

VISION

Vision on technology for a better world

ALLGRO TAKES ON PIONEERING ROLE IN WATER TREATMENT AND REUSE

THE NEGLECTED ENERGY TRANSITION

COOPERATION WITH THE **WORLD BANK** ON **SUSTAINABLE DEVELOPMENT**

VITO SUPPORTS INNOVATION AND ENTREPRENEURSHIP IN SUSTAINABLE CHEMISTRY



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Dear reader,

Last summer was marked by two phenomena that have become more common in recent years: heatwaves and severe droughts. Both phenomena highlight the fact that Flanders still has a long way to go in terms of a sustainable and climate-friendly economy, industry and society.

VITO is continuing to work hard towards this goal. Read our full article on the energy transition in the 'non-ETS sector' (e.g. transport, buildings, agriculture) to find out more about our preference for an integrated approach towards this challenge. This type of approach looks beyond the purely technological potential of possible solutions. For example, these solutions must also be accepted by society. In terms of energy efficiency, this means that a sustainable technology or solution is only ready if it is financially and socially viable.

The sustainable transition also requires policymakers, as well as the general population, to have access to objective and scientifically accurate information. VITO also plays a key role in this regard, as illustrated by the SIS Biodiversity development project. In this edition you can read how this online platform is enabling us to convert reliable yet complex climate data into accessible, action-oriented information, which we can then present to policymakers, companies and other stakeholders.

The success of a transition depends on close cooperation between the key players. VITO also excels in this area. What's more, in this issue you can read about how we have teamed up with the World Bank to encourage the roll-out of renewable energy technologies. You can also find out more about what we are doing, along with various stakeholders from the chemical industry, to support BlueChem: Antwerp's new sustainable chemistry hub.

Together we are moving towards a sustainable society. Enjoy reading this issue of VITO VISION!

Dirk Fransaer Managing Director of VITO

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More info: vito@vito.be - www.vito.be/en

Dirk Fransaer, Boeretang 200, 2400 Mol

ALLGRO TAKES ON PIONEERING ROLE IN WATER TREATMENT AND REUSE



The Sint-Lievens-Houtem-based fruit and vegetable cutting business Allgro opened the doors of its brand new water treatment plant at the start of May 2019. The facility turns waste water into drinking water, drastically cutting the food company's mains water consumption. The commissioning of the plant also marked the end of an innovation process that started in 2015, which received intensive support from VITO/Vlakwa.

The food sector is subjected to very strict rules about water use. For many companies, all water used must be of drinking water quality, including water that is only used to clean machinery or production areas. As a result, food companies are traditionally large mains water consumers. Now that extreme periods of drought are occurring more frequently, there is a need for better water resource management.

Preliminary research in house

With the Flanders Knowledge Center Water (Vlakwa), VITO has a wealth of in-house expertise when it comes to water management, how to make it more sustainable, and how to reduce the impact on water resources in Flanders. The East Flemish family business Allgro, one of Belgium's largest fruit and vegetable cutting companies, turned to VITO/ Vlakwa for advice in 2015 on cutting water consumption and reusing waste water. As usual, the first step taken by the VITO/Vlakwa experts was to carry out preliminary research in house. 'We gathered all of the relevant information already available within the company', explains VITO's Veerle Depuydt. 'How do the water flows work, what are the sources, where and how much is discharged, what is the existing vision in terms of water reuse, and so on? Once we had answered all these questions, we were able to make an in-depth project recommendation.'

The first-line advice subsequently led via the open call in 2016 to a demonstration project in which Allgro, together with another food company, commissioned technology supplier Pantarein to install a pilot plant. This facility combined biological water treatment with membrane technology, while RO (reverse osmosis) technology ensured a supply of drinking quality water. Both the functioning of the pilot plant and water quality were monitored and evaluated.

Sustainable water use

This assessment proved so successful that Allgro decided to invest in a full-scale treatment facility, which was unveiled at a ceremony in early May 2019 attended by Deputy Prime Minister Alexander De Croo. 'From now on, we can reuse up to 70 per cent of our process water', reveals Paul De Meyer, Manager of Allgro. 'This means we are setting a good example for sustainable water use, a fact that is also acknowledged by VITO/Vlakwa.'

