

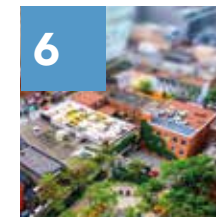
Annual report 2021

# Vision on technology for a better world



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## SUSTAINABLE SOLUTIONS FOR BUILDINGS

Sustainable buildings are not just buildings that are lit, heated and cooled with green energy. They are also designed and implemented in a manner that makes the impact on the environment, the climate and humans as low as possible.



## ROBUST WATER MANAGEMENT

Through research and innovation VITO will help Flanders to evolve towards a model region for efficient water usage.



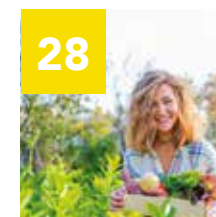
## TOWARDS A CIRCULAR AND BIO-BASED ECONOMY

In a circular bio-based economy, as few new primary raw materials are used as possible. Fossil fuels become bio-based. Materials are being reused and recycled as much as possible – losing as little value as possible.



## ENERGY SOLUTIONS FOR THE FUTURE

Europe wants to be the first climate-neutral continent by 2050. Talking about this ambition may be one thing, but effectively achieving it is quite another. We need to be moving at full speed.



## CLIMATE SERVICES

Global warming is not the only crisis threatening our planet. Biodiversity in the many unique ecosystems that the Earth has in abundance is under great pressure or is already declining.



## PERSONALISED AND PREVENTIVE HEALTHCARE

Good health is very precious to us. Naturally, prevention is always better than cure. This is making preventive healthcare more and more important.



## VALORISATION OF SUSTAINABLE TECHNOLOGY

The expertise and technology that VITO develops does not remain in-house. It is also valorised by transferring it to the business world.



# Preface

Dear reader,

2021 was the second COVID-19 year for everyone, including at VITO. Maximum remote working, keeping a distance and face masks remained in force in VITO operations for the whole year, up until early March 2022. There was some parallel thinking about the "Work Organisation of the Future". The principle of activity-based working, with sufficient contact and physical consultation sessions, combined with broader home-working arrangements, was brought together into a new way of working by an internal working group. The VITO buildings and procedures are now being adapted to this. The aim is to continue to raise productivity and employee satisfaction.

The long-running COVID-19 crisis has had little negative impact on VITO's financial and scientific results. The labs continued to be manned for tests and research. VITO project proposals are scoring very highly in the new European research programmes, with research projects already approved for more than 60 million euros. Scientific output also saw unprecedented growth, with 323 SCI papers and 25 patents submitted (43 granted). The digital welcome app (which was developed in-house) was received by new staff with great enthusiasm. VITO welcomed 112 new staff members in 2021. This growth brings the total number of staff to 983, including 17 % foreigners from 45 different countries. VITO's budget in 2021 amounted to around 221 million euros.

Bringing about a sustainable future and collaborating in Flanders and abroad remain the guideline for VITO's research. This report contains VITO's foremost achievements, from establishing four spin-offs in 2021 to the efforts by Prof. Dr. Karl Vrancken, who was tasked with co-ordinating the approach to the PFAS issues in Flanders. VITO is focusing on climate projects in India and Africa, and is developing a new electrolysis device along with imec for the generation of cheap, green hydrogen as part of implementing the Green Deal. This research project has also been picked up by industry at an early stage.

In June 2021, as part of the geothermal research, the energy plant in Mol was restarted. Prior to this, there was extensive consultation with neighbouring companies, surrounding municipalities and the authorities concerned.

A number of small changes have also been made to the plant and several additional seismometers have been fitted. The aim of the current phase of the research is to gain a better insight into the mechanisms in the subsoil for various pressures and flow rates of the pumps, in order to gain a better view of the underground water flows and ground movements. At present, the facility is working with a maximum flow rate of 25m<sup>3</sup>/h. It was still possible to generate sufficient heat (thanks in part to the warm winter of 2021-2022), so as to reduce VITO's CO<sub>2</sub> emissions by 40 %. More than 2,500 MWh of heat produced, which would otherwise have blown 530 tons of CO<sub>2</sub> into the air.

We celebrated LIBOVITO's 10th anniversary. The Flemish government also made additional resources available for setting up the WaterClimateHub in Ostend.

G-STIC, the annual SDG (Sustainable Development Goals) conference that we organise along with 7 other international research institutions, took place beyond our borders for the first time in 2021. The World Expo and the organisation of the Flemish week in Dubai presented a great opportunity. This raised the success and the international recognition of G-STIC further, with almost 4,000 participants from more than 125 countries.

It is now early 2022 and the gradual end of the COVID-19 pandemic is in sight, along with the definitive transition to an endemic phase. The human and economic consequences will continue to haunt us for a while. The impact of the current crisis in Ukraine should not be underestimated either. But with the support of the Flemish government, VITO will continue to support the Flemish economy and its people with future-oriented scientific research in the future.

I hope you will enjoy reading this report.



I. Vanden Berghe  
Chairman of the Board of Directors

# Board of Directors



**Chairman:**  
Ingrid Vanden Berghe

**Members:**  
Dirk Fransaer, Kurt Deketelaere, Elke Van de Walle, Michel Meeus, Renate Hufkens, Wim Van den Abbeele, Eric Vermeylen, Caroline Ven, Marc Decorte, Isabel Van Driesche, Luc De Schepper

**Government commissioners:**  
Bob Van den Broeck, Nele Roobrouck (not present in picture)

**Observers:**  
Frank Gérard (PMV), Wesley Boëne (VITO), Maarten Spruyt (VITO)





# Sustainable solutions for buildings

## BUILDING TOWARDS A FOSSIL FUEL-FREE AND HEALTHY LIVING AND WORKING ENVIRONMENT

Sustainable buildings are not just buildings that are lit, heated and cooled with green energy. They are also designed and implemented in a manner that makes the impact on the environment, and the climate as low as possible. In addition, they are healthy and comfortable for residents, users and visitors too.

VITO/EnergyVille has a strong focus on all these aspects. This takes place as part of the transition towards a sustainable economy and society, for which a sustainable building stock is a crucial component. The European Commission's Green Deal is helping to spur on this transition. But it is also in line with Flanders' climate ambitions. After all, our region is aiming to be able to heat and cool its building portfolio without the use of fossil fuels by 2050.

Many different domains come together in the transition towards a sustainable building stock. That means innovations need to be optimally integrated into a larger perspective. And, of course, they must first see sufficient testing, ideally in a realistic setting.

Just like elsewhere, making buildings sustainable goes hand in hand with ever more intensive digitalisation. Digital technologies make innovations smarter, more flexible and easier to use. VITO/EnergyVille is also strongly contributing to that.



## oPEN Lab Genk

### A TEST SITE FOR POSITIVE-ENERGY NEIGHBOURHOODS

Positive-energy neighbourhoods, as they are known, or PENs, produce more energy than they consume. They do this through a combination of energy-saving measures and an efficient use of locally generated sustainable energy. In addition, technologies such as energy storage and smart, flexible demand control ensure that the wider energy grid does not become overloaded. A PEN brings together innovations from which lessons can be learned for making the transition to a climate-neutral infrastructure in urban environments.

In the European Green Deal project oPEN Lab, technologies, services and social innovations for the implementation of positive-energy neighbourhoods are tested and optimised. This takes place in the setting of living labs, innovative hotspots where the transition is being deployed so as to help achieve positive-energy neighbourhoods at a large scale all across Europe later on. VITO/EnergyVille's Living Lab at Thor Park in Genk is among them. At this oPEN Lab in Genk, more than thirty homes are linked to

a test environment – a smart data platform is among the things being used to achieve this. Aside from Genk, there are also some test sites in Pamplona in Spain and in Tartu in Finland. The oPEN Lab project is being co-ordinated by VITO/EnergyVille.

Even after the project finishes, in the spring of 2026, Thor Park and the adjoining neighbourhoods and companies will continue to function as a test environment for VITO/EnergyVille's activities. An innovative heat grid, direct current grid and an advanced data platform are also being rolled out on the site. They all aim to make optimum use of the energy available and to be able to offer businesses a lasting test environment for the development of innovative technologies and services.

**Flanders is aiming to be able to heat and cool its building portfolio without the use of fossil fuels by 2050.**





## Heat zoning inspiration map

### A GROUNDBREAKING TOOL FOR LOCAL AUTHORITIES

If Flanders wishes to achieve its stated aim of being able to heat and cool its entire building stock without fossil fuels by 2050, local authorities in particular will need to be involved in the process. Cities and municipalities find themselves at the level where the transition towards a fossil fuel-free building stock becomes very concrete. For example, they can have coloured zones on their territory where it is better to heat buildings collectively (through a heat grid), or where the heat provision is ideally organised individually. This means the transition will move along nicely in line with the specific local context.

In order to help local authorities in this, the Flemish consortium WarmteWerkt developed a 'heat zoning inspiration map', as they called it, at the request of the Association of Flemish Cities and Municipalities (VMSG). VITO/EnergyVille is among the partners in the consortium.

Aside from defining zones for collective or individual heating and cooling, the inspiration map will also allow for running simulations on potential new developments such as new-build neighbourhoods (through which heat sources can be temporarily added or altered, for example). Alongside this, authorities will be able to rely on support from experts in the consortium when using the map.

Because there is not yet a reliable total overview of available heat sources in Flanders today, the inspiration map is being drawn up from the perspective of the heat demand. This will make the map a major starting point for further, more targeted research to take place later on. It will also accelerate the heat zoning process for local administrations.

## GSASgate

### DIGITAL SUSTAINABILITY ASSESSMENTS FOR CONSTRUCTION PROJECTS

In the Middle East and North Africa, countries are making use of an assessment platform for the sustainability of construction projects that was developed by the Qatari non-profit organisation GORD. This platform, known as GSAS, determines objectively, accurately and efficiently the extent to which projects are sustainable and thus deserve a green stamp. The assessment takes place along the entire duration of the projects, from the planning phase prior to construction up to and including the use of the building.

In 2015, a delegation from GORD came to VITO asking for the GSAS platform to be fully digitalised. The aim: to create an online platform that keeps all stakeholders in the construction projects proactively and entirely digitally (i.e. paperlessly) up to date. In addition, the digital platform, which was to be called GSASgate, would allow for clarifying visualisations to be created for projects that were already being assessed.

For the development of GSASgate, VITO began with a blank sheet, with data that were already available or were provided by GORD. In the past few years, the digital platform has become more and more sophisticated. Indeed, the scope was very broad: all the aspects that had anything at all to do with sustainability were included. This was not just for individual buildings and homes, but also for entire neighbourhoods and urban districts.

Upon completion, GSASgate was fully transferred to GORD's servers in Qatar, which now manages the platform itself. The organisation now offers the digital assessment platform to neighbouring countries and other countries in the Gulf region too.

## Healthy air, including at work

### EMPLOYERS GAIN AN INSIGHT INTO INDOOR AIR QUALITY

Since the corona pandemic, consideration for good indoor air quality has increased sharply. But healthy air in rooms is not only important for avoiding virus infections from corona or flu – it is also important for the general state of our health.

