources and can potentially better protect 30 million people from floods. Erosion will be stopped and coastal communities will gain new economic prospects with the renewable cultivation of shrimp and fish.

According to Dolfi Debrot, Senior Researcher at Wageningen Marine Research, there are various reasons for the massive coastal erosion in North Java. One of them was shrimp cultivation, for which the population cut down mangrove forests and excavated pools, causing the country to continue to subside. But groundwater extraction also caused more than three kilometres of coastline to disappear. It made the area even more vulnerable to stormy weather and rising sea levels and caused a decline in fish stocks.

Nature's resilience

In 2015, a consortium of water experts and knowledge institutes launched a programme for mangrove recovery on North Java. Along the coast, permeable wooden dams, each of a hundred metres in length were constructed to retain the sludge, which raised the soil level and allowed the mangroves to grow. Dolfi Debrot, who undertakes similar projects in the Antilles and in Bangladesh, is always so surprised by nature's resilience. "You help a little by placing dams and protecting the mangroves from waves, and nature takes over. Aside from a few exceptions, it is not necessary to plant trees, the seeds floating about germinate by themselves."

Marker Wadden

The project is a fine example of building with nature, a concept in which nature reduces the risks of climate change, such as wave motion and sea-level rise. Among other things, the Netherlands applies it to the shoreline zones of Marker Wadden. Nature development islands of sand, clay and sludge are constructed in such a way that sufficient food is available for birds. On Java, too, fish stocks quickly recovered, allowing the local population to regain their livelihood. There is a new experiment with dams made of less perishable, local bamboo poles. These are easier to maintain than branches and can serve as a base for mussel cultivation. "The income gives the population an extra incentive to maintain these small dam walls." This pilot scheme can be applied across the North Javanese coast by the local population using local raw materials. ■

Who: a consortium of water experts and knowledge institutes (WUR, TU Delft, Deltares, EcoShape, Wetlands International) and local public authorities.
Duration: 2015-2021.
Budget: €5 million, of which more than half has been contributed by the parties involved.
Follow-up: as from September 2020, three NWO researchers will start cultivating green mussels. This is done on dams made of less perishable bamboo poles.

Problem: to make the care sector more effective, insight must be gained by combining data from various care organisations. However, sharing such data is undesirable due to privacy or competition-sensitive business.

TO2 Solution: together with partners in the care sector, TNO developed the Care for Data platform based on Secure Multi-Party Computation (MPC). Using cryptographic techniques, the parties are able to discover and monitor statistical relationships as if they have access to each other's data, without actually sharing or tracing data – not with each other, neither with TNO, nor with other parties.

Impact: the Care for Data platform enables continuous analysis of care data by various parties to measure effective care applications; and all this is done privacy-proof.

Share care data securely and privacy-proof

TNO

Sharing data between hospitals and health insurance companies makes useful effectiveness analysis possible. However, that could not simply be allowed as such because privacy and data security must be guaranteed. It is for this reason that TNO has jointly developed the innovative platform Care for Data with its partners.

The costs of care are soaring in the Netherlands. To reduce the upward trend, new applications of (digital) care are being devised. For example, healthcare professionals at Zuyderland Medical Centre – which is a project partner – provide remote care to patients with chronic intestinal infections via an online coaching app. This leads to considerable cost savings, while the patient's health and the quality perceived is much better. "To measure whether such an app is indeed effective, and for which target groups, the results must be analysed constantly," says Pieter Verhagen, Senior Business Development Manager at TNO.

Multi-Party Computation

In the care sector you should not arbitrarily share data and that makes analyses so difficult or very expensive. TNO and its partners conjured up an idea for this: Care for Data. "This software allows you to analyse data from various sources without actually sharing or tracing it," says Verhagen. Care for Data is based on Multi-Party Computation. Cryptographic techniques enable various parties (e.g. hospitals and health insurance companies) to jointly analyse the data and to draw conclusions at a local level, without the parties being able to see each other's data.

Put into operation

Since being launched in 2017, the first phase has now been completed successfully. Care for Data offers TNO and its partners a prototype that is able to provide ongoing insight into the effectiveness of care without sharing patient data. "We have already started on the next step: to further operationalise the system. This means that, in addition to technical improvements, we also provide a watertight legal analysis before we begin to analyse actual personal data via the system. If all of this goes well, we can put the system into practice by 2021." TNO is now seeking care providers who want to use Care for Data next year. ■

Who: TNO, in co-creation with Zuyderland Medical Centre, health insurance company CZ and Statistics Netherlands (CBS) within Techruption; the field lab affiliated to the Brightlands Smart Services Campus in Heerlen, and the top sector High-Tech Systems & Materials (HTSM).
Duration: Research and prototype: 2017-2020. Put into operation: 2020-2021. Scale up 2021 onwards.
Budget: €500,000.

Aircraft paint without chromium-6

NLR

Ludmila 't Hoen, researcher at Royal NLR, is looking for a chromium-6 paint system suitable for aircraft wings.

Problem: chromium-6 paints prolong the life of metal objects but can have a severely detrimental impact on health after exposure.

TO2 Solution: NLR has developed environmentally-friendly alternatives in cooperation with AkzoNobel, to prevent corrosion of metal objects without being detrimental to health.

Impact: if this leads to a useful alternative, it means that the health risks associated to working with chromium-6, are a thing of the past.