Allgro consumes as much as 130,000 litres of drinking quality water every day. De Meyer: 'Extracting groundwater or taking fresh water out of the drinking water network is anything but eco-friendly, as is discharging waste water. By recycling our process water, we can reduce our water costs by fifty percent, meaning that the treatment facility will pay for itself in the long term.' Since the facility was brought into use, almost three quarters of the company's process water has come from treated waste water.

With its first-line advice and subsequent demonstration project, VITO/Vlakwa successfully played the role of technology facilitator. 'It is important that water treatment and reuse technology spread to as many companies as possible', says Depuydt. 'Particularly in a sector that is so reliant on water. Amongst other things, we help smaller companies to navigate the various laws, regulations and available technologies.'

More info veerle.depuydt@vito.be sofie.vanermen@vito.be





VITO/ENERGYVILLE DEVELOPS STRATEGIES FOR THE 'DEFOSSILISATION' OF OUR TRANSPORT AND THE HEATING OF OUR BUILDINGS

THE NEGLECTED ENERGY TRANSITION

Belgium must reduce the emissions of sectors not covered by the European Emissions Trading System, which account for more than half of our greenhouse gas emissions, by more than one third by 2030. This will require: climatefriendly mobility, an alternative to large-scale natural gas heating systems and sustainability improvements in sectors such as agriculture and waste management. At VITO/ EnergyVille we are researching and assessing all measures that can support this effort. We are doing this by using a systemic approach. And from different perspectives: technological, economical and sociological.

Based on the public discourse about climate change, and specifically the debate about how Belgium and Flanders can achieve their objectives, it seems to be simply a matter of identifying a low-carbon electricity source. Partly thanks to plans to phase out nuclear power, the energy transition debate has boiled down in recent years to a discussion about where we should obtain our electricity.

That is a shame of course because, in reality, CO₂ emissions from electricity production make up less than twenty per cent of national emissions in Belgium. And yes, this is partly due to the significant contribution of nuclear energy towards the energy mix (even if, in the hypothetical case of one hundred per cent fossil fuel power plants, emissions would still be less than fifty per cent). On top of this, electricity generation forms part of the European Emissions Trading System, or ETS, along with other energy-intensive sectors such as the steel, cement, petrochemical and aviation industries within Europe. The emissions of this

ETS sector are regulated at European level, via emission limits that are constantly being lowered. This sector generates forty per cent of European CO₂ emissions.

35 per cent reduction by 2030

The non-ETS sector includes the transport industry (which still draws largely on fossil fuels), heating systems in homes and buildings (natural gas!), agriculture and waste management. These sectors are therefore responsible for the largest share of greenhouse gas emissions, despite their often neglected role in the media and public debate. They also encompass sub-sectors over which Belgium and Flanders have direct control. Indeed, Europe has tasked national and regional authorities with curbing and reducing emissions in these sectors via the Paris climate agreement and a number of European directives. And by more than just a bit: Belgium needs to achieve a 35 per cent reduction in the emissions of its non-ETS sector by 2030 compared to the reference year 2005.

At VITO/EnergyVille, we take the challenges facing the non-ETS sectors seriously. Our status as a knowledge organisation and technology supplier obliges us to do so. And thanks to our long-standing and broad expertise, we are extremely thorough. We focus not on individual sectors, measures or scenarios but on the system as a whole. An important part of our approach is to look at things from not just a technological but also an economical and sociological perspective. We can do this thanks to VITO/EnergyVille's highly diverse workforce, with specialists ranging from exact scientists to economists and sociologists to architects. This approach also allows better understanding of the value and potential of technologies. After all, it would not be the first promising technology to fail because it did not find its way onto the market.

The success of the energy transition depends on enough people being willing to participate and invest in it. This means that measures that are not only climate-friendly, but also offer a higher level of user comfort, have a better chance of succeeding. Finally, the numbers also need to add up in financial terms for the various authorities. Investments, subsidies and other support measures always need to be tested in a broad macroeconomic context.