At the request of Agoria, the Flemish Construction Confederation and Voka, VITO drew up a comprehensive memorandum that gives employers an insight into what good indoor air quality actually involves. In addition, the memorandum contains advice on improving that air quality and keeping it healthy at companies and organisations.

The document covers all the facets of indoor air quality. From the difference between ventilation, aeration and air purification to the importance of CO<sub>2</sub> measurements as an indicator for indoor air quality. It also goes into more detail on potential sources of indoor air pollution at companies, such as construction materials, office furniture and cleaning products.



**As commissioned by the Flemish government, VITO is carrying out a research project during one year about the practical effect of measures such as ventilation and air purification on the risk of viral infections at schools, childcare facilities and assisted-living centres. The research is highly solution-oriented: how and how far can that risk be limited? What impact will any measures have on people's comfort and well-being?**

**In the case of schools, for example, VITO's experts are researching what teachers and pupils think about noise pollution, arising from both the outdoor environment (in the case of aeration) and from air purification. The extent to which extra ventilation and air purification may limit the risk of viral transmission is also being studied. The research is being coordinated by VITO and is taking place in collaboration with Ghent University, Liantis, Antwerp University Hospital (UZA) and the Jessa Hospital.**





# Robust water management

## TOWARDS A CLIMATE-PROOF WATER SYSTEM THROUGH RESEARCH AND INNOVATION

From a region plagued in turn by drought and water scarcity, then by water nuisance and flooding, to a model region for efficient water usage. This ambitious transition is what the Flemish government is proposing in its Blue Deal. With this broad package of measures, Flanders is seeking to accelerate its robustness against water problems that threaten us not only directly, but also indirectly – for example, through the great dependence on ground and surface water for agriculture and the food industry.

Part of the answer lies in technological innovation, both physically and digitally. Because drought and flooding are closely connected to global warming, Flanders is getting its own research and innovation hub on this theme: the WaterClimateHub. This hub will aim to drive the development of a climate-proof water system.

Specifically in terms of drought and water scarcity, there is a need to provide water where (and when) it is needed. This prompts a kind of water redistribution that covers all of Flanders, but at the same time is also very locally focused. The Flanders WaterProof project may be seen as a serious step up for this. The systemic vision the project is operating from characterises VITO's approach.

As mentioned earlier, digital innovations are very welcome in enhancing and accelerating the transition towards sustainable water management too. By making information accessible and available to farmers, water supply and demand can be better aligned. Data from sensors, drones and satellites can also be used to help limit the impact of water nuisance and flooding.



## WaterClimateHub

### A LEADING WATER KNOWLEDGE CENTRE FOR THE WHOLE OF FLANDERS

In recent years, various periods of extreme drought, as well as serious flooding, have reminded us that if we want to safeguard our economy and quality of life, there is no alternative but to arm our region against water scarcity and drought at an accelerated pace.

The Blue Deal sets off on that transition towards a climate-proof water system. The ambitious package of measures aims to make Flanders a model region for efficient water usage. One of the measures is the establishment of the WaterClimateHub. The goal of this 'hub' for research and innovation is to encourage the development of technological innovations across the fields of water, energy and climate. The innovations may be both physical and digital.

The WaterClimateHub was founded by VITO at the request of the Flemish government. Its head office is located in the Ostend Science Park. From there, as well as from other locations in Flanders, the hub encourages research into sustainable water management and helps bring these innovations to market more quickly. Because there is already a great deal of knowledge and expertise present in Flanders, the WaterClimateHub is being grafted onto existing collaborations with universities and regional and Flemish actors. This is taking place in the form of open innovation networks. By building upon existing synergies and attracting innovation projects, the WaterClimateHub could grow into a major, leading water knowledge centre for the whole of Flanders.

### For companies, citizens and authorities

Innovations in terms of sustainable water management are necessary for sectors such as agriculture and industry, as well as for citizens and authorities, in order to provide an answer to the water and climate challenges. The innovations may vary widely, from buffering water on agricultural plots or company premises, through smart reuse of rainwater or wastewater, to reducing water usage in businesses.

Through intensive and cross-field collaboration, the WaterClimateHub aims to use existing knowledge more broadly, quickly and effectively to meet the various challenges too. The development and enhancement of the current know-how should boost innovations.

As open innovation demands, the WaterClimateHub is also open to companies (small and large) and organisations to enable them to test and validate their new technologies, concepts, and business models. They are supported in this by scientific and technical experts who have over twenty years' experience in the fields of water, energy and climate. The team of forty experts works from offices spread across Flanders, in Ostend as well as in Genk, Kortrijk and Mol.





## Flanders WaterProof



### WATER REDISTRIBUTION WITH A SYSTEMIC VISION

Specific actions will be taken at three locations in Flanders to achieve a more resilient water supply by means of a combination of smart spatial planning, intelligent management of buffers and optimised circular water networks. The intention is that these regional 'demo areas' will deliver new knowledge and expertise on how to make Flanders more resilient to drought and to the effects of global warming.

The actions and the research in the demo areas are part of Flanders WaterProof, a project led by VITO that is researching how smart buffering can combat drought. Although the three demo areas have a local dimension, the project exceeds this through the systemic vision it maintains. The new or adapted knowledge and experiences arising from the project will shortly be applied across Flanders. The initiative could also be described as a water redistribution project that will make our region waterproof.

In the 'Waterarchitect' demo area, a business park in Tielt (West Flanders) is being equipped with a local and smart water network that aims for maximum alignment between supply and demand. The intention here is to bring about a decentralised collective water circuit. In 'Klimaatplassen' (in the wide region around Mol/Antwerp), more specifically in the lakes of the former white sand pits, water is being buffered during wetter periods to increase availability in dryer times. In 'Watergemeenschap', in the Hesbaye fruit-producing region, the focus lies on local buffering, infiltration and reuse of rainwater, both at the level of individual fruit-growers and collectively.

During the project's implementation there will be a maximum focus on synergies with local stakeholders. They will help to formulate the central issues, such that support is guaranteed from the start. There will be a bottom-up review with all the actors to examine what needs to happen on the three sites in practice.

### Dynamic learning process

In each of the three demos, VITO's broad knowledge and experience in the field of water, climate and spatial planning is being integrated at a system level. This is the systemic vision for Flanders WaterProof. If we look at the wider picture, the project is the first practical phase of a dynamic learning process that is in line with the Flemish government's ambitions for the Blue Deal.

VITO's system-based approach is also central to the project's horizontal action lines. By carrying out system analyses, the most important cause-and-effect relationships within the Flemish water system will be mapped out further, including the interactions with other systems such as energy, mobility, food and health. The approach is necessary in order to eventually arrive at a water redistribution project for the whole of Flanders. The project will run until early 2025.

## WaterRadar

### TOOL CONNECTS WATER DEMAND WITH WATER SUPPLY

In collaboration with its partners, VITO has developed a tool that helps farmers and gardeners to find suitable alternative water sources close by. These could be Aquafin facilities with purified household wastewater, but equally food processing companies that purify their wastewater themselves. The WaterRadar tool determines the sources after the user enters their location or address in the search function. The water providers are then shown on a map, along with their address, their contact details, the average daily quantities they make available and the chloride concentration of the water provided.

Moreover, the tool uses a colour code to show which sources meet the legal criteria for providing water. After all, for use in agriculture, providers of purified wastewater need to possess a resource certificate. These sources are coloured green on the WaterRadar. In addition, alongside the actual water provision, the WaterRadar also visualises the theoretical irrigation requirement at the regional scale.



In order to do so, the project partners mapped out the crops present on all agricultural and gardening plots across Flanders for the year 2020. For each crop (group), they then made a rough estimate of the extra irrigation requirement for the entire growth season, beyond natural precipitation. They assumed a normal weather pattern when doing so. The map clearly shows at a glance the regions in which the potential water demand is the highest.

## First aid for flooding

### SENSORS AND SATELLITES MONITOR IMPACT OF FLOODING

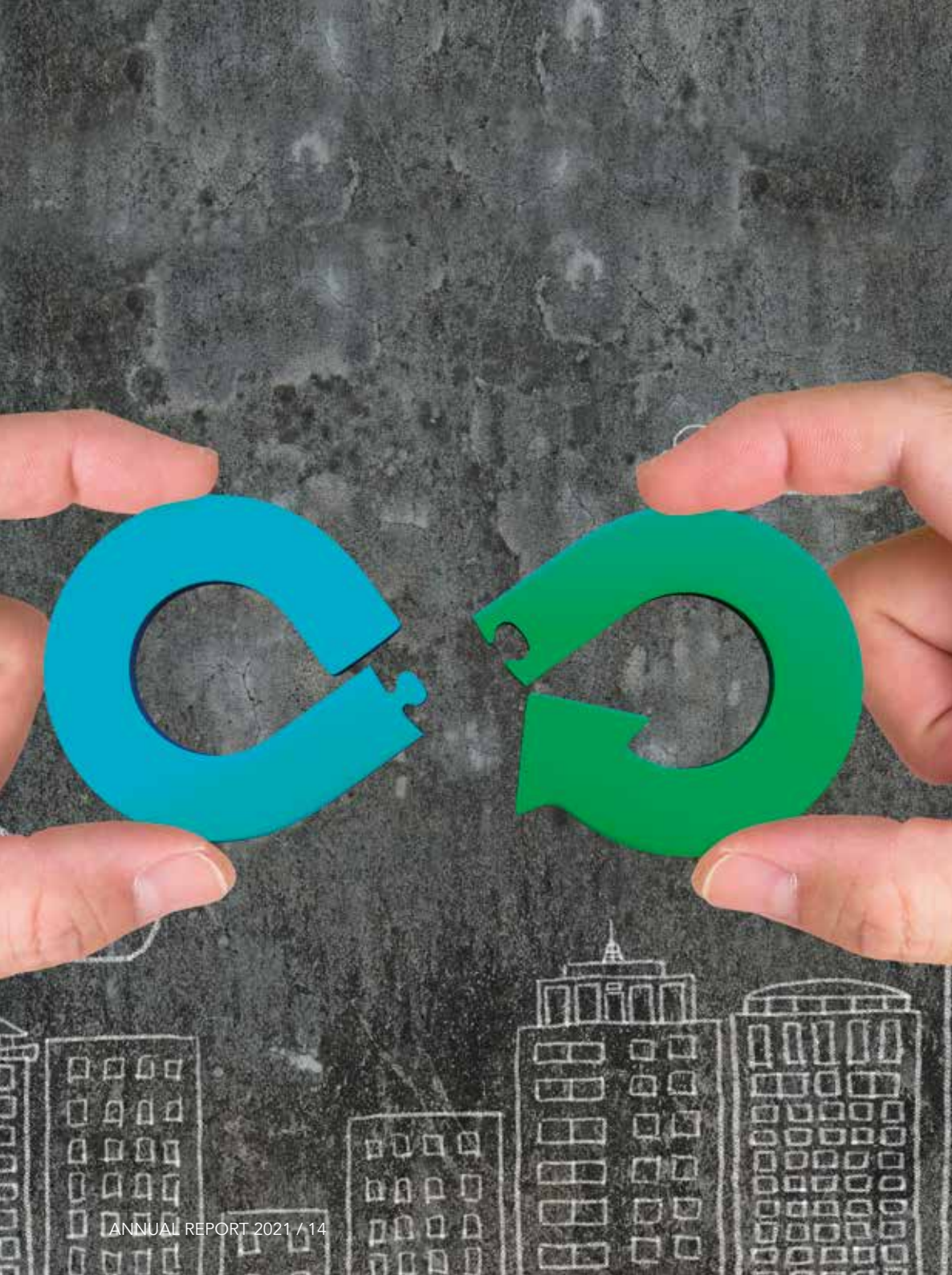
While Flanders may have escaped the gigantic 'water bomb' that struck this country in the summer of 2021, there is no guarantee that our region will be spared again in the future. Furthermore, Flanders is in close contact with Wallonia in various respects, including through the supply of drinking water from the Meuse via the Albert Canal. No less than 40 percent of Flemish drinking water reaches our region that way.