Chromium-6 was often used in the paint of bridges, trains and aircraft 20 years ago, because it works well in counteracting corrosion and prevents mould formation. "Basically, it is bad for everything that lives," says Ludmila 't Hoen. We now know how harmful chromium-6 is to health. It can lead to cancer and autoimmune disorders, chronic pulmonary diseases and contact eczema. This gave NLR good reason to seek – in consultation with Defence – an alternative that is less harmful to human beings and the environment.

A paint system consists of three layers. First of all, the surface treatment: a thin coating of a chromate-containing solution. This is followed by the primer: this coating has the highest amount of chromium-6. Finally, a chromate-free topcoat. Chromium-6 has an exceptional characteristic: if paint containing chromium-6 gets damaged, the chromate forms a protective layer in the scratch, which keeps the underlying metal protected.

Exception

Under European rules, chromate-containing paints should no longer be used on bridges and trains, but an exception has been made for aviation because no suitable alternative has yet been found. 't Hoen: "Paint on aircraft wings must, however, provide adequate protection from damages, otherwise safety is jeopardized." NLR and AkzoNobel are jointly researching whether other anti-corrosion substances exist that mix well in paint and are suitable for use on aircraft in civil and military aviation.

Magnesium particles

AkzoNobel has discovered two variants that work well: paint with a lithium salt base and paint containing magnesium particles. Both appear to be suitable for use on aircraft. "We have already gone through some of the tests and procedures to show that the protection lasts long and does not affect the aircraft's material," says 't Hoen. It is difficult to demonstrate this in a laboratory, which is why the paint has first been tested on a small piece of an aircraft. Researchers at TU Delft helped in carrying out corrosion measurements and the results were very promising. This autumn, the Royal Dutch Air Force will have its first aircraft fully sprayed with three coats of chromate-free paint. Before Defence can use the new paint, usage of this paint must first be approved by the Dutch Military Aviation Authority, because that is a requirement for everything that can change the airworthiness of aircraft and could thus have an impact on safety. NLR supports the Air Force in its certification of the chromate-deficient paint system for a single type of aircraft. ■

Who: AkzoNobel and NLR.
Duration: two years.
Budget: €190,000.
Follow-up: certification of a chromate-deficient paint system for use on aircraft and exploring other, even better technologies for chromate-deficient paint.

Less usage of antibiotics, more animal health

Problem: antibiotic usage in livestock causes increasing resistance to antibiotics in humans and animals. Livestock farmers fear that a reduction in usage will be at the expense of production and yield.

TO2 Solution: research by WUR shows that tailored veterinary advice on animal health management in the broiler chicken and pig sectors contributes to a reduced use of antibiotics. Reduction of veterinary antibiotic use by 63% in the Netherlands from 2009 to 2017 showed no evidence of a negative effect on average production and economic results on broiler and pig farms.

Impact: since 2009, there has been a reduction of 58% (pigs) and 74% (broiler chickens) in the use of antibiotics due to more preventive animal health management with tailored advice from WUR. So, a reduction in the use of antibiotics has had no adverse effect on the economic results of businesses.

WUR

Since 2009, the use of antibiotics in livestock farming declined sharply. Livestock farms feared for loss of production and a deterioration in their competitiveness. Mistakenly, as was apparent from research conducted by Wageningen University & Research at broiler chicken and pig farms.

Expats are surprised that Dutch veterinarians are so reluctant to administer antibiotics. These are prescribed far more frequently in other countries. However, antibiotic resistance, which prevents infections from being combated effectively, is a significant hazard to public health. In livestock farming, antibiotics were still generously administered until 2009. Usage, in the meanwhile, has been reduced by 69%. It was apparent from random testing by WUR in 2019 among 1,500 pig and broiler chicken farms, that this had no demonstrable negative effect on production. This is not only significant news for the Netherlands, but also for those countries that still use many antibiotics, says Ron Bergevoet of Wageningen Economic Research, which is part of WUR.

Adapting

Not much research has been carried out worldwide into the economic effects of measures that inhibit the use of antibiotics. Relatively simple and inexpensive measures were implemented to restrict broiler chicken producers and pig farmers, says the researcher of animal health economics. For livestock farmers, it mainly meant 'adapting' and learning new animal health management routines. This included paying more attention to hygiene, usage of painkillers, anti-inflammatories or preventive vaccinations as a substitute for antibiotic usage. The biggest reduction (of 74%) was achieved by broiler chicken producers, partly thanks to the introduction of slow-growing broiler chickens with more space per animal and fewer 'teething problems'. Pig farmers achieved a reduction of 58%. A pivotal role was reserved for veterinarians, who, through their coaching role, offered alternatives by providing each farm with a risk profile and tailored advice on animal health. "Producing healthy animals rather than sick animals, with better results as a consequence."

Follow-up study

Not all livestock farmers enthusiastically embrace the new policy. It is precisely this group for which we need to conduct additional research to achieve a next step in the reduction. "We know the forerunners are more willing to innovate and see fewer obstacles in the process." But how do you convince farmers who have not yet brought about that reduced usage of antibiotics on their farms? Follow-up research by WUR should reveal how they will participate. ■