Emphasis on defossilisation

In terms of the transition of non-ETS sectors, the emphasis lies firmly on 'defossilisation': drastically reducing our dependence on fossil fuels and resources. Most heating systems in Belgium are still largely fuelled by natural gas imported from abroad. Just like the Netherlands, we will gradually need to move away from gas. The fact that current imports have a negative impact on our trade balance and thus also on our economic growth is a further incentive. A number of fully fledged alternatives are available for heating, such as deep and shallow geothermal energy, residual heat from industry, electric heat pumps and so on. And let's not forget insulation: making our homes and buildings more energy-efficient reduces the need for heating.

At VITO/EnergyVille we are exploring not just the visible benefits of these alternatives, such as markedly lower emissions and less dependence on imported gas, but also the indirect, sometimes even hidden, positive effects. Of course the same applies to the downsides. Take the example of a district heating network powered by residual heat from industry, as in the





port of Antwerp. The installation of this type of heating network requires major infrastructure works, and if there's one thing people don't like, it's road closures that last for weeks or months. So the benefits of this type of network must be clear and substantial, including for the end users. One example is low, capped, energy prices. Large-scale infrastructure works also create local jobs, therefore boosting the economy. Another example is double glazing, which has proven very successful because people see quick and marked returns in their wallets as well as a rise in home comfort levels. At VITO/EnergyVille we combine all these aspects to produce a complete vision for long-term measures and policy actions.



Making life easier for end users

The transition will not happen if people associate it with loss of comfort, particularly in the non-ETS sector, which is so close to the end user. People need to feel that their daily lives are being enhanced. Clever marketing can certainly help. Take, for example, Tesla's marketing of its electric cars as 'the latest new thing'. People are willing to pay more if they know they are driving around with the latest technology. New business models can also help. Look at companies, and now also households, that no longer purchase electricity and pay per kilowatt hour consumed, but instead sign up to a complete energy service. This means they no longer need to bother with things like broken lightbulbs or new meters that need to be installed. In other words, their lives are made easier. Such services are becoming attractive to more and more end users, who are then caught up in the flow of the energy transition – sometimes without immediately realising it.

The transformation of those other 'guzzlers' of fossil fuels, the passenger transport and goods transport sectors, also poses a significant challenge. At VITO/EnergyVille we firmly believe in the future of the electric car. Admittedly, battery storage could be much better and alternatives still need to be found for what are referred to as 'conflict materials', and we are investing considerable effort in research in this area. The huge potential of the electric car lies in the high energy efficiency of the electric engine, namely over ninety per cent compared to a maximum of thirty per cent for combustion engines. What's more, energy is also recovered during braking. This high efficiency means that we expect much more from the electric car, despite the fact that its battery makes it heavier, than from the hydrogen car, which is powered by a combustion engine. We are also aware, of course, that the intensive electrification of vehicles will drive up power consumption. That is something we take into account in our models, which brings us back to the ETS sector.

Different levels

The electrification of passenger transport also provides a good example of the impact different policy levels can have on the success of the energy transition and the speed at which it is rolled out. For example, car manufacturers are constantly faced with more and more stringent European and national standards, forcing them to bring ever cleaner vehicles onto the market. But, of course, for electric vehicles you also need an extensive and dense charging infrastructure network instead of filling stations. Regional and local authorities are primarily responsible for taking action in this area. At VITO/EnergyVille we are examining how the various administrative and policy levels impact each other.

Heavy goods transport is another story. In this sector we envision a central future role for synthetic fuels produced using products such as CO_2 from industrial flue gases. Our systemic approach shows that this technology can succeed

and become financially viable if it is properly integrated into a broader industrial setting.

The benefit of long-term objectives

The main aim of defossilisation is to reduce our CO₂ emissions. The extent to which we achieve this is important and even determines which technologies we can use to this end. A modest carbon reduction of 10 to 20 per cent demands a different approach than a drastic reduction of 80 to 90 per cent. It is not a case of simply using the same technology and then scaling it up. That is why it is so important that we know well in advance what we need or want to aim for. This is precisely why the European long-term objectives are so useful.