Thanks to a network of sensors that VITO manages along with water company Water-link, with the measurements analysed by VITO experts, it was possible to determine that polluted floodwater had largely flowed into the Netherlands and not Flanders during the fateful floods. Had this not been the case, an alerting system would have informed Water-link in a timely manner so it could take measures.

In addition, VITO has developed a tool that makes flooded areas visible on a map, practically in real-time and at a scale of hundreds of kilometres – enough to oversee all of Flanders at a glance. The TerraFlood tool makes use of radar signals sent out by satellites. The biggest advantage of these signals is that they are not hindered by clouds. The tool is available on the Belgian open-source platform Terrascope, meaning both authorities and private companies can make use of it.

TerraFlood's radar satellite imagery is a useful supplement to aerial imagery taken by drones, for example, which are sent out to measure the water surplus when there is flooding. Because these drones are largely deployed in built-up areas, the satellite imagery complements the aerial imagery.





## Towards a circular and bio-based economy

### CIRCULARITY RHYMES WITH SUSTAINABILITY

In a circular economy, as few new primary raw materials and ingredients are used as possible, and as many as possible are reused and recycled – losing as little value as possible. Because extracting raw materials often goes hand in hand with a great impact on the environment and the climate, circularity chimes with sustainability a great deal.

Bio-based raw materials and products can help to make the circular economy more sustainable, on the condition that those raw materials and products are well-chosen. The use of bio-molecules from green waste and by-product streams for the production of chemicals not based on petroleum derivatives seems obvious. Another example is insects, from which raw materials can be derived for cattle feed, for example – instead of using soya grown in fields for which rainforests were cut down, for example.

At the same time, reuse and recycling makes Europe less dependent on importing primary raw materials from other continents. This makes a circular economy, particularly in today's troubled political times, a more robust economy too.



## Valorisation of bottom ashes

### SMART CHARACTERISATION TURNS WASTE STREAMS VIRTUALLY INSIDE OUT

The problem with processing and recycling waste streams is that the composition is often unknown or insufficiently known. This is certainly the case with bottom ashes, which remains after household waste or industrial and construction waste is incinerated. The more information a waste processing company has about the composition, the more valuable components can be recovered and valorised from the ashes.

In collaboration with SUEZ Recycling & Recovery Belgium, VITO developed a unique characterisation method for waste streams that appear homogeneous, but in fact consist of a wide range of ferrous and non-ferrous metals, minerals and other valuable substances. The method works in real-time: it scans the bottom ashes 'on the fly' while it slides past on a

transport belt at a processing facility. It differs radically here from conventional methods, whereby samples need to be taken and then analysed, which takes time and money.

Characterise-to-Sort technology (CtS), as it is known, is composed of a range of imaging, modelling and AI techniques. With the latter, a virtual representation of the waste stream can be created through a digital twin, through which it can virtually be turned completely inside out. This is how CtS forms the basis of smart waste processing.

Now SUEZ and VITO have demonstrated that the characterisation technology works for bottom ashes, it can be scaled up to an industrial level. That will take place in the CHARAMBA project. The aim is to implement a demonstration of the technology, whereby it is upscaled from 'scan the bucket' to 'scan the truck', so as to demonstrate its industrial relevance.





## Demolition Guide

### STREET IMAGES REVEAL MATERIAL STOCKS IN BUILDINGS

When buildings are demolished or renovated, reusable or recyclable construction elements and materials are still mainly disposed as rubble today. That means Flanders' buildings portfolio accounts for some very extensive waste streams. A stream that is only set to increase owing to the drastic renovation operation we face.

Unless we start to collect, sort, reuse and recycle these elements and materials en masse and at a large scale. In order for this to take place in the most circular manner possible, however, the local material stocks need to be known. This is why VITO developed the Demolition Guide tool. It works by using automatic material recognition as applied to images of home and building façades taken from the street.

The tool was developed and has already been applied as part of a pilot project in Leuven. The tool analysed street images in order to map out how the exact quantities of construction elements and materials are distributed across local building stock. The tool works semi-automatically: there is still some manual work involved in selecting the images, but after that, the material recognition takes place through AI algorithms trained on thousands of photos of construction elements and materials. At present, the tool's reliability is over 80 %.

VITO is now aiming to upscale the Demolition Guide to the city level. The evaluation of the pilot project will contribute to this. This project was subsidised by OVAM – Circular Flanders and carried out by VITO Remote Sensing and VITO Materials in close collaboration with the partner Immoterrae.



**When buildings are demolished or renovated, reusable or recyclable construction elements and materials are still mainly disposed as rubble today.**

**The research is intended to pave the way for a new supply chain of platinum metals for European industries.**

## Platinum from the urban mine

### NEW TECHNOLOGIES FOR MORE EFFICIENT RECYCLING

The European PLATIRUS project has been examining ten sustainable recycling technologies for metals from the platinum group, as it is known (besides platinum, this includes metals like osmium, iridium, cobalt and ruthenium), for over four years. The research concentrated on three aspects of recycling: leaching, separation and recovery.

With the examined technologies, platinum metals can be reclaimed from electronic, mining and (car) catalyst waste – which is eminently available in great quantities in the urban mine, as it is known. Three of these have turned out to be reclaimable with particularly high efficiency at the end of the journey, alongside low costs and a limited impact on the environment too. These technologies are now ready for upscaling with a view to industrial use.

The research is intended to pave the way for a new supply chain of platinum metals for European industries. In doing so, it will help to make Europe less dependent on importing critical raw materials, as they are known, from other continents.

VITO is also part of another similar European project that has only just begun, which aims to recover precious metals from waste streams through a metallurgical process that is yet to be developed. This process is intended to be economically and ecologically viable. This PEACOC project focuses on the recovery of gold, silver and platinum metals from waste.







## Insect Pilot Plant

### INSECTS AS A SUSTAINABLE RAW MATERIAL

We have known for some time that insects can play a major role in the transition to a bio-based economy. Fed on a diverse range of organic waste and residue streams, they can convert these into useful and high-quality raw materials such as proteins, fats and chitin. These substances, which have been obtained sustainably, can serve as cattle feed or as raw materials in the food or chemical industry.

Despite the potential, however, some uncertainties remain that are preventing the immediate application of insect cultivation at an industrial scale. Because projects on cultivating, harvesting and processing insects often still remain at the lab scale, VITO began constructing the Insect Pilot Plant along with several regional partners in 2017. Four years later, the pilot infrastructure is ready and a new value chain based on insects is another step closer.

The Insect Pilot Plant spans the gap between the level of research and expertise at the lab scale, and that of industrial production. This flexible and widely deployable pilot installation fills that gap. The installation is used for research, demonstration projects and the production of bio-based chemicals.

At the same time, the development of the Insect Pilot Plant is putting Flanders on the map as a hub for the knowledge, production and processing of insects.



## Synthetic resins from lignin

### 'GREEN' EPOXY RESIN MOVES OUT OF THE LAB

Today, resins are mainly still produced from petroleum derivatives. However, the fossil-based basic components can be replaced with lignin, a biochemical compound that is produced as a by-product stream in the manufacture of wood pulp and paper, for example. At present, most of that lignin is still incinerated, which is in fact a waste.

For years, VITO has been actively researching the use of lignin as a basic raw material for chemicals, including synthetic resins – through the intermediate substances phenol and bisphenol A. The focus here is on two types: epoxy resin and phenol resin. Replacing the fossil-based raw materials with lignin not only makes the resins more sustainable, they become part of a wider circular value chain too. A further plus point is that the resins can be recycled better.

The research into sustainable, 'green' synthetic resins was accelerated in 2021 with various new European and Flemish projects, which often involve close collaboration with industry. In two projects, lignin – in both solid and liquid form (oil) – is processed into epoxy resin for use as a coating for metals and as a composite material for car components. With these two projects, the green resin really did leave the lab.

In addition, VITO is continuing to build up the LignoValue Pilot, a pilot installation in which small bio-aromatics (components of larger organic compounds) will be produced from lignin. In the meantime, when it comes to the broad research landscape around lignin, VITO plays the role of spider in the web. Its researchers have an excellent view of the sources and availability of this bio-organic material. And the properties of this wonderful gift of nature, and how they translate into specific applications, hold few secrets for them.







## CCU and green hydrogen

### CROSS-THEME RESEARCH IS BOOMING

VITO is involved in a record number of projects on the capture and reuse of CO<sub>2</sub> (carbon capture & utilisation, or CCU) and on the production of green hydrogen. This illustrates the success of the research programme on this, which covers many themes. This multi-disciplinary involvement makes CCU and green hydrogen the subject of a very wide and integrated affair.

Within the 'sustainable chemistry' theme, for example, there is research into how CO<sub>2</sub> (captured from industrial emissions or from the air) can be converted into synthetic fuels or into basic chemicals. Based on the 'sustainable materials' theme, the focus can lie on components for improving the CO<sub>2</sub> capture and on methods for processing greenhouse gases into end products, such as construction materials. Finally, in the 'sustainable energy' theme, models and scenarios are being developed and drawn up on the value chains for CO<sub>2</sub> and hydrogen.

The strength of this research at VITO is that various different thematic fields join forces in the CO<sub>2</sub> and hydrogen activities. The technical and economic results and insights arising from it create great added value for the research field.

The seven projects on CO<sub>2</sub> and hydrogen launched in 2021 in which VITO is involved – whether or not in a leading role – vary widely, both in terms of development stage and content. VITO is not only developing new technology, it is also running demonstrations at the pilot scale. This is demonstrating that the upscaling of technology previously developed is feasible and could have a meaningful economic impact.

## Towards circular and sustainable textiles

### WHERE AND HOW TO BEGIN?

On behalf of the European Environment Agency, VITO investigated how the European textile industry could evolve towards a more circular and sustainable sector. The result was documented in a report entitled 'Plastics in textiles'. This states that the textiles industry needs to move towards sustainable fibre choices, limiting microplastics and improve separated collection, high-quality reuse and recycling.

Today, a mere 1 percent of the textiles sold in Europe are recycled in a high-quality manner. Furthermore, the production of those textiles has a large impact on the environment and on the climate. It is therefore unsurprising that the European Commission, in its ambitious Green Deal programme, highlights textiles, alongside plastic, as a crucial sector in an emerging European circular economy.