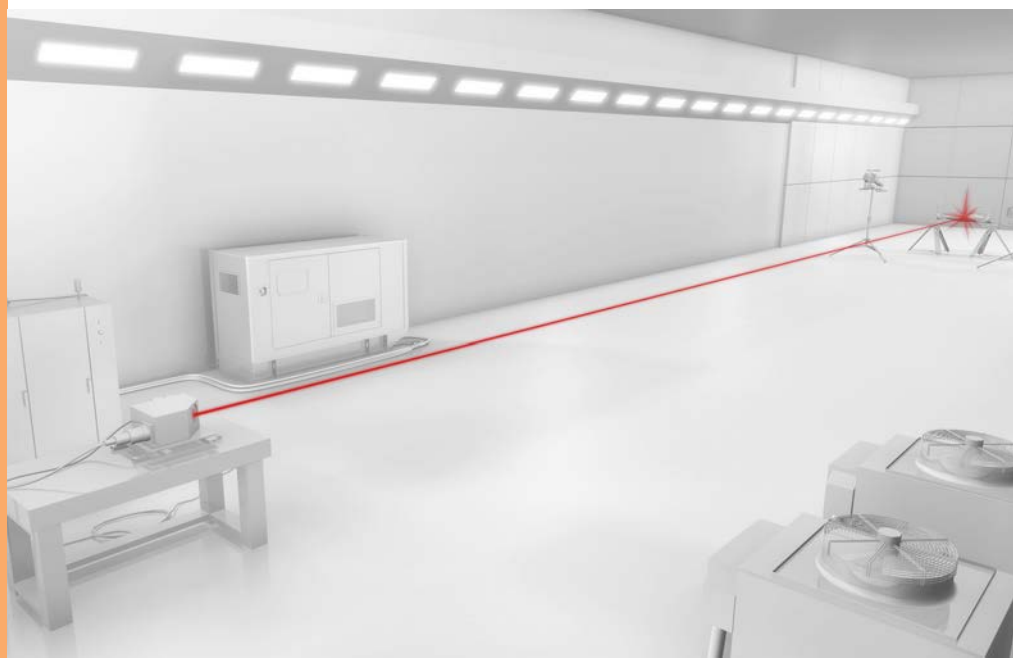
Who: Wageningen Economic Research, colleges and test locations.
Duration: 2019 (one year).
Budget: €90,000.
Follow-up: projects to further inhibit antibiotic usage, projects involving critical success factors that lead to less usage.

Problem: the rising number of unwanted drones, not just among private individuals. More and more armed forces and stateless groups are using drones as a weapon. Drones are increasingly getting smaller; they can fly for longer and they can even fly completely autonomously in large swarms. It makes the combating of unwanted drones more difficult.

TO2 Solution: in collaboration with NLR, TNO has developed defensive counter-drone weapons based on high-energy laser beams. These are weapons that can also be deployed for other purposes, such as hostile ammunition and missiles.

Impact: TNO and NLR's counter-drone weapons enable the Dutch armed forces to be more resilient to drones and other threats in future. Moreover, the Netherlands can become an international player with the high-energy laser technology known as optics.

Light as a weapon



TNO, NLR

Using light to eliminate hostile airborne drones and, in time, to also keep missiles at bay. A team of scientists and engineers from TNO and NLR have been commissioned by Defence to develop defensive high-energy laser weapons.

"It is said that Archimedes used a solar mirror to set a hostile ship at sea on fire. At any rate, the idea behind this technique is already very old," says Federica Valente, TNO's Business Development Manager for Protection, Munition and Weapons. "High-energy laser weapons that quickly point laser beams at a certain point via telescoping lenses and mirrors, have become far more relevant to the armed forces and so too for TNO in recent years. The industrial world uses laser beams to cut through steel, which has resulted in the technology of using high-temperature laser beams with sharp focus being used to eliminate hostile objects such as airborne drones."

Tiny mirrors

A beam can range from a few metres to kilometres, but the force decreases. The power of the beam at the start of the launch and the distance to the target determine the effect. Due to the technology developed by TNO, it is possible to continuously correct interference of the laser beam by the atmosphere. Federica: "It is mainly the atmosphere that affects the beam's operation. Wind, rain or moisture in the air will interfere with the effect. Droplets break the force of the laser beam; they act like little mirrors that scatter the light." TNO developers regularly test the operation of laser weapons and evaluate the models. Federica: "Every three months we go into TNO's bunker for a few weeks. It is adapted to the laser's high power of 30 kilowatts. An armoured vehicle can even be driven into the bunker to act as a target." In 2014, Defence asked TNO and NLR to gather information and knowledge for the future (possible) procurement of laser weapons. Federica: "At that time, America and Germany were the only players in this market. Over the years, our knowledge and expertise has grown. Now that we understand the technology, TNO is involved in the development of laser weapons in European consortia. Our strongest point is that having gained knowledge from various domains – such as weapon effectiveness, atmospheric propagation, sensors and optics – we can combine it with the unique *advanced optics* technology." ■

Who: TNO in collaboration with Defence and NLR.
Duration: start 2014, extension 2020-2024.
Budget: over the next four years: €2 million.
Follow-up: development of a totally European laser weapon and to advise and support the Dutch armed forces in introducing laser weapons into its arsenal.