We don't just need to reduce our carbon emissions. We can also try to lower the surplus of CO_2 in the atmosphere which is driving climate change. We can do this by planting trees, but also by removing CO_2 directly from the atmosphere. Ten years ago this idea was still considered outrageous. However, we now largely recognise the benefits. 'Capturing' CO_2 in the atmosphere offers much higher flexibility since you are not dependent on the output of an industrial plant. The problem is also simpler. The only relevant question is: how do I remove a tonne of CO_2 from the atmosphere as cheaply as possible? By contrast, the question for industrial facilities is: how do I remove as much CO_2 as possible from the airflow formed by flue gases?

But the big question remains: what happens with the carbon dioxide afterwards? Does it go into the ground, for example in an aquifer or an abandoned gas field or oil field? Or is it valorised in fuels and materials? These are questions that VITO/EnergyVille is exploring from both a technological and a socioeconomic point of view. It goes to show that, regardless of sector (ETS or non-ETS), the energy transition is always a work in progress.





More info jan.duerinck@vito.be

COOPERATION WITH THE WORLD BANK ON SUSTAINABLE DEVELOPMENT

VITO/EnergyVille is cooperating with the World Bank on sustainable development projects. This cooperation is now being applied in the roll-out of battery technology for electricity storage in developing countries. Thanks to the leverage provided by the international organisation, VITO/ EnergyVille's knowledge and expertise are being applied to low-carbon energy production worldwide.

The World Bank, which has its headquarters in Washington, was set up after the Second World War to help fund the reconstruction of (Western) Europe. Today, it is one of the world's biggest development organisations. By providing 'soft loans', the World Bank supports countries in their efforts to tackle extreme poverty and income inequality. The organisation places a strong emphasis on the United Nations' sustainable development goals (SDGs) when granting these loans, whereas in the past it focused more on infrastructure projects.

'Belgium has played an important role in the governance of the World Bank since its foundation. Our country is now being represented by Mr Schoenleitner, who is one of the 25 executive directors; he comes from Austria but also has countries like Belgium, Czech Republic, Hungary and Turkey in his election group. As a Belgian representative I am very proud that the World Bank appreciates and calls upon our Belgian expertise' explains Nathalie Francken, currently substitute Deputy Director for Belgium in Washington.

Although the vast majority of the supported projects are coordinated by the receiving country, the World Bank also manages initiatives itself. VITO/EnergyVille has cooperated on a number of these initiatives in the form of contract research. One recent example is 'ThinkHazard!': a tool that shows project leaders at a glance the risk of flooding, earthquakes and other disasters. The World Bank turned to VITO/ EnergyVille to develop the section on extreme heat. 'This was a walk in the park for our climate specialists', says Arnoud Lust of VITO/EnergyVille. 'We were able to draw on many years of knowledge and expertise to produce the tool. But it's thanks to the World Bank that this knowledge and expertise is now being used at a global level. That kind of leverage cannot be underestimated.'

Within large organisations such as the World Bank, it is essential to stay on the radar at all times if you want to be involved in projects as a stakeholder. And VITO/EnergyVille is keen to be involved. 'There is considerable overlap between the World Bank's mission and our own goals', explains Lust. 'Our work also has very strong links to the SDGs. We hope that a more structural cooperation will enable us to boost our impact and to implement at a



global level the technologies and applications we are working on.'

The involvement of VITO/EnergyVille also helps to raise the profile of Belgian companies. 'This also benefits our national economy, in line with our own mission.'

The cooperation between the World Bank and VITO/EnergyVille is now taking shape within an ambitious and large-scale programme currently being rolled out from Washington. The project involves the introduction



of battery technology for electricity storage in developing countries. The World Bank has earmarked one billion dollars of its own funds for the programme, and hopes to secure a further one billion from donors and three billion from private investors in the coming years. 'In many southern countries, solar energy is the first choice of renewable energy source', states Jeroen Büscher of VITO/ EnergyVille. 'Power generation varies widely, which means that storage infrastructure could offer a solution. We want to (help to) provide this infrastructure in the form of stationary batteries.' The batteries will ensure the stability of the (often still to be installed) electricity grids.