The VITO report identifies three major areas for a circular, more sustainable textiles sector. Sustainable fibre choices are important because these choices not only determine the production properties and performance, but also the environmental impact of the end product and its fate in the rest of its lifecycle. It is crucial that the fibre choice is tailored to the expected application.

In addition, there is a need for more research so that we can properly understand and control microplastic emissions. How these can be reduced during the full lifecycle of textiles needs to be thoroughly examined. It is also important to work on improving separated collection of discarded textiles and on high-quality reuse and recycling. After all, closing the circuit could significantly reduce the environmental effects of our textile consumption.

## Innovation process towards textile-to-textile

### CLOTHING BRANDS JOIN FORCES FOR CIRCULAR FASHION

Developing a closed-circuit solution for discarded textiles, encouraging conscious design and production practices, creating new business opportunities within the textiles value chains and raising public awareness of the environmental and social effects of textile consumption. This is the goal of the European SCIRT project, co-ordinated by VITO, in which research institutions, along with five clothing brands, are aiming to make a start on a circular textiles sector.

Among the projects aims are to develop and demonstrate a complete textile-to-textile system for discarded clothing. In developing that system, in which stakeholders from the entire value chain are involved, the focus lies on the reuse and recycling of both natural and synthetic fibres, as well as fibre blends. In collaboration with the clothing brands, six representative clothing types are being designed.

In SCIRT, supporting policy measures and tools to ease the transition from a linear to a circular textiles sector are being developed as well. In doing so, the consumer's perspective is also being considered.

The project, which will run for three years, focuses on breaking down the current barriers to the recycling of textiles, which vary widely in nature (technological, socio-economic and policy-related). This could begin the transition towards a sustainable circular fashion economy.





# Energy solutions for the future

## IN THE VANGUARD OF THE ENERGY TRANSITION

Europe wants to be the first climate-neutral continent by 2050. Talking about this ambition may be one thing, but effectively achieving it is quite another. We need to be moving at full speed.

VITO/EnergyVille uses a systemic vision for the energy transition. That involves intensive cross-border collaboration, among other things. Between sectors, between fields and between countries and governments. Consequently, the transition is also viewed through various different lenses: technological, economic and sociological. Thanks to this strongly multidisciplinary character and the way the research partners complement one another, VITO/EnergyVille covers the entire energy chain systematically.

At the same time, innovations in energy coming from VITO/EnergyVille's labs are putting Flanders on the map as a pioneer in the transition in various fields. From the hydrogen economy through smart and flexible energy distribution to carbon-neutral industry. In doing so, technological developments will quickly find their way abroad, including beyond Europe.

**Europe wants to be the first climate-neutral continent by 2050.**



## 10 years EnergyVille

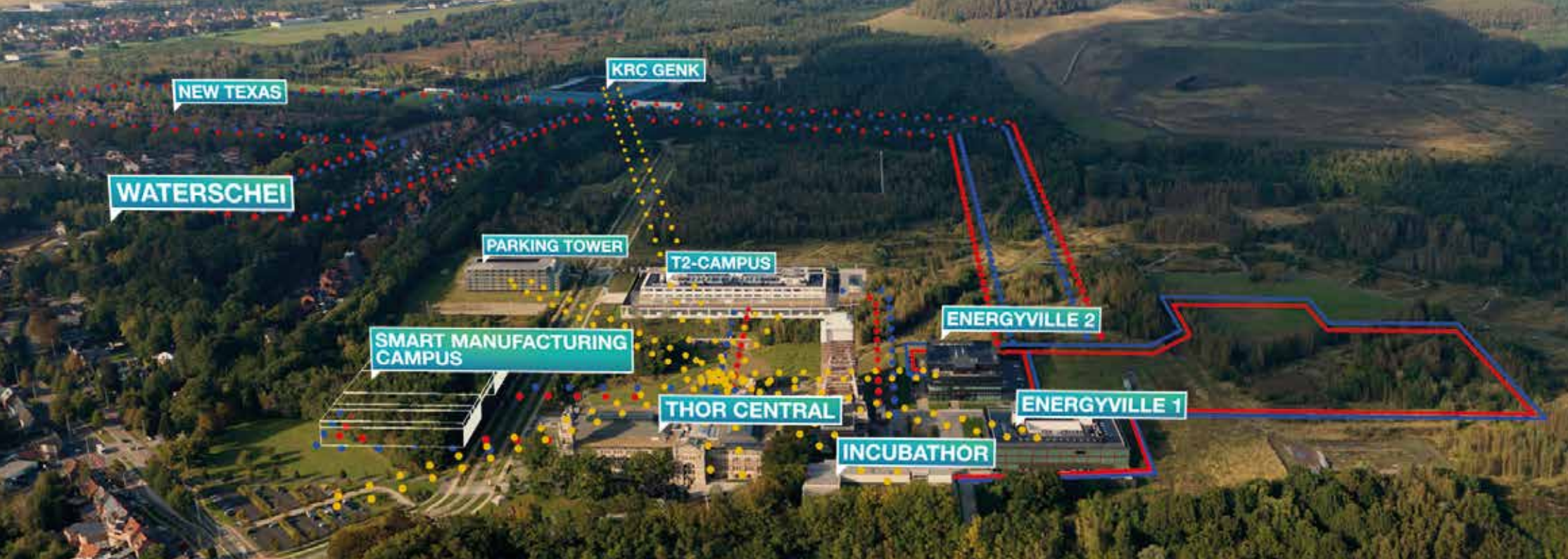
### MATURE, BUT GROWTH CONTINUES

On 1 June 2021, EnergyVille celebrated its tenth anniversary. At the same time, Ronnie Belmans passed on the torch to Gerrit Jan Schaeffer as General Manager. The latter immediately made clear that EnergyVille still holds strong ambitions. 'We are far from fully grown.'

EnergyVille has charted an impressive course in the past decade. What initially began as a collaboration between VITO and the KU Leuven on smart grids in 2009 has today become a fully-fledged research and innovation centre with offices and state-of-the-art labs located at Thor Park in Genk. With a highly multi-disciplinary research community of no less than four hundred staff, it is now a unique knowledge player in this country in terms of energy. At a European level, too, EnergyVille has grown into a research centre of high regard, which is preparing the way for the transition to a sustainable, affordable and safe energy system.

Several visible milestones in EnergyVille's ten-year existence were the construction and commissioning of two new research buildings in Genk, EnergyVille 1 and 2. Less visible, but equally as important, is the close community that has come about in the past few years. It can accomplish things that we could not achieve if we were split up. 'I've always felt that our people like to come here,' said the departing General Manager Ronnie Belmans of the working atmosphere at EnergyVille.





## Smart management of district heating networks

### STORM CONTROLLER IMPROVES CHINESE DISTRICT HEATING NETWORKS

With the STORM controller, VITO/EnergyVille has developed an artificial intelligence-based tool for autonomous control and optimisation of district heating networks. Managers can use it to raise the efficiency of their district heating networks and reduce CO<sub>2</sub> emissions, for example. The tool has also been implemented in FLEXharvester, a platform for the development of solutions for energy management through energy flexibility.

Along with co-developer and co-owner NODA, VITO is attempting to offer the STORM controller worldwide. This is going rather well – the Chinese company Runa Smart Equipment will be applying the technology in China. Runa is one of the largest manufacturers of heat meters and a leading heat network operator in China.

In a country like China where district heating infrastructure is state-owned, private companies such as Runa are contracted by the state for the operation and maintenance of its heating networks. Important criteria that must be fulfilled for winning such contracts are energy efficiency, low CO<sub>2</sub> emissions, and quality of service for end consumers. Runa is convinced that the STORM controller gives it the in-house technology to enable it to address these challenges and gain a competitive advantage.

In the winter of 2020-2021, experts from VITO and NODA conducted a successful demonstration of the controller in one of the district heating networks operated by Runa. Training for the Runa experts and knowledge transfer followed, with full-scale integration of the STORM controller into Runa's existing smart heating networks platform.

## Living lab for energy

### THOR PARK IN GENK: A BREEDING GROUND FOR INNOVATION

The oPEN Thor Living Lab on the EnergyVille site in Genk is a strategic breeding ground where authorities, policy-makers, companies, academics and citizens collaborate. The goal: to develop, test and validate innovative energy solutions, always interacting with the full energy system. The research is taking place as part of the transition towards a sustainable energy system.

The solutions being developed at the living lab and the choices made there are not just technological, but also economic and societal. That means the key lies in proactive collaboration, whereby everyone contributes depending on their own background.

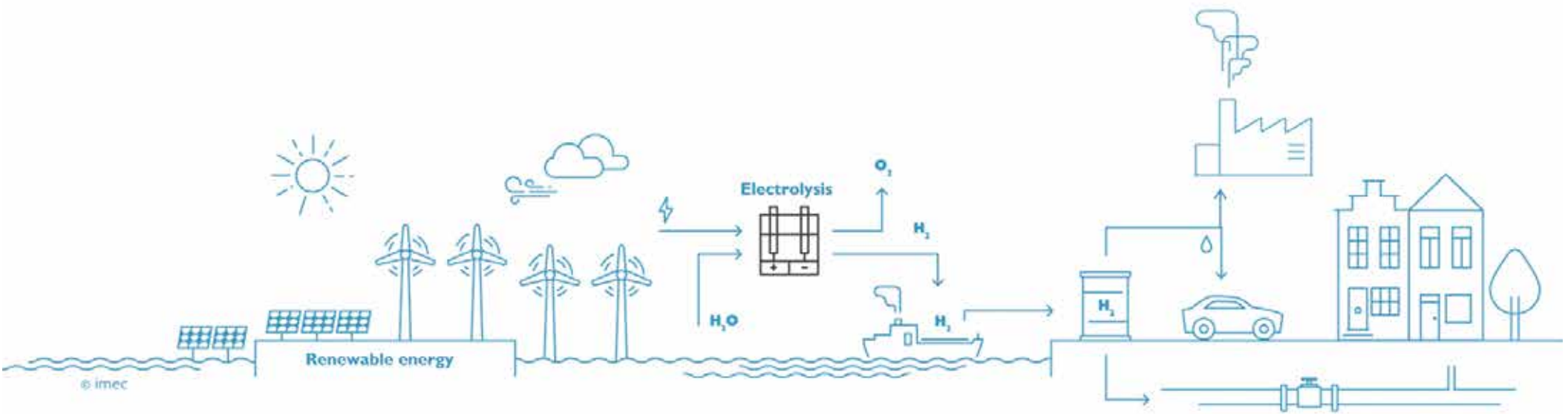
The living lab was set up around the EnergyVille site at Thor Park in Genk. Along with the Smart Manufacturing Campus, IncubaThor, the T2 campus and the Thor Central community centre, the energy research centre is a unique focal point for encouraging and valorising synergies in the energy transition and the smart manufacturing industry.

At present, there are around eight hundred people working for forty organisations at Thor Park. The number of employees is set to see strong growth in the coming years. By 2035, the living lab is even aiming to have several thousand employees.