Secure and fast data transmission via satellites

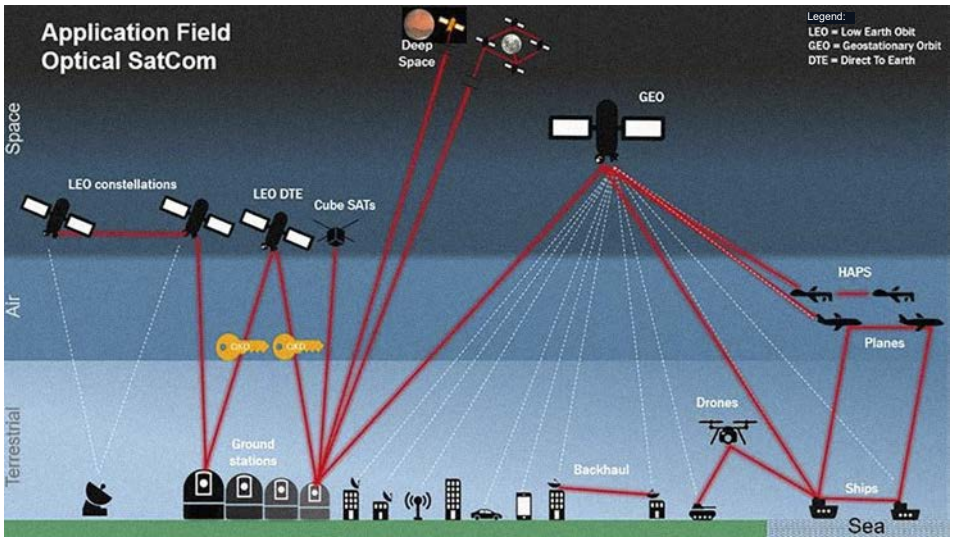
TNO

TNO Space & Scientific Instrumentation enables secure broadband connectivity that supports the growing demand for data. The Netherlands and Europe will benefit: it will enable companies to realise new products and business and to improve their competitiveness.

Problem: data exchange will grow exponentially over the next decade. The current radio frequency communication infrastructure is teetering at the edge of its limits, it can be detected, tapped and disrupted. There is an increasing risk of scarcity of available communication bandwidth.

TO2 Solution: TNO is working on laser satellite communication, which makes use of satellites via laser signals to transmit information between optical communication terminals onshore, offshore, in the air and in outer space.

Impact: lasers make it possible for larger volumes of data to be transferred, they can be secured better and are extremely difficult to detect. Financial institutions can handle their banking traffic securely and telecom companies can handle larger volumes of data. Furthermore, Defence can communicate safely during its mobile operations (e.g. in aircraft). This groundbreaking technology, which TNO jointly wants to market with the Dutch high-tech industry, end-users and various international parties, strengthens the position of the Netherlands in the international playing field and provides high-quality employment in the high-tech industry.



The emergence of the Internet of Things, self-driving cars or, for example, digital 'remote' healthcare solutions: the exchange of data will increase explosively over the next few years and that must be done securely. TNO is therefore working on the development of laser satellite communications technologies, which can transmit larger volumes of data faster and more securely. "Together with businesses, we are developing optical subsystems (such as advanced optomechatronics) and laser communication terminals to be used onshore, offshore, in the air, and in outer space," says Senior Business Developer Niel Truyens of TNO.

Examples

Due to the extremely narrow laser beam, laser communications are very difficult to intercept, monitor or to interfere with, says Truyens. "TNO is developing technology in which networks of hundreds of satellites exchange data across thousands of kilometres between each other and with users on the ground. The data links are superfast and exceedingly secure. New constellations of such satellites with laser links in-between can transport the data links to any location in the world. We can, for example, secure data using encryption keys based on quantum technology. A quantum key from a satellite can be transmitted to both an office in Amsterdam as well as in New York. Then the key ensures that the network is secure over land between these two cities."

"TNO helps businesses in their research and innovation to achieve the new systems they need. We design these systems and build demo models and prototypes to demonstrate technological feasibility. We have already figured out that it can provide the Dutch high-tech and space industry business prospects of €5 billion." ■

Who: TNO works in conjunction with Dutch companies in optomechatronics, FSO Instruments (VDL, DEMCON, Nedinsco and Hyperion Technologies) and aerospace companies such as Airbus Defence & Space.

Duration: 2019 saw the first tests on the stability of the laser beam between two ground terminals. Within a few years it is expected that the first commercial orders for batch production of the laser communication equipment will be achieved. The aim is to achieve a new high-tech value chain that undertakes the batch production.

Budget: over the next five years, €170 million will be needed for this technology development, innovation and to bridge the 'valley of death'.

Follow-up: working with parties in the chain to acquire the necessary budget and further develop future product market combinations.

Containers ~~overboard~~ on

Problem: a ship on the North Sea has lost containers that caused pollution in the vulnerable nature conservation area of the Wadden Sea Islands.

TO2 Solution: MARIN and Deltares mapped the impact of waves on (ultra large) container ships, specifically in extremely rough sea conditions and in shallow parts of the North Sea.

Impact: in the short term, this knowledge helps public authorities and the coastguard to advise captains on these routes and to warn them of adverse weather conditions. In the long term, it may lead to better shipping routes on an international level, e.g. together with Germany where it concerns the Wadden Sea. Although options for designing container vessels are limited, the research results do contribute as input for ship design.

MARIN, Deltares

In January 2019, MSC Zoe lost 342 containers from its deck, off the coast of the Wadden Sea Islands. Many of them washed ashore in the midst of a vulnerable nature conservation area. How could such a disaster be prevented in future? MARIN and Deltares investigated it for the Dutch Safety Board.

According to official statistics, of the 226 million containers carried by ships worldwide each year, 1,400 of them topple overboard (World Shipping Council 2019). This is a relatively small volume, but the impact on the environment can be enormous.