The World Bank launched the Energy Storage Partnership with the aim of implementing the battery technology in the South. VITO/EnergyVille works in close cooperation with the team involved. Jeroen Büscher recently travelled to Washington to share his knowledge of battery standards and we welcomed a delegation to our battery lab in EnergyVille. 'We can see that our input is highly valued', he tells us. 'It is important that we are involved from the outset, so that we can also take part in the technical roll-out in the future.'

The aim is not for developing countries to build infrastructure solely using World Bank funding. 'Ultimately, we need to ensure that the private sector invests in battery technology and energy production', says Arnoud Lust. 'The programme takes a very strategic approach. It identifies potential obstacles to the roll-out of battery technology as well as the pros and cons of specific technologies. Lithium-ion batteries are currently the most popular, for instance, but they are primarily designed for electric cars. To what extent can they also be used as stationary storage in a hot climate? We need to find out by also looking at other technologies.'

'The primary aim of the support provided by the World Bank is to accelerate development and steer it in the right direction, namely lowcarbon energy production', adds Jeroen Büscher. 'The projects being launched are often demos that give new technologies a chance. That ties in well with what we are also doing at VITO/EnergyVille: sharing knowledge and exploring ways to implement a specific technology.'



Meer info arnoud.lust@vito.be



VITO CLIMATE EXPERTS OFFER CONSERVATIONISTS A HELPING HAND

Climate change will have a growing impact on the extinction (or survival) of animal and plant species over the course of the century. In order to respond to future trends and proactively protect biodiversity, VITO is developing a user-friendly online tool that will allow biodiversity managers to better assess the impact of climate change.

The latest report of the IPBES – the 'IPCC' for global biodiversity – did not lie about it. More than a million species are currently at risk of extinction, while fifty per cent are 'under pressure'. The causes include overuse of pesticides and other chemical substances in agriculture, the destruction of forests and other valuable ecosystems (often also for agriculture), environmental pollution and, of course, climate change. Although climate impact is not yet the biggest threat facing biodiversity, forecasts show that this could change by the end of this century. If greenhouse gas emissions continue at the current rate, global warming could be the main factor affecting species survival by 2100.

What do environmentalists and conservationists need to do to proactively tackle both the current and the future threat? How can policymakers ensure the continued protection of plant and animal species, not just now but also in about ten to twenty years' time? In short, how can our knowledge of climate and global warming contribute towards a better response to the biodiversity crisis?

Online platform

The answer: by converting this knowledge, which often consists of raw and highly complex data, into clear, useful information. That,

in a nutshell, is the aim of the Sectoral Information System (SIS) to Support the Biodiversity Sector, which is being developed within the Copernicus Climate Change Service (C3S, the climate component of the European satellite monitoring programme). VITO is coordinating the project. 'During the two-year project we will develop a publicly accessible online platform where users can find specific information gathered on specific variables such as species, regions and climate zones', clarifies VITO's Koen De Ridder

VITO's expertise within the project will focus mainly on climate, such as interpreting raw data, modelling, simulation and scenario extrapolation. Knowledge and experience of biodiversity will be provided by six of VITO's cooperative partners – including the Antwerp Zoo. 'With these six partners we are seeking to cover a large proportion of biodiversity', says De Ridder. The work of the organisations involved centres on land animals, sea creatures, plants and specific animal species that live on sea ice (such as seals).

Grasslands, monkeys and seals

How will users soon be able to use the platform to protect or support biodiversity? De Ridder gives three specific examples: 'one of the many



cases in the platform concerns grassland management in the Baltic states. Farmers in these countries receive subsidies to keep these grasslands wild. But imagine they are suddenly faced with a severe drought: what should be done with the grasslands if that happens? And will the farmers be held accountable? The information we provide will enable authorities to adapt their

policy now to what is to come."