**In a country like China where district heating infrastructure is state-owned, private companies such as Runa are contracted by the state for the operation and maintenance of its heating networks.**





## Hyve

### SUSTAINABLE AND LARGE-SCALE PRODUCTION OF GREEN HYDROGEN

Hydrogen is an essential element of the European Green Deal for the transition towards a sustainable, carbon-neutral energy system. Hydrogen produced with renewable electricity – known as green hydrogen – is the key to decarbonisation for the chemicals, steel and cement industry and heavy goods transport.

In order to make the production of green hydrogen competitive, not only does the cost price of green energy need to drop further, but electrolyzers need to become far more efficient too. In addition, the technology needs to be able to scale up more easily and drastically.

Six Belgian companies and organisations that have been working on hydrogen for a long time have therefore joined forces. Within the Hyve consortium, they are pooling their resources to drive up the efficiency of electrolysis technology significantly so as to prepare the way for the sustainable production of hydrogen at gigawatt scale. Aside from VITO, these are the research institution imec and the companies Colruyt Group, DEME, Bekaert and John Cockerill Group.

VITO's contribution to the research within Hyve mainly comes from its knowledge and expertise in membranes, catalysis and system integration. This system approach is typical of VITO in its development of sustainable technology. In addition, there is also consideration for the broader techno-economic fabric around the production of green hydrogen. The research is also benefiting the Flemish economy. With Hyve, Flanders can play a pioneering role in the roll-out of a hydrogen economy and the transition towards carbon-neutral industry.



## Trilateral collaboration for carbon-neutral industry

### VITO IS JOINING FORCES WITH COLLEAGUES FROM GERMANY AND THE NETHERLANDS

If Europe wants to be the first climate-neutral continent by 2050, collaboration at an unprecedented scale will be needed. Between different economic and industrial sectors, between countries and governments and between the various energy and raw material sources and streams too (known as vectors). Only this way the ultimate goal of net zero greenhouse emissions can be reached.

This is why VITO, along with research institutes from the Netherlands (TNO) and Germany (DECHEMA), has enhanced and expanded existing collaborations. The result: an international, cross-border knowledge platform. This platform is public-private and aims to promote international collaboration between stakeholders from industry, governments, regulators and infrastructure owners or managers. This will encourage the transition towards industrial carbon-neutrality in the three-country region.

The new platform builds upon the existing collaboration that has emerged between the three research institutes in the past few years. It mainly took place in the context of various nationally financed research projects.

With the ports of Antwerp and Rotterdam and the highly industrialised Rhine-Ruhr area, the three-country region is one of the largest global hotspots for energy-intensive industries and international logistics. The region has a highly developed cross-border fuel, electricity and raw material infrastructure that serves a range of industrial clusters. Nonetheless, the opportunities for reusing the existing energy infrastructure and the requirement for new infrastructure remain unclear from a cross-border viewpoint. The new knowledge platform will need to change that.







## Climate services

Global warming is not the only crisis threatening our planet. Biodiversity in the many unique ecosystems that the Earth has in abundance is under great pressure or is already declining.

This demands action. But detailed and reliable monitoring are indispensable for targeted measures. With its activities in the fields of analysis, modelling and remote sensing, VITO has been very well-equipped for this for years. However, monitoring takes place not just through observing and measuring, but also through calculating. This is particularly important in the battle against global warming, in which countries and regions need to be able to put their efforts and objectives into figures based on the best available science. VITO's expertise in this remains premature, but in recent years, the momentum around this has been rapidly increasing too.

In projects on climate monitoring or biodiversity, VITO has, as always, been working with respected partners, ranging from the European Space Agency (ESA) through the United Nations' Environment Programme to the African Union. This, too, emphasises the international, global character of the activities. The climate and biodiversity crisis are eminent examples of problems that are occurring at a planetary scale too.

**Biodiversity in the many unique ecosystems that the Earth has in abundance is under great pressure or is already declining.**



## WorldCover

### A DETAILED WORLD MAP OF LAND COVER

Monitoring worldwide land cover is essential for the management of soils, forests, water reserves and biodiversity. Due to the changes often happening at a rapid pace, it is important for this to take place in high resolution, both in space and in time.

This was why VITO began the WorldCover project in collaboration with the European Space Agency (ESA) in 2019. The aim: to develop a worldwide land cover chart with a resolution of 10 metres based on satellite imagery. This chart would then be able to contribute to the monitoring and improvement of biodiversity, of food security and of assessments of carbon emissions and storage and climate modelling. Two years later, in 2021, the WorldCover chart was ready.

One of the major advantages of the land cover chart is the unprecedented level of detail. The chart was composed with data from both the Sentinel-1 and Sentinel-2

satellites. This combination not only enhances the spatial resolution, but also allows for looking through clouds, which allows map users to work in real-time. The wealth of spatial details also ensures that, for example, main roads and urban green can be recognised, whereas these were previously often ignored or considered part of the built-up area.

Its users may be working in agriculture, in nature and biodiversity management, in spatial planning or in climate research. Moreover, the chart is open and freely accessible.

**Monitoring worldwide land cover is essential for the management of soils, forests, water reserves and biodiversity.**



## NDC Support Centre

### A KNOWLEDGE CENTRE FOR ENERGY AND CLIMATE IN THE SOUTH

It was agreed in the 2015 Paris Climate Agreement that countries will keep track of their own contributions to the battle against global warming. These 'nationally determined contributions', or NDCs, include the climate plans for countries and their national climate objectives, among other things.

The development of the NDCs is a complex scientific exercise. In order to support countries in Africa in this, VITO launched the NDC Support Centre along with its partners. This aims to help African countries to supply and adjust their own NDCs, to improve their national energy information systems and modelling ability and to prepare their climate-related communication – all of which in line with commitments as stipulated in the Paris Climate Agreement. This will all take place from a newly launched African knowledge centre.

In this way, the NDC Support Centre aims to contribute to the growth and maturity of African countries in energy statistics, modelling and reporting greenhouse gas emissions. The initiative, which began last year, is presently focusing on three countries that reflect the versatile geography of the African continent to some degree: Morocco, Uganda and Malawi.

The climate conference in Glasgow, as well as the G-STIC conference in Dubai in the autumn of 2021, certainly highlighted the pan-African collaboration with the NDC Support Centre.



## GlobDiversity

### LARGE-SCALE BIODIVERSITY MONITORING

Satellite data forms an invaluable (and objective) source of information for biodiversity monitoring too. As early as 2017, the European Space Agency (ESA) initiated a project to set up large-scale biodiversity monitoring this way.

Central to the project are essential biodiversity variables (EBVs), as they are known – representative indicators for biodiversity in an area. Some examples of EBVs are the phenological (periodic phenomena) of the land surface, the chlorophyll content of the foliage and the fragmentation of ecosystems. These indicators can be monitored remotely using remote sensing.

Algorithms were developed for the three EBVs mentioned to monitor them based on data from the Sentinel-2 (10-metre resolution) and Landsat-8 (30 metres) satellites. Within GlobDiversity, among VITO's responsibilities was the demonstration of the operational feasibility of the algorithm prototypes. It did so by applying them to two countries that acted as a test case: Finland and Senegal. Both countries were selected based on a number of important elements, including the presence of various ecosystems and accompanying land cover, relevant connections with the three EBVs in question and high user potential for biodiversity monitoring. The demonstration succeeded, allowing GlobDiversity to close down successfully. The next step now is to use the gathered knowledge and technology for further development at a global scale. This is already happening within the EuropaBON project.

**Satellite data forms an invaluable (and objective) source of information for biodiversity monitoring too.**





## Personalised and preventive healthcare

### PREVENTION IS HEALTHY, PRIVACY IS DESIRABLE

Good health is very dear to us. Naturally, prevention is always better than cure. This is making preventive healthcare more and more important. One of the factors influencing our health is our living environment. If this is healthy, there are some automatic benefits to our own health.

Therefore, harmful substances need to be kept away from the environment and the food chain as far as possible. Hence the importance of thorough and continuous monitoring of the living environment and of the effects substances have on human health.

This biomonitoring, whether it involves human monitoring or ecotoxicology, is constantly evolving. This is due in part to new insights coming about, new substances being developed and ending up in the environment or the regulations changing. Just look at what the crisis in 2021 around PFOS pollution in and around Zwijndrecht has brought about.

At the same time, treatments and therapies are becoming ever more individual, a consequence of the rise of personalised healthcare. Prevention, as it happens, is often highly tailored to the individual. However, this can cause concerns about privacy around our health. How safe is our personal data? Is it sufficiently protected? These are some quite recent concerns. Yet, there are already some strategies for using and storing our health data in a fair, ethical and responsible manner in the pipeline.



## 20 years of biomonitoring

### AN IMPRESSIVE TRACK RECORD IN FLANDERS AND IN EUROPE

VITO's specialist expertise in biomonitoring goes back to the late nineties. Back then, the main focus was on ecotoxicology. At the start of this century, the study of the effects on human health was added to this. This brought about a very broad programme in which – right from the start– the focus was on the multi-disciplinary nature of the research. This is still the case today, now VITO's biomonitoring can look back on an impressive track record spanning no less than two decades.

VITO was a pioneer with its biomonitoring in both Flanders and Europe. This was how VITO helped form the basis of the Flemish biomonitoring programme, and thus in fact of the Flemish environmental and health policy. As known, VITO's approach centres around a consideration for translating results and data into policy. VITO also saw an

international response. A similar system arose in Europe, which was also based on technology, multi-disciplinarity and policy translation.

The progressive environmental and health research also ensured that VITO could take some ambitious initiatives, such as the European biomonitoring programme HBM4EU. This initiative, which ended in late 2021, measured and assessed the exposure of the European population to chemical substances for years

As the successor for HBM4EU, PARC is now being rolled out, which will run until 2028. In this initiative, too, VITO's biomonitoring experts gain a seat at the table where, among other things, European legislation is being developed. One important task for PARC is to provide access to environmental and health data at a European level. VITO has a lot of experience with this and will therefore submit a proposal for a separate work package on data. In this way, it is continuing to stand out in the field of biomonitoring, both in Flanders and in Europe.



## PFAS

### STRONG PERFORMANCE IN MONITORING AND POLICY SUPPORT

In the spring and summer of 2021, the PFOS pollution in Zwijndrecht was front-page news. Thanks in part to the experience that VITO has spent years building up in the monitoring of these forever chemicals, as they are known, the extent of the environmental pollution and its seriousness on the health of the population of Zwijndrecht was able to be mapped out quickly. This took place with a wide-ranging arsenal of methods that VITO has developed and refined in the past few years, from analytical measurement methods through statistical tools to good practices for recruiting participants and drawing up questionnaires for citizens.

Various PFAS components (PFAS is the family that includes PFOS) have been measured in serum and umbilical cord blood in the Flemish reference populations since 2008. In 2019, OVAM commissioned the development of proposals for soil remediation values for PFOS and PFOA (another PFAS component). In order to carry out these complex tasks to support policy, the necessary pieces of the puzzle from a range of disciplines were brought together at VITO: analytical chemistry, human biomonitoring, epidemiology, (eco)toxicology, dissemination in the environment, transfer throughout the food chain, modelling techniques, etc. The scientific knowledge in many of these fields has evolved quickly in the past few years. At the same time, the realisation remained that there were still many gaps in the knowledge around PFAS.