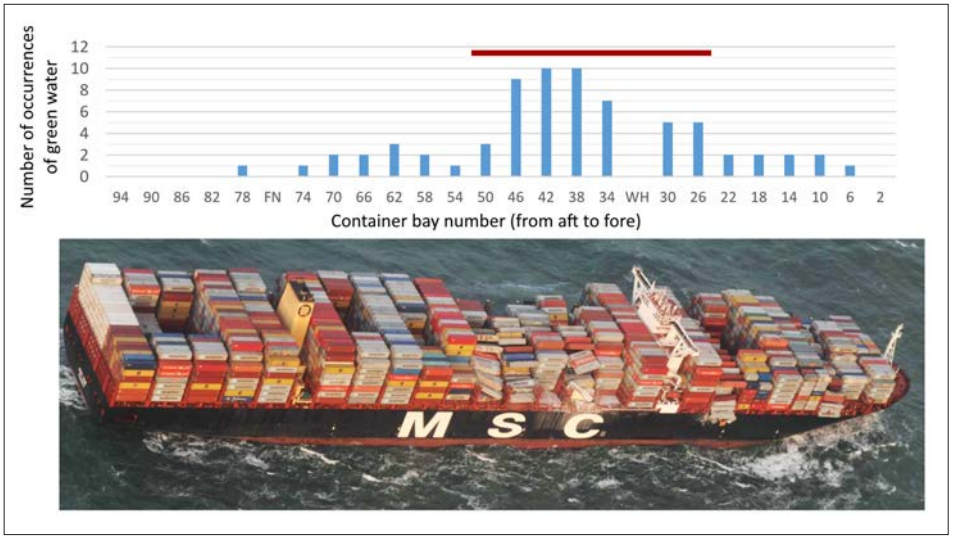
Reconstruction

In order to take effective measures, it must first be clear where things go wrong. What can cause problems for an ultra large container ship in this specific part of the sea? During their reconstruction of the storm, MARIN and Deltares discovered quite a few causes.
"We did not investigate the actual cause of the MSC Zoe accident," says Bastien Abeil, Project Manager at MARIN. The ship was flying the flag of Panama and so that country had to lead the investigation. The Dutch institutes investigated how a ship of the same size sails in similar weather conditions. In so doing, they investigated the impact of the waves and the shallow water – characteristic for this area in the North Sea – on a ship. Abeil: "If only the cause of the accident is investigated, the focus lies on one phenomenon and other possibilities might be overlooked."

Simulating a strong gale

Deltares simulated the weather conditions on 1 and 2 January 2019 by using a hydrodynamic model developed by Deltares and TU Delft. Based on these calculations and measured data such as the tide and weather conditions, they reconstructed the wind, water level, waves and currents on the navigational route during the strong gale.
There are two routes through the area in question: the northern route at that time was about 35 to 40 metres deep and the southern route was shallower at between 21 and 27 metres depth. MARIN researchers used this data for their calculations. However, they then ran into a problem. Abeil: "Ships mainly navigate in deep water. This is what the mathematical models are based on worldwide. We simply cannot calculate a full impact of waves on ships in shallow water yet."
The solution: an experiment in MARIN's test basin. MARIN built a scale model of an ultra large ship, except it was 63 times smaller. At its true size, such a ship can transport 22,000 standard containers of 6 metres long. A loaded ship has a draft of more than 15 metres.

Bastien Abeil



The model was equipped with measuring equipment and underwater cameras to measure and observe all movements. The water's depth also had to be to scale. Abeil: "Normally, our test basin is 10 metres deep. For this experiment we had to set the adjustable floor at knee height, 30 to 40 cm below the surface."

Combination of factors

What did they discover? First of all, there is something like a ship that is too stable. Until recently, scientists mainly investigated the effects of inadequate stability, which means that ships could capsize. The wider a ship, the more stable it is. Then it does not roll slowly but quickly. When the 'rolling period' of this model came close to the motion of the waves, they strengthened each other and created large yaw angles, up to 17 degrees. "Skippers call that extreme. The model was shaken considerably and even hit the bottom," Abeil sums up. Furthermore, the researchers measured the impact of the waves. Normally, containers are at a level of up to 18 metres above the water. Due to the striking waves against the side of the swaying ship, they reached the bottom layer of containers of the scale model. "That is where the rest of the stack – about five containers – are anchored. This can cause containers to crash, or complete stacks to fall over like dominoes."

Finally, water smashed against the hull and caused vibrations in the hull that exerted even more force on the containers. Containers are anchored onboard, but it is unknown how much strength these fastenings can handle in practice. The second uncertainty is whether anchoring is always carried out properly.

Trend

What can we do with this knowledge now? Abeil: "In the first instance, the coastguard could offer advice so that captains are more aware of the risks when they plan to navigate in this area. We cannot change the waves or the seabed, but we can change the routes and the design of ships. This will allow us to use this new knowledge of stability in the design of ships."

As far as the routes are concerned, it is not so easy to prohibit or to relocate a navigational route. Over the largest part of the North Sea, the Netherlands is not the only country to exercise control. This study by the Dutch Safety Board (OvV), will enable public authorities to investigate the measures that are most appropriate and to seek international support for them.

Who: Deltares, MARIN and the Dutch Safety Board.
Duration: one year (2019).
Follow-up: research into the situation for smaller ships in this area, on commission for the Ministry of Infrastructure & Water Management.

Problem: the corona crisis has had a major impact on our society and the world economy. There is a need for knowledge and expertise to resolve immediate problems and shortages caused by the corona crisis.

TO2 Solution: TNO is committing its innovative power to find solutions that can rapidly be deployed to combat the coronavirus. TNO's specially established 'Brains4corona Team' coordinates projects that its own employees have devised and started, and also answered corona-related questions posed by third parties to TNO.