Another case is that of the goldenheaded lion tamarin in Brazil. Deforestation and climate change have placed this species of monkey at serious risk of extinction. As part of the BioBrazil project, biologists from Antwerp Zoo are looking at how they can use climate data from the SIS platform to explore the chance of survival of the goldenheaded lion tamarin. This survival is important not just for the monkeys themselves, but for the ecosystem as a whole since the monkeys play a major role in distributing plant seeds via their droppings.

'Climate change could determine whether certain populations or entire species survive or become extinct', states Peter Galbusera of the CRC, the Antwerp Zoo's science team. 'The same is true for the goldenheaded lion tamarin in Brazil's Atlantic Forest, which is also at risk due to deforestation and habitat

fragmentation. Simulations can provide a better estimate of this risk, but this requires accurate climate data. The SIS platform will therefore be an important resource for us.'

A third case involves research into the impact of rising temperatures on the reproductive behaviour of seals in and around the Baltic Sea. De Ridder: 'Seals give birth to their young pups on the sea ice. But if the ice continues to melt, the animals will be increasingly forced to give birth on land, where their young can fall prey to predators. By visiting our platform, authorities can find out things like where and when they should avoid destroying the sea ice by using icebreakers.'

VITO's designation as leading contractor by the C3S is an achievement to be proud of. 'Within the Copernicus programme there is a strong recognition that those involved in a project have an excellent understanding of what end users need, and that they will do everything they can to deliver it. In this case the conversion of raw climate data into tangible and action-oriented information', De Ridder explains.





Meer info koen.deridder@vito.be



Meer info peter.galbusera@kmda.org

INNOVATIVE RESEARCH INTO THE IMMUNOTHERAPY SUCCESS RATE FOR LUNG CANCER PATIENTS

According to the latest statistics, more than 8,000 Belgians are diagnosed with lung cancer every year. Two in three are male, but the percentage of females is rising every year. Four in five of these patients die within five years of diagnosis. Early diagnosis is essential in order to reduce the death rate and improve quality of life. Early and accurate diagnosis leads to more effective treatment, better quality of life and a more favourable prognosis. In the pursuit of a better prognosis, VITO doctoral student Eline Berghmans is cooperating with Prof. Dr. Patrick Pauwels (Head of the Pathological Anatomy Clinic at Antwerp University Hospital).

What exactly is lung cancer?

Prof. Dr. Pauwels: Lung cancer occurs when something goes wrong with the division of the cells in the respiratory tract and they start to divide uncontrollably, forming a lump or tumour. These cells can then invade the surrounding tissue and cause a lot of damage. There are two types of lung cancer: small cell and non-small cell lung cancer.

What are the symptoms of lung cancer?

Lung cancer patients experience a persistent cough, which often produces a mixture of blood and mucus. They also commonly have pain around the chest area, particularly on coughing, laughing and breathing in deeply. They complain of shortness of breath. Regular respiratory tract infections can also be a sign of lung cancer. Other symptoms are also common in other types of cancer. They can include loss of appetite, weight loss and feelings of fatigue and weakness.

Is lung cancer difficult to detect, and how is it diagnosed?

Lung cancer produces almost no symptoms at an early stage of tumour development, which means that the diagnosis is not usually made until a later stage. By this time the cancer has often spread. In many cases, small lung tumours are discovered as a chance finding on an X-ray or CT scan.

Is lung cancer a common type of cancer?

With around two million diagnoses every year worldwide, lung cancer is one of the most common cancers along with breast cancer. Lung cancer occurs more frequently in men: in Belgium there are more than 8,000 new cases of lung cancer every year, of which 5,439 are men and 2,835 women.

Has science already identified possible causes? Is there a hereditary element?

Smoking is still the main cause of lung cancer. Cigarette smoke is responsible for 85 % of lung cancers. Smokers need to be aware that around 17 % of smokers eventually develop lung cancer. It's not just active smokers who are at risk. Passive smoking also increases the risk of developing lung cancer by 30 %. Longterm exposure to fine particulate matter is the second biggest cause, followed by exposure to asbestos, radon and other substances. Smokers with a family member who has, or has had, lung cancer are three times more likely to develop lung cancer themselves.