#### From sampling to communication

It was precisely thanks to all that expertise that we were able to switch gear very quickly when the crisis broke out. VITO experts supported the authorities in immediately taking no regret measures, as they are known, to limit the exposure of the residents of Zwijndrecht to PFAS. In order to map out the extent of the pollution and the seriousness for public health, residents in the affected area were invited to have a blood sample analysed over the summer of 2021. VITO, along with the government and the Provincial Institute for Hygiene, strongly acted on the organisation and implementation of this research. This involved: drawing up the study design, recruiting the participants,



taking samples, analyses, creating a biobank, data management, statistical analyses, interpreting the results and communication to the residents in the affected region, local and regional policy-makers and the press.

One of the problems with PFAS is that the family is so large: it includes around six thousand substances – although no more than forty different components that are the most relevant according to current insights are generally measured in environmental pollution. The challenge lies in developing measurement methods that can measure the low contents with sufficient reliability. After all, because they are barely degradable, so do not disappear from the environment (hence their illustrious nickname), PFAS components can build up in humans and the environment. This is also why VITO is continuing its research into better methods for monitoring. Ultimately, this should lead to a general screening that delivers a meaningful total picture of PFAS exposure.

Aside from the research work, the translation of research into policy is also VITO's core focus. The practical implementation of this is the role VITO assumes in the Flemish PFAS working groups. There was (and is) intensive collaboration here between a range of government services, led by PFAS commissioner Karl Vrancken. VITO plays a prominent role in these working groups in supplying scientific advice for the action framework, the long-term strategy and data management.



## Health and privacy

### A PERSONAL DATA VAULT

Particularly when it comes to data about our health, privacy is very precious to us. Indeed, we do not readily share this data. If health data does need to be shared anyway – with a healthcare institution, for example – then we demand a watertight guarantee of privacy. Citizens therefore need to be able to have confidence in data management, and to have full control over their own data at any time.

This was why an initiative was launched on personal data vaults as part of a European project called Personal Data Management Platform, for which VITO is the international co-ordinator. A citizen's data would then be stored in their personal vault, to which only they have the (digital) key.

This initiative is called We Are and is in rapid development. There was a conscious choice to place the focus on health data, involving collaboration with doctors, hospitals, patients' associations and the King Baudouin Foundation. The principles behind the initiative guarantee a fair, ethical and responsible manner of using technology and applying data.

Although We Are is still in development, the concept of the personal data vault is already being used in BIBOPP, a prevention platform for citizens that is currently being developed and rolled out. Through this platform, citizens with health apps can take control of their own health and health data themselves.





## Valorisation of sustainable technology

### ENHANCING THE FLEMISH ECONOMY AND MAKING IT MORE SUSTAINABLE

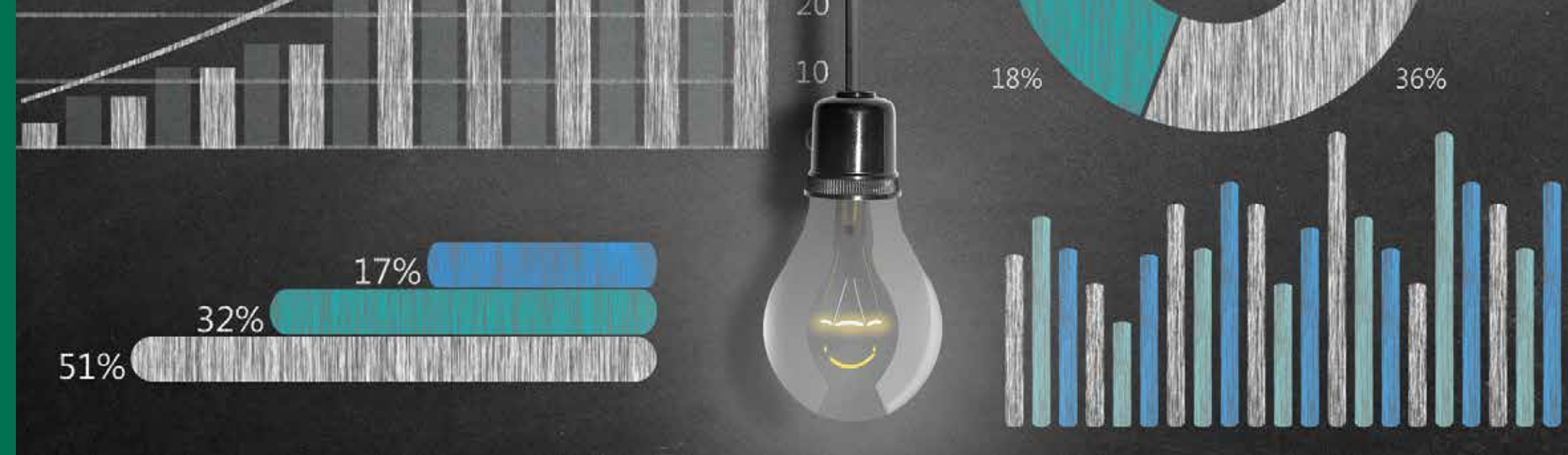
The expertise and technology that VITO develops does not remain in-house. It is also valorised by transferring it to the business world. This is another part of VITO's mission, as this tech transfer enhances the Flemish economy and makes it more sustainable.

Tech transfer can take place in two ways: through the sale of licences to existing companies or through the creation of spin-offs. 2021 mainly saw the latter, with a record number of VITO spin-offs going independent.

The spin-off programme has evolved since its launch in 2015. Whereas spin-offs initially came about from within VITO, they are now more often launched in collaboration with other knowledge institutions. Several long-term partners with which VITO is a 'co-parent' of spin-offs are the KU Leuven, the University of Antwerp and imec. As a rule, the intellectual property is also shared by the partners in these collaborations. This makes it all somewhat more complex, but it also produces stronger spin-offs.

Meanwhile, VITO's spin-off count amounts to more than ten. This number will only continue to rise in the years to come. After all, on the input side, the spin-off pipeline is being continually fed with fresh innovative ideas and opportunities that have the potential to be valorised.

Several spin-offs are expected to spread their wings in 2022 as well. In doing so, VITO is enhancing the economic fabric in Flanders and injecting sustainability into the business world.



## An exceptional year for tech transfer

### RECORD NUMBER OF SPIN-OFFS SPREAD THEIR WINGS

The results of VITO's valorisation programme for 2021 are looking highly impressive. No less than four spin-offs went independent (a record), with a further novelty in the very first sale of a VITO spin-off.

In the case of the spin-offs that went independent, these are MONA (innovative optical diagnostics), Enperas (digital sustainability evaluations for the construction sector), A-membranes (innovative industrial membranes) and Hyve (green hydrogen production). All four came about from within VITO ('incubated'), although each does have a unique story. The launch of MONA and Enperas, for example, saw a considerable capital injection. The funding largely comes from private investors, who received shares in exchange. But VITO also retains a strong tie to both spin-offs in the form of a share package.

This is not the case, however, with A-membranes, although VITO does have a licensing agreement with it. And Hyve is another different story: it is more of a consortium than a true spin-off, in which VITO is involved as a knowledge partner and technology developer. What does connect the three 'true' spin-offs, however, is that they are controlled by external entrepreneurs attracted specially to do so by VITO. First and foremost, for these CEOs, people are sought who have great experience in the business world or a strong profile in entrepreneurship. An affinity with the sector in which the spin-off is active naturally plays to their advantage too.

In 2021, there was a further novelty, namely the sale of the VITO spin-off LCV (laser cladding and 3D printing with metals). This spin-off was launched in 2015, and the development of the laser cladding technology began even longer ago at VITO – more than ten years ago. LCV's operations now continue under the wings of the Swedish company SKF.





**One major asset of Enperas is that her software also takes into account the specific legislation on sustainability certificates for construction products.**

## Enperas



### DIGITAL SUSTAINABILITY EVALUATIONS FOR THE CONSTRUCTION SECTOR

Reliable assessments of the ecological footprint of products and materials are receiving greater attention from the business world. So, too, in construction. But such an evaluation generally takes a lot of time and effort. This was why VITO developed a digital solution a few years ago, which businesses in the construction sector can use to cover their whole product range in no time at all. This innovation led to the spin-off Enperas, which went independent in 2021.

An architect, contractor or constructor can find out the ecological footprint of construction materials, products and raw materials by consulting the Environmental Product Declaration, or the EPD as it is known. This is an information sheet that collects all the details on sustainability, not just in terms of the environment and climate, but of human health as well.

EPDs are generally based on a thorough lifecycle analysis. The results of this analysis are compiled in the information sheet and then validated by an external expert. The EPD is then uploaded into a government database.

With Enperas' solution (in the form of a software package), companies can make that lifecycle analysis and figure out the environmental costs in practice themselves. Because the whole process has been digitalised, it now goes far more quickly than before and companies can rapidly draw up EPDs for their entire product range.

In addition, Enperas' software is also a powerful tool for companies in making their product range and business operations more sustainable. Besides the software, Enperas can also advise companies on the sustainability of construction products.

One major asset for Enperas is that its software also takes account of the specific legislation on sustainability certificates for construction products, as this varies from country to country. This national testing can easily be carried out with a single mouse click.



## A-membranes



### ENERGY-EFFICIENT AND SUSTAINABLE SEPARATION TECHNOLOGY

Separation processes for liquids are often a huge drain on energy and are rarely very efficient. The technology from the spin-off A-membranes changes that. It not only makes membrane separations in liquids far more effective, but energy-efficient and sustainable too. The chemical industry has an interest in reducing its CO<sub>2</sub> emissions too. The spin-off, which comprises the membrane technology and expertise of both VITO and the University of Antwerp, went independent in 2021.

Liquid separations often need to take place in difficult chemical circumstances, such as high temperatures or in the presence of organic solvents. With classical methods, this also takes a great deal of time and energy, as the efficiency is low. A-membranes' membrane technology, however, actually excels in these circumstances. The secret? The right combination of the membrane and the organic layer on that membrane. This makes the technology robust and adaptable, giving it high potential for use in a range of chemical process streams.

Thermal separations such as distillation and evaporation today account for around 40 percent (!) of total industrial energy consumption. For membrane separations, the energy consumption amounts to only a fraction of that. This makes the technology an energy-efficient and sustainable alternative, with strong potential for CO<sub>2</sub> reduction in the chemical industry. Today, membrane technology is already being used at a large scale in the water and food industry.

The spin-off A-membranes is the result of years of experience in and development of membrane technology at VITO and the University of Antwerp. For both organisations, the launch and independence of the spin-off is part of the task to valorise sustainable chemistry and materials.





## MONA

### SPIN-OFF SPEEDS UP SCREENING FOR EYE DISEASES

There are half a million people in Belgium with diabetes. Few patients are aware that they run a far higher risk of diabetic retinopathy, or damage to the retina, as a result of their chronic condition. If they are treated improperly, or too late, the eye disease can lead to blindness.

Far too little diabetics see ophthalmologist, though, which comes from the acute shortage of these doctors, as well as the discomforts of a traditional eye screening. MONA, a VITO, spin-off that went independent in 2021, aims to do something about this with its innovative eye-screening method. This method combines fundamental medical research with state-of-the-art AI techniques. The result is an eye test that is very reliable, produces immediate results and gives no discomfort at all.