Impact: in the short term, TNO devised a collection of solutions – large and small – which contribute to the fight against the coronavirus. For example, a rapid corona infection test has been devised to relieve the existing, hectically busy test lanes.

TNO is using its brains

TNO

When the corona crisis broke out in all its intensity in March, TNO committed its innovative power to combat the corona crisis. Under the banner of Brains4corona, employees devised dozens of proposals, some of which have been applied throughout the Netherlands.

In March 2020, TNO felt compelled to contribute to resolving the corona crisis. The idea arose from Peter Werkhoven, a member of the Board of Directors, who wanted to use TNO's 'brains' to combat the virus. Help came from employees in all sections of TNO. They submitted at least 79 proposals, 21 of which were selected. Although there was an important limiting condition; the project proposals had to lead to a solution within eight to ten weeks and they had to be practically feasible. "Normally, as an institute, we conduct research and investigations with longer start-up times. Due to the immediate problem of the corona crisis, we had to act quickly," says Jaap Lombaers, who, as the Director of Knowledge Management and Partnerships, led the Brains4corona programme.

Promising projects

The projects ranged from developing cooling jackets against overheating while wearing corona attire in hospitals, to a model that helps Dutch hospitals to respond better to the number of patients that end up in intensive care. By now most projects have been completed and implemented. Lombaers mentions three successful projects:

1. A panel of experts answered questions from hospitals about accommodation and air control in the context of corona

There were many questions from hospitals: what to do with their installations when a regular hospital ward was converted into a ward for corona patients. Do the installations need to be adapted, what are the contagion risks? TNO's BIM (Buildings, Infrastructure & Maritime) unit has extensive knowledge about climate and air treatment of installations in buildings. They contacted experts from other institutes and joined forces. Since Monday 23 March 2020, TNO has run a helpdesk that was set up in collaboration with Royal Haskoning

to combat corona

DHV, VCCN and TU Eindhoven, to answer questions from hospitals about climate and air treatment. In this way, dozens of hospitals and nursing homes have been provided with practical advice.

2. Rapid test for corona infection
TNO has developed a test that provides a result within one hour, the so-called LAMP-test: loop-mediated isothermal amplification. It is a technique for analysing genetic material faster to trace the coronavirus. The technique was first tested for eight weeks in the TNO lab and was then used in cooperation with the Municipal Health Service (GGD) and National Institute for Public Health and the Environment (RIVM) in a corona test lane at the RAI in Amsterdam. Further upscaling will follow if it is successful. The rapid test, which works with a cotton swab that is used to remove tissue from the throat cavity, could be a solution to relieve the existing, overstretched test lanes. Having much faster results than with existing tests that take 1 to 2 days, new useful applications are coming to the fore. Take for example, the testing of air passengers directly at check-in.

3. ICT tool for the demand aggregation of shops
During the corona crisis, people ordered more online. Large companies have handled that delivery process well, but it was difficult for SMEs to set up efficient, affordable home delivery services. TNO developed the home delivery concept called PUPPY (Pop-Up, Pick-Up and Home Delivery). Customers can order from various stores via an online portal. The home delivery service for these stores is then combined. Retailers prepare the orders, a logistics party collects them and delivers them to the customer. Or the customer can pick up the orders at the centralised collection point in the neighbourhood. The concept was tested in Dronten and Kampen and then all the lessons learned were disclosed. Shopping centres and retail associations use this solution in several places in the Netherlands.

Apart from its own projects, TNO was often approached by external parties during the corona crisis for questions and help concerning corona. This gave them good reason to designate a multidisciplinary team (in the fields of health, infrastructure, ICT) to deal with incoming queries or to refer them to the right place.

Unorthodox approach
As the unorthodox approach proved to be successful (not years of investigation and research, but to arrive at a practical solution quickly) TNO's Brains4corona put their thinking caps on. Lombaers: "It explored the creativity throughout the organisation. Colleagues were really driven and liked it so much that we continued with this approach. We are considering tackling a social problem in a similar fashion once or twice a year, in which we rapidly conjure up quick and practical solutions for it. This could include the shortage of housing or the growing isolation of the elderly; topics that affect us all." ■

Who: TNO in cooperation with (semi) public authorities, institutes and the business community. For its expert panel/helpdesk, TNO worked in collaboration with TU Eindhoven, VCCN and Royal Haskoning DHV.
Duration: 8 to 10 weeks.
Budget: approximately €1.5 million for implementing 21 selected projects.
Follow-up: some projects will get a follow-up. For instance, TNO will explore whether it can develop the rapid test further for the coronavirus, similar to a pregnancy test. In a broader perspective: TNO wants to tackle social issues more often to achieve readily applicable solutions.

Problem: availability to scientists and professionals of data about corona in the healthcare sector is woefully poor, whereas this is particularly necessary to map out the spread of the coronavirus and to improve and upscale diagnostics.