What treatments are available and how invasive are they?

If the lung tumour is still relatively small, is not embedded and has

not yet spread, the tumour is often surgically removed. Chemotherapy and radiotherapy, alone or in combination with other therapies, are also widely used in the treatment of lung cancer patients. Depending on the type of cancer, some patients are eligible for targeted treatment. This treatment affects the cancer cells much more specifically, with a much lower impact on healthy cells. As a result, patients experience much fewer side effects. Unfortunately, a downside is that the therapy is only suitable for a small percentage of all lung cancer patients. Immunotherapy is a recent but promising treatment for lung cancer patients. It strengthens the immune system so that it attacks and eliminates the tumour cells.

What is the prognosis for someone diagnosed with lung cancer?

Around 85 % of lung cancer patients worldwide eventually die as a result of this cancer because it is a disease that is not usually detected until at a late stage, after the cancer has already spread.

VITO is currently carrying out research into lung cancer in cooperation with the Antwerp University Hospital. What exactly does this involve?

Eline Berghmans (VITO): We analyse tissue from the lung tumour. If a lung tumour is surgically removed, we can examine the lung tissue. Although the lung tissue removed during a lung biopsy – in which doctors collect a small amount of lung tissue using a needle – is sufficient for the lung cancer tests the hospital carries out, it is not enough for the tests that we want to perform. That is why, at present, we only work with tissue that has been removed during a surgical procedure. These tissue samples are bigger for the purpose of testing.

What exactly are you testing for?

Some non-small cell lung cancer patients are eligible for treatment with PD-1 and PD-L1 inhibitor immunotherapy drugs (Nivolumab, Pembrolizumab or Atezolizumab). One in four patients who receive immunotherapy respond well to the treatment and sometimes have a significantly longer survival rate. Even if the cancer has spread, they survive for a number of years with a relatively good quality of life. However, three in four patients treated do not benefit from the treatment. Worse still: they experience serious side effects that reduce their quality of life to below pre-treatment levels. We want to avoid this as much as possible.

That is why we want to be able to predict more accurately which patients will respond well to the treatment and which patients will not benefit from it. As part of this research, we are using mass spectrometry imaging to try to predict more accurately how each individual patient will respond to immunotherapy. This technique enables us to visualise proteins and their distribution directly from the tissue. We can then determine which proteins are present and which are absent in new lung cancer patients based on a biopsy or lung tumour tissue removed during surgery using mass spectrometry imaging. The results can then be used to identify those patients who will benefit from immunotherapy.

What volume of samples/data has already been collected?

We have currently collected around 10 test samples from different lung cancer patients, and have used this tissue to optimise our technique (mass spectrometry imaging). None of these patients had previously received immunotherapy. At the same time, we have also started to study lung tumour tissue from 30 lung cancer patients who had already received immunotherapy. This includes patients who responded well and those who did not respond well to the therapy.



More info eline.berghmans@vito.be



How does the cooperation between Antwerp University Hospital and VITO work?

We are able to contact both the Pathology Department (via co-promotor Prof. Dr. Pauwels) and Biobank to obtain tissue samples for this research. Antwerp University Hospital's Multidisciplinary Oncology Centre Antwerp (MOCA) provides us with the information we need about patients who have received immunotherapy and whether or not the patient responded positively to the treatment.



More info patrick.pauwels@uza.be



RESOURCITY BRINGS **CHEMISTRY** TO LIFE WITH A UNIQUE **APPROACH**

Have you always secretly wanted to be a goldminer? Want to capture carbon and combine it with oxygen? Now you can: in Antwerp, Mechelen, Mortsel, Mol or even Paris, Copenhagen or Oss in the Netherlands. With ResourCity, VITO has developed a unique app that lets you capture chemical elements in your neighbourhood and carry out fun and educational experiments on them. With the ResourCity app, VITO aims to raise young people's awareness of the importance of sustainable development while at the same time getting them involved in STEM (Science, Technology, Engineering & Mathematics).