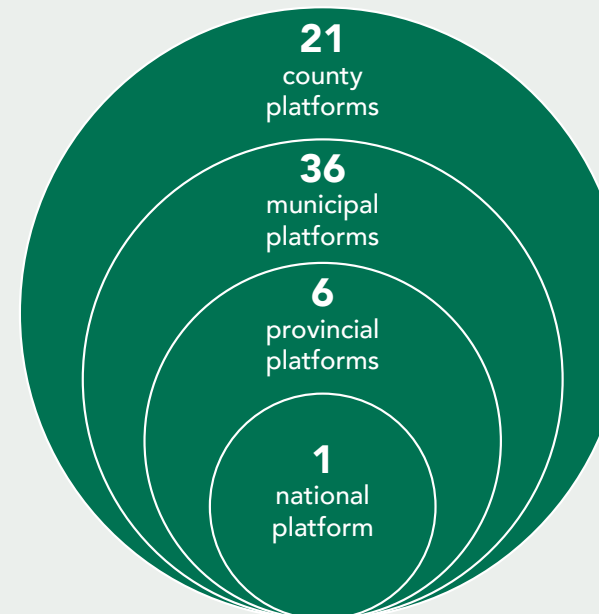


In the run-up to the launch of the spin-off and the commercialisation of the eye-screening method, MONA collected 1.5 million euros from leading Belgian investors. The funding was used to recruit additional personnel such as software developers and commercial employees, as well as to carry out several large-scale pilot projects on diabetic retinopathy. The spin-off is also aiming for regulatory approval for glaucoma screening.

MONA's customers are mainly hospitals. They can subscribe to a service solution whereby only the software is delivered to them, or to an all-in solution whereby they also receive a special retinal camera.



### 64 Opaq projects implemented in China



## Big in China

### 10 YEARS OF LIBOVITO

In the run-up to the Summer Olympic Games of 2008 in Beijing, when the world's eyes were fixed on the city and on China, the Chinese government was very concerned about the poor air quality in the city. So they turned to VITO, asking it to develop and supply several services for air quality forecasting.

These were contracts on a project basis that were mainly carried out at a European level. But the seed had been sown and, in 2011, VITO established a lasting presence in China. LIBOVITO was launched in September 2011, with its original goal being to valorise VITO's environmental and air quality models – developed in Flanders – in China. LIBOVITO took a commercial approach: Chinese clients would be able to call upon its paying products and services.

LIBOVITO's experts faced a steep learning curve in the first few years. They soon discovered that the Flemish and European air quality models could not simply be extrapolated onto China. The initial application of the Aurora air quality model was hardly an unqualified success either. But this learning process meant that the VITO experts had done their homework when the Chinese government rolled out its major multi-year plan to drastically improve the air quality in 2014.

LIBOVITO set up Opaq, an affordable and reliable forecasting model for air quality that provides information in real-time and also sends out notifications in the event of peaks in pollution. This was a big success: in the past few years, more than sixty Opaq projects have been implemented in China.

Ten years after the launch, LIBOVITO is now an established player in China in terms of environmental monitoring. This is now covering much more than just about air quality. Its experts are now also working to help improve the water and soil quality. This not only focuses on monitoring and forecasting, but on modelling work around flooding too.





## Citizen science

Citizen science has been extraordinarily popular for some years now. By calling upon citizens who want to volunteer for research, for example by supplying data, scientists gain the opportunity to carry out large-scale projects that they never would have been able to fund or organise in the classical manner (without the help of citizens).

CurieuzeNeuzen was a milestone in Flanders. Across the entire territory, as well as in greater detail in cities as part of sub-projects, citizens helped to map out the air quality. The project was a huge success, which asked for more.

A new theme high on the scientific as well as social agenda was sought, and quickly found. How does the greenery in our gardens, parks, nature reserves and agricultural fields respond to extreme weather phenomena that are becoming more and more frequent due to global warming? The successor CurieuzeNeuzen in de Tuin was born.

## CurieuzeNeuzen in the potato field

### LARGE-SCALE CITIZEN SCIENCE PROJECT CONTINUES IN 2022

As the successor to the citizen science project CurieuzeNeuzen, CurieuzeNeuzen in de Tuin was launched in early 2021. This project aims to check the extent to which gardens, parks, nature reserves and agricultural fields in Flanders are resistant to drought and heat. Five thousand "lawn daggers" collected data on the 'microclimate' in all these forms of greenery in 2021. The summer of 2021 also saw five hundred sensors fitted in almost three hundred potato fields. The aim: to find out more about the impact of extreme weather on the harvest.

Over the course of the second half of 2021, the initial results from the citizen science project were collected. This showed that city gardens function surprisingly well as air conditioners in cities heating up. But the largest effect came from parks and from nature reserves in or around a city or an urban area. These forms of public greenery act as refrigerators that temper the heat island effect in warm periods. This effect soon causes the temperature to rise several degrees in cities compared to the countryside. It also cools down far less there in the evening and at night.

### Lower quality due to extreme rainfall

But ... 2021 is mainly engrained in our memory as the year in which this country was struck by the worst water surplus and flooding in decades. This had consequences for potato crops in Flanders too, as the five hundred CurieuzeNeuzen in de Tuin sensors showed. The long-term high air humidity and the moderate temperatures were the greatest threat to the crops last summer, also resulting in serious disease-stress. The quality of the harvest suffered from this more than the quantity. The great quantity of precipitation and the high presence of nitrogen meant that tubers often grew far too quickly, which caused problems like growth cracks and hollowness.

CurieuzeNeuzen in de Tuin continues in 2022. The heat and drought will be mapped out with "lawn daggers" this year too (as well as the humidity, of course, should we have such an extremely wet summer as in 2021). And yes, the potato fields will be monitored further too. These measurements will be integrated into WatchITgrow once more, the online tool developed by VITO through which potato-growers can better estimate their production and increase it sustainably.

In the meantime, the measurement data from the soil sensors in 2021 is being analysed. In addition, it will be combined with satellite imagery and meteorological information. This should deliver some valuable insights into the impact of the dry spring of 2021 and the extreme rainfall in the summer.

The new CurieuzeNeuzen in de Tuin measurement campaign was launched on 26 March 2022. In the potato fields, the sensors will be fitted as soon as possible after planting (generally in April and May). They will then stay in place until just before the harvest.



# VITO employees in the spotlight



**Professor Karl Vrancken, a project manager at VITO, has been well-known for a long time. He has made a name for himself at VITO and the University of Antwerp as a highly valued international expert in the circular economy. In 2021, he was tasked with coordinating the approach to the PFAS issues in Flanders by the Flemish government. This came as a surprise to many, and as a challenging opportunity for Karl Vrancken.**

## **DID THAT REQUEST SURPRISE YOU AND DID IT TAKE YOU A WHILE TO THINK ABOUT IT?**

When the PFAS pollution emerged and the government understood that it was more than a single incident, policy-makers asked a number of people if they knew of any candidates for the role of co-ordinator. My name apparently came up because I do have experience in policy advice, including on waste policy and through the BAT knowledge centre, where there needs to be a link between industry, science and government. I've been involved in around 35 BAT studies as a co-ordinator, as well as an author for a number of European BREF documents.

## **BUT WITH NO EXPERIENCE OF PFAS ...**

That was exactly what they were looking for: someone with no background in the PFAS issues so they could approach their task with an open mind towards all stakeholders – residents, industry, government. I'm a doctor in chemistry, so I was hardly out of my comfort zone and I'm also a member of the European Environment Agency's scientific committee. From a circular economy and waste processing perspective, you also need to be familiar with everything to do with toxicology, technology and industrial policy.

## **DID IT TAKE YOU LONG TO DECIDE?**

I didn't have much time. I got a phone call from the Demir cabinet and the Minister was expecting an answer that same evening. I felt challenged and knew that this was what I wanted to do. But I also knew that this would have consequences for my work at VITO and that I would have to cut my ties with VITO temporarily. So I phoned my unit manager about it right away. We understand each other very well and he assured me that he'd find a solution for the running projects. I also messaged VITO's CEO. His answer was short and clear: 'Great! Do it!' A few hours later, I was looking up everything to do with PFAS. I had exactly 24 hours to prepare myself before they were expecting me at the Council of Ministers.

## **WHAT CHARACTERISTICS DOES A GOOD MANDATE HOLDER NEED TO HAVE?**

You need to be able to bring people together, to be able to listen to all parties with an open mind, to be receptive to everyone's point of view, to be willing to understand everything and to give people a great deal of credit. You also need to be able to learn things quickly, make links and understand. And you need to be prepared to start from square one. That's the most pleasant part for me – I like to be a pioneer. But the complexity of this topic and the urge to unravel it are also important elements. Moreover, this task is entirely in line with what I've been doing at VITO for 25 years: scientifically underpinning policy and creating a science policy interface. This is the task and added value of a knowledge organisation like VITO. We need to weigh in on the social debate. That takes collaboration, exchange, co-creation and collective advancement of knowledge, so there's a foundation for decision-making.

## **DID IT GO THE WAY YOU EXPECTED?**

I'd never thought this pollution would be so widespread, across all of Flanders. We began in Zwijndrecht and, a few months later, I was at residents' meetings all over Flanders. This is not an isolated incident. And I'm still a bit shocked at how the media and politics treat each other day by day. And that we're sometimes quite far removed from reality in our scientific thinking. I can't say the problem has been exaggerated, but

we've got a magnifying glass on PFAS now. The whole PFAS affair is the result of choices that we've made as a society. It's wrong to think you can just implement industry in a living environment. We're dealing with new pollutants and we can't estimate how harmful they're going to be (yet). This is what we at VITO have been arguing for years for: there needs to be a turnaround in the way we produce and consume things. An organic farmer next to an industrial estate?

## **WILL THAT EVER BE POSSIBLE?**

We'll need to make some choices. And we need to strive for a balance. In doing so, we'll need to take decisions that have an effect on our daily lives, the things we buy and use. We're really at the limit of what our planet can handle and that's not just about far-off Amazonian forests – it's closer, so it's also about Zwijndrecht, the port area, etc.

## **YOUR MANDATE WILL RUN TO MID-JUNE 2022. WILL YOUR TASK BE DONE BY THEN?**

A sign of good policy is when your own administration can handle these kinds of things or a crisis itself. I've laid the foundation, but it's too soon to let go of everything yet. The PFAS experts' group and the communication team are working particularly well. At the same time, we've only just begun the stakeholder consultation in Zwijndrecht. A lot of knowledge has been gathered, but that still needs to be translated into action. Someone still needs to take on the co-ordination there. Once everything's been set up, the pioneering project is over for me and the administration needs to take over the work. It's also about time for me to return to VITO, to thank my colleagues for all the work they've taken over from me, but that I'll be taking it back now.