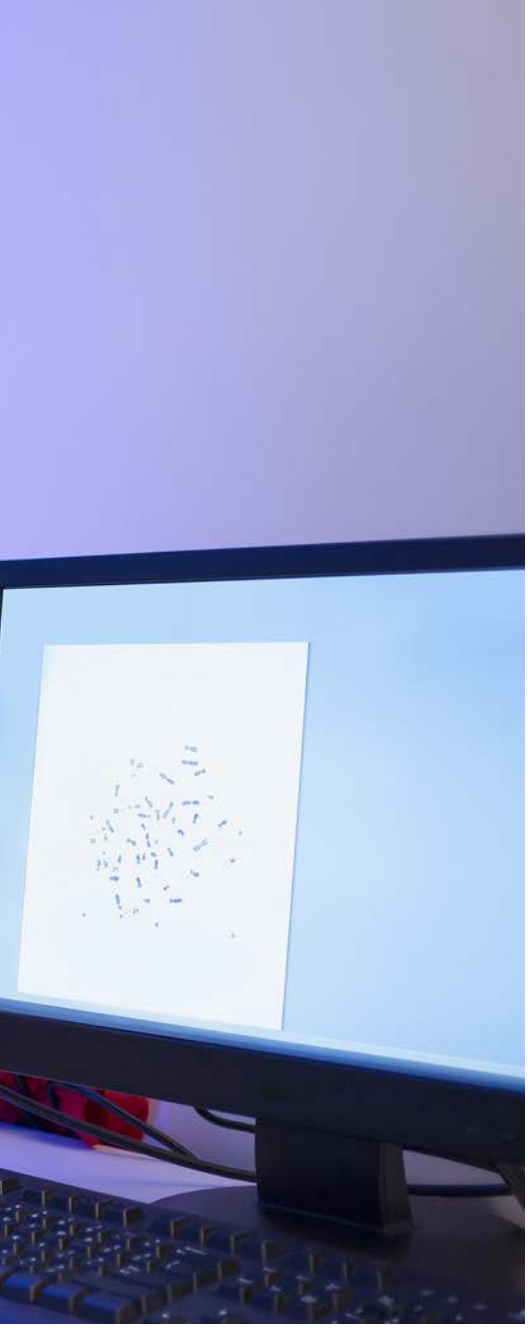
TO2 Solution: the Virus Outbreak Data Network (VODAN) ensures that hospitals share corona data FAIR, i.e. the data is Findable, Accessible, Interoperable and Reusable, both for people and for machines. This allows for linking to FAIR data from research institutes, companies and public authorities. WUR makes data available and is seeking viable alliances.

Impact: in current and in future virus outbreaks, we can establish links between data more quickly and upscale more precisely for testing. In the case of researchers from Wageningen, for example, using research on air quality or outbreaks at mink farms.

Sharing data (directly) has never been so important

WUR

International scientists believe the outbreak of corona lends itself to making a serious effort in sharing the FAIR (medical) data. The VODAN network mobilises hospitals and other owners of relevant data to make it instantly available worldwide. They are already working on this at Wageningen University & Research, who is a VODAN network user.



The course of events surrounding Ebola just goes to show how things can go wrong with sharing data, says Ben Schaap of the Wageningen Data Competence Center. Data on outbreaks in recent years have barely been recorded and, if they are available, it is not at all possible to consult them. And that makes it impossible to compare or reuse data. "Scientists in Europe and the US took samples and collected data, but doctors and scientists in Africa never got access to these logbooks and to this data. This meant that almost nobody in Africa could learn from their own data."
Ben Schaap believes it underlines the importance of sharing FAIR data. The European Commission embraces the principle of FAIR data. Further efforts are being made with a European Open Science Cloud (EOSC) in which participants can share data FAIR. GO FAIR, an initiative of the Netherlands, France and Germany, has been working on implementing the FAIR data principles in a European Open Science Cloud since 2017.

Little trains

According to Schaap, the corona crisis works like a pressure cooker: all of a sudden everyone notices how important it is that data must be internationally accessible for scientific research. This makes the global pandemic 'an ideal case' to underline the importance of FAIR data and to find an answer to urgent questions sooner. What are the main symptoms of corona, how long does a patient stay in intensive care? The answers are logged in the patient data that hospitals are now sharing with each other. Nowadays, this Virus Outbreak Data Network mainly focuses on patient data, but Schaap also envisages opportunities in combination with WUR's research fields. For example, Wageningen has access to environmental data that may be relevant to corona, such as air quality. And Wageningen conducts research into outbreaks of corona at mink farms, in which researchers learn a great deal about the transmission of the virus from humans to animals. This data may perhaps offer better insights into the spread of the virus in combination with sharing FAIR data from the National Institute for Public Health and the Environment (RIVM).
It may be worthwhile to possibly link to data on air quality. For example, do patients in regions with poor air quality suffer more from corona? "The more experts investigating a problem, the better we gain insight into its control," says Schaap. The network is now mainly working on the conditions to store data, for which data stations have to be built. Soon 'little trains' with algorithms will pass through the data stations of research institutes to retrieve results for further analysis.

Culture shift

WUR itself wants all data to be FAIR in four years' time, but it will take a while before everyone has taken this step. "It is a culture shift and that takes time." Scientists with fabulous datasets are not used to making it readily available to others. "They first want to publish it themselves before others can get access. Yet, that is exactly what we want with FAIR data." The data science alliance manager notices that FAIR data principles are increasingly being applied. Eventually, more and more research financiers such as NWO will call for data to be FAIR.

Digital twins

A next step is that the data must also be useful from the outset for machine learning and artificial intelligence, thus making it easier to predict corona's progression. On other topics like tomato cultivation, diets and precision-farming, WUR already works with so-called digital twins, which are digital models that digitally emulate these processes. An advantage of a digital twin model is that it is constantly updated when something changes in the greenhouse, on the scales or in the nitrogen cycle on a farm. This makes the model consistently accurate, so too in the prediction of future developments. There is still a long way to go to achieve this, says Schaap. After all, you can only use data of which the origin is known. "In other words, the metadata of models must also be machine readable, so that we can trust that the FAIR data has been generated by the models." ■

Who: GO FAIR Foundation, ZonMW, LUMC and various universities in the Netherlands (WUR, University of Twente) and the rest of the world.
Duration: started at the outbreak of corona (Go FAIR started in 2017).
Budget: part of development at Data Driven & High Tech and Digital Twins, about €3.1 million per year.
Follow-up: with FAIR data, artificial intelligence and machine learning can predict the progression of a virus outbreak.

WUR

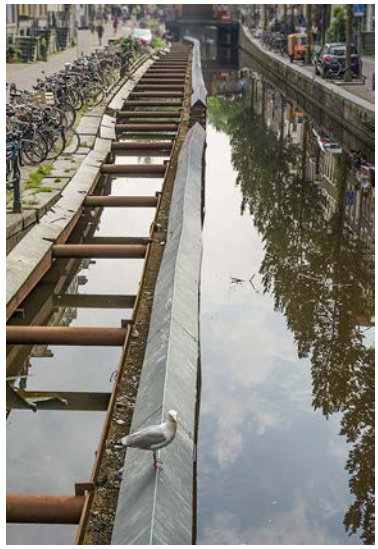
The natural combating of the oak processionary caterpillar works

In recent years, the nuisance caused by the oak processionary caterpillars increased considerably in the Netherlands. The caterpillars cause skin irritations and sometimes serious health problems in humans and animals. WUR is involved in a 2-year study of the social impact and control of the caterpillar. Due to increasing volumes of caterpillars, people make less use of nature. Moreover, the caterpillar is responsible for high costs and biodiversity has come under pressure due to control with biological agents, which are also fatal for caterpillars of other butterfly species. In the research, WUR examines the effectiveness of the various control measures that municipalities apply. For example, by using natural enemies, such as hanging nesting boxes for birds who eat the caterpillars. It takes some time before natural enemies have settled and the effects are often only visible after a few years. However, a small-scale pilot in Drenthe shows that a combined approach (different mowing scheme for verges, targeted ecological edge control by adjacent farms, the placing of nesting boxes, the placing of former oak processionary caterpillar nests infested with natural enemies) leads to fewer infected trees and fewer oak processionary caterpillar nests.

Deltares

Solid quay walls and bridges for Amsterdam

800 bridges and dozens of kilometres of quay walls in Amsterdam have a maintenance backlog and/or are at the end of their service life. Some quays have already subsided with all the consequences that this entails. Together with TU Delft, Deltares has developed a method using satellite measurements to demonstrate the risks to houses before the renovation activities of quays or bridges begins. “At present, we are also looking at whether these measurements can act as a warning sign when quays or bridges start to move and are possibly of poor quality,” says Mandy Korff, a geotechnical expert at Deltares. Deltares is also developing the related software which can also be applied to other building projects. Testing grounds have been installed to examine the strength and capacity of the wooden poles under bridges. The results have been included in the assessment model of quays and bridges with the aim of continuing to use them safely for longer.



WUR

Analysis of additional biodiversity costs for farmers

Many dairy farmers and crop farmers want to contribute to improving biodiversity, such as protecting pasture and farmyard birds or reducing crop protection products. All parties involved are working together on this in the Biodiversity Recovery Delta Plan. But, because of uncertainty about the investment and its recuperation, farmers do not often take action. The report 'Additional costs for biodiversity measures at dairy farms and crop farms', provide WUR researchers with an indication of the additional costs for a greater biological variation within their territory. According to researchers, a dairy farmer can introduce additional measures that costs between €2 and €3 per hundred kilo of milk, to ensure a more biodiverse business operation. For a crop farmer, these additional costs average between €185 and €324 per hectare.

NLR

Using drones safely in the skies

Drones are playing an increasingly important role in our society. To be able to share airspace safely with manned aviation, comprehensive research is needed. With that in mind, Royal NLR carried out permitted test flights with a drone in the normally closed airfield around Schiphol. This test fits in well with initiatives of other drone flights jointly conducted with Dutch Drone Delta (DDD), a coalition of a dozen parties, which explores the possibilities of transporting goods and people using drones. DDD focuses on safe, socially accepted and sustainable applications for solving bottlenecks in urban mobility.
NLR will evaluate the results of these test flights: "This step will help us to find mobility solutions that meet the future needs at airports and in cities," says Project Manager Wesley Poland. In the long term, this can lead to the development of a new NLR facility: a DronePort, an airport for drones near the A10 highway, close to the city centre of Amsterdam and a stone's throw away from Schiphol Airport.

TNO

Seaweed as fuel for trucks

After using seaweed as a fuel for passenger vehicles, TNO and TU Eindhoven started to develop fuels (such as ethanol and butanol) from seaweed for use in heavy-duty equipment and more specifically in heavy-duty road haulage. This is a worthwhile sector, because full electrification of freight traffic is not entirely possible and renewable alternatives are needed. Seaweed is a renewable biomass with several advantages: there is no claim on land, no competition with the food chain and seaweed does not need fertilisation. For example, the use of seaweed contributes to the ambition to accelerate the energy transition. Measurements by TNO and TU Eindhoven show the potential for various applications of ethanol and butanol fuels derived from seaweed. The measured engine-off NOx emissions are very low and show the potential to meet the most stringent emission requirements, even without the use of an exhaust gas after-treatment system. In addition, the efficiency achieved is approximately 20% higher than that of current petrol engines and at least equal to the efficiency achieved in diesel engines used in heavy-duty road haulage.


federatie
De samenwerkende organisaties
in toegepast onderzoek