## **IS THERE ANYTHING YOU'LL BE BRINGING TO VITO FROM YOUR EXPERIENCE WITH PFAS?**

A great deal. Mainly, how important VITO's transition platform is. I really want to do even more with that. Resolving sustainability and climate issues will take a multi-disciplinary approach – it's impossible for any one person to maintain an overview. You need a structure at the intersection between science and policy. An organisation of experts who can provide the connection. Both scientists and politicians need skills, and training too, in order to achieve this properly. That's what we aim for.



## Walter Eevers goes Denmark

### VITO RESEARCH DIRECTOR HELPS OUTLINE DANISH TRANSITION TO SUSTAINABLE FUTURE

VITO Research Director Walter Eevers was asked by the Danish government's Innovation Fund to join the advisory council of this renowned innovation institute. The Innovation Fund aims to lead Denmark – already among the global front-runners in terms of green energy – to carbon neutrality by 2050. CO<sub>2</sub> emissions need to reduce by 70 percent by 2030 in any case.

The Innovation Fund focuses on four strategic innovation pillars: carbon capture and storage and (re)use of CO<sub>2</sub>, green fuels for heavy transport and industry, climate and environmentally friendly agriculture and food production, and circular economy. The fund's mission-driven approach to innovation is groundbreaking, and VITO also embraces this approach. This was partly why the organisation wanted to include Walter Eevers in its (current) panel of seven Danish and international advisors.

The VITO Research Director did not hesitate to accept this assignment. 'It demonstrates VITO's international recognition in terms of sustainability.'



## G-STIC Conference during world expo in Dubai

### SUSTAINABLY SHAPING A POST-PANDEMIC WORLD

Expo 2020 in Dubai was focused on knowledge and technologies that are crucial to achieving the UN's 17 Sustainable Development Goals (SDG). It was therefore the perfect setting for holding the fifth G-STIC Conference, the first one to take place outside of Brussels (Belgium).

The G-STIC Conference in Dubai consisted of two parts. The first part took place on the occasion of the Flemish Week and the 76th United Nations Day from 24 – 27 October 2021. The second part of the G-STIC Conference took place during the Global Goals Week from 17 – 19 January 2022.

3,900 participants and 390 speakers from 125 countries participated at 71 sessions, 4 workshops and 4 innovation tours. Among the many esteemed speakers, we had the honour of receiving Leymah Gbowee (2011 Nobel Peace Laureate), Mariana Mazzucato (Founding Director of the UCL Institute for Innovation, University College London) and H.E. Lazarus Chakwera (President of Malawi) who used his keynote address to emphasise that technology and innovation are key enablers to curbing global challenges such as climate change.

*The COVID-19 pandemic has emphasized the importance of science and technology for the well-being of global populations. Advances in science and technology are necessary, not only to recover better from the crisis, but also to address other global challenges, such as poverty, inequality and climate change. That's why it was so important to gather the G-STIC Community in Dubai and online on the occasion of the Global Goals Week of the World Expo.*

DIETRICH VAN DER WEKEN





# VITO in figures

“Despite the challenges of the corona crisis, VITO closes 2021 with a positive result. VITO continues to grow and the new climate and water related projects give the results an extra boost. The creation of Clean Vision Invest stimulates the valorisation and spin off policy and is starting to show its success. The sale of the VITO spin off LCV (Laser Cladding Venture) is hereby a good example of the generation of extra resources for research and valorisation. Together with the support that VITO provides to Flanders, Europe and the industry, we are now well prepared for the challenges of the coming years.”

Dirk Fransaer  
Managing Director

## REVENUE 2021

Financing Reference Tasks

**11 603 kEUR**

Activation R&D

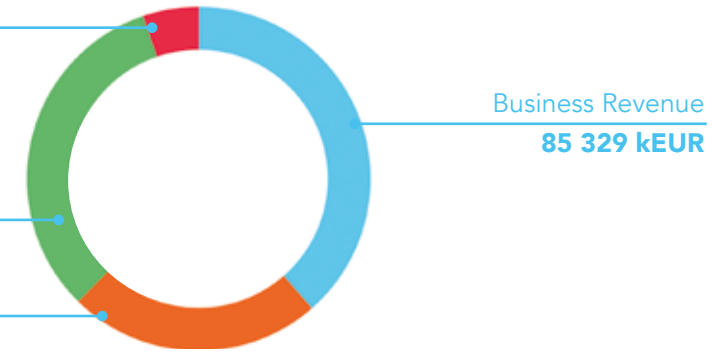
**71 700 kEUR**

Grants

**52 631 kEUR**

**TOTAL**

**221 263 kEUR**



## EXPENDITURES 2021

Normal Depreciation

**14 147 kEUR**

Operating Means

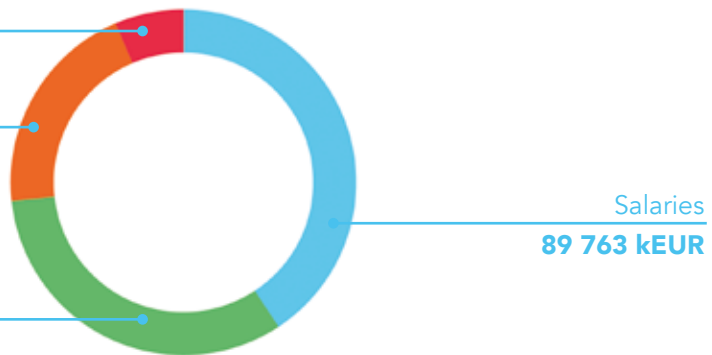
**44 763 kEUR**

Depreciation R&D

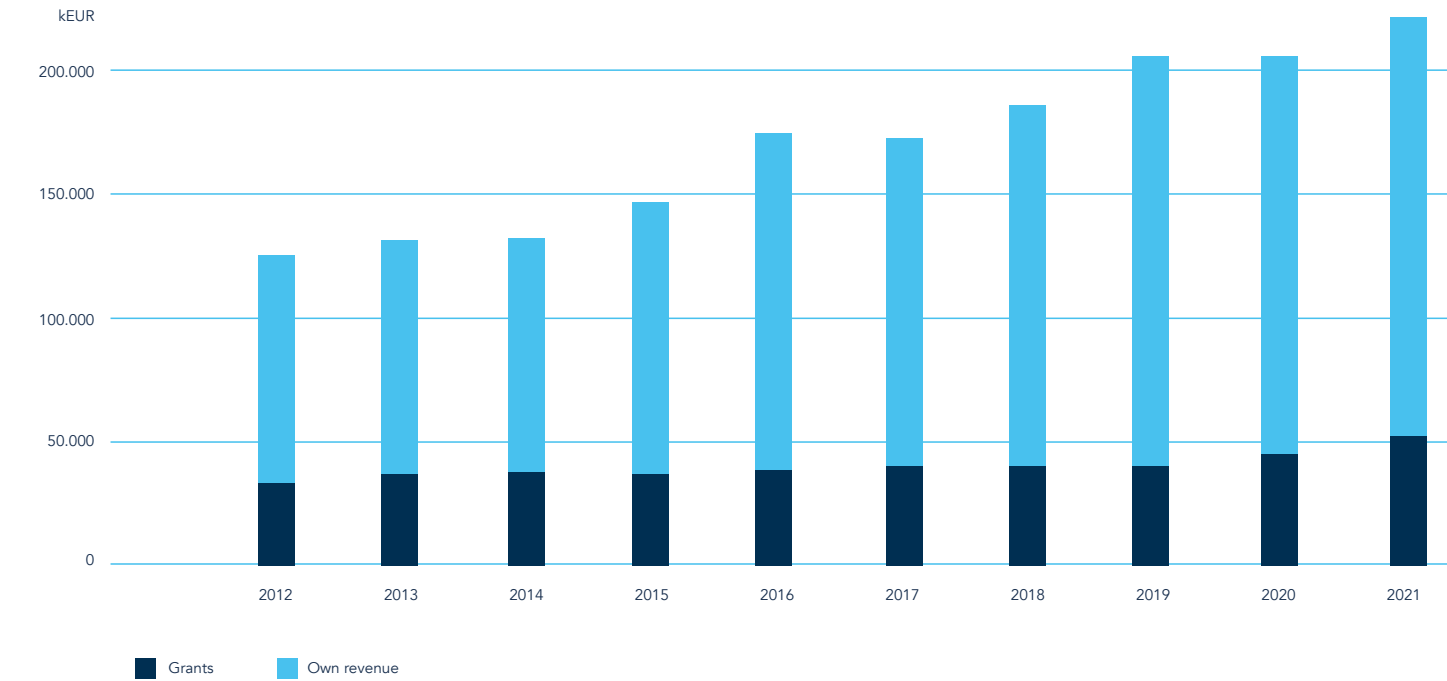
**71 700 kEUR**

**TOTAL**

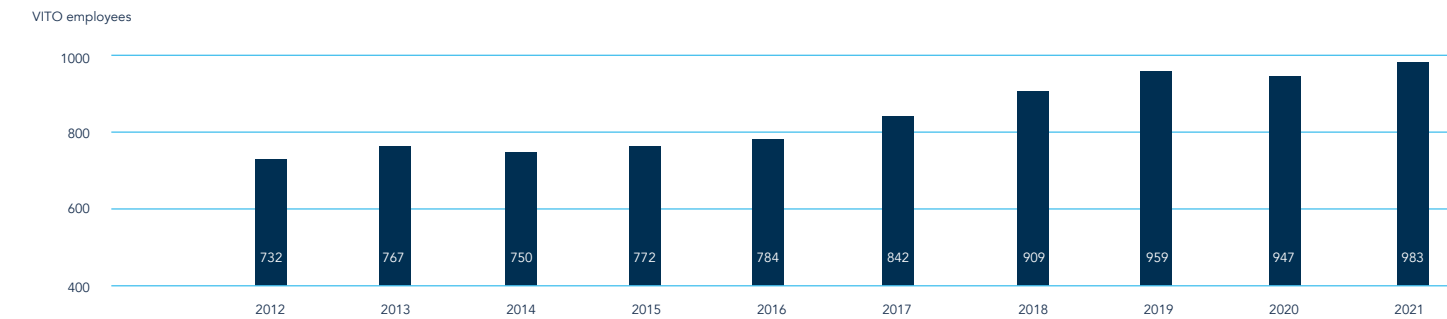
**220 373 kEUR**



## EVOLUTION OF REVENUE (kEUR)



## NUMBER OF VITO EMPLOYEES





As many other organisations, the corona crisis forced VITO to change its way of working and collaborating in a very short time. Early 2021, VITO set up the internal working group 'Work organisation of the future'. The working group set a series of objectives and starting points and looked at them from 4 perspectives: Bricks, Bytes, Behaviour and Business. An important change in VITO's work organisation is that the activities and interactions of employees will determine where they work. That's why our offices will no longer be the standard workplace for employees. Team members formalised all team agreements together in agreement frameworks. We have also reviewed the role of our buildings. After a long period of working from home, we have started this new way of working and have been building on our work organisation of the future since spring 2022.



**983**  
EMPLOYEES



**323**  
SCIENTIFIC  
PUBLICATIONS



**45**  
NATIONALITIES



**168**  
INTERNATIONAL  
EMPLOYEES



**102**  
POSTDOCS &  
PHDS



**352 922**  
WEBSITE VISITS



**43**  
GRANTED PATENTS





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