VITO launched its ResourCity app at the SuperNova technology festival in Antwerp in September 2018. The app allows users to hunt

down numerous chemical elements that can be found in their city or neighbourhood. 'We were looking for a very tangible and accessible way to explain the circular economy, in which materials and natural resources are reused as often and as effectively as possible', explains VITO's Philip Marynissen. 'Our aim was to make young people aware of the need for a circular economy, as well as to demonstrate the initiatives already being carried out in this area in an urban context.'

Passing on complex knowledge

The development and launch of the app were a big success. Marynissen continues: 'By the end of SuperNova we had more than a thousand downloads and we were "trending" among the educational games in the app stores'. 'We also learned from the enthusiasm of students, teachers, tourist services and numerous parties within the STEM profession that ResourCity is a promising science



communication platform. A platform that effectively communicates complex chemistry and sustainability knowledge via attractive gameplay', according to Marynissen.

One year on, the positive response to the app has led to a focus on further development and dissemination. Marynissen: 'Further successful development and roll-out is dependent on a high degree of cooperation with the target group and with STEM stakeholders.' This cooperation is in full swing and has, amongst other things, inspired Technopolis to present ResourCity at a special conference for science centres in Copenhagen. The Royal Netherlands Chemical Society (KNCV) is also promoting ResourCity in the Netherlands. The international attention is attracting interest from cities around the world. Marynissen: 'However, our primary aim is to reach as many young people in Flanders as possible by converting other central cities into a genuine ResourCity.'

Further expansion as a learning tool

The fact that the United Nations has proclaimed 2019 the international year of chemistry to mark the 150th anniversary of the periodic table of chemical elements, has given ResourCity an additional boost. It also helps, of course, that sustainability is featuring higher and higher on cities' agendas. However, the growing number of high-quality STEM initiatives is playing the most important role in the further expansion of ResourCity as a learning tool. What started as an idea for the SuperNova tech festival has become a promising product with which VITO hopes to fulfil its enhanced science communication ambitions.



More info philip.marynissen@vito.be resourcity.vito.be

VITO EMPLOYEE IN THE SPOTLIGHT

Marianne Wens has been working in VITO's HR department since the early 2000's. She has seen first-hand how VITO's evolution as an organisation has affected the day-to-day operations of the HR department and the effect it has had on the recruitment of new employees. "In the last few years, for example, there have been many more market-focused and commercial profiles," says Wens. "Our international recruiting has also increased, and at the same time, we need data researchers, business developers, product developers and IT staff more than ever."

Many sectors, including high-tech industry, are not managing to fill their vacancies. Is that something you are also seeing here at VITO? Well, the stream of applications and CVs that flow into our office hasn't dried up yet. For research profiles in particular, we are very attractive as an employer, and in recent years our international recruiting has also been strong, which is essential when you are looking to recruit top experts. Currently, as an organisation we are fighting a 'war for talent' when it comes to IT profiles, primarily because VITO's reputation as an interesting (local) employer is not so strong for them yet.

VITO's HR policy has certainly undergone great change in the last two decades. What development really stands out to you, when you look back at your 18-year career here?

I see a significant shift in focus, from an administrative organisation to a more holistic approach in which

the employee takes centre stage and in which employee well-being, employee development and cultural values are important issues.

We have also followed the trend towards more data and more analysis. Our well-being project, FIT@VITO, allows us to keep our fingers on the pulse using comprehensive well-being surveys, for instance. We also carry out regular surveys to monitor how valued our employees perceive themselves to be. The results of these surveys always produce relevant insights for our HR policy and allow us to implement targeted measures.

In recent years, we have also found that it is important to ensure that the HR services bring managers and employees as close together as possible. In that regard, the HR Business Partners are an important link to the business units.

The 'VITO community' now consists of nearly a thousand people. What do you look for in applications? What do you think is important in a future employee? For one thing, it is important that people come to work here for the right reasons, which often prove to coincide with our core values (excellence, sustainability, innovation,



fair corporation and customer focus). Many of our colleagues want to give a little something back to society, though that doesn't mean we only recruit idealistic types - the social engagement can also be entirely realistic. And of course, we also place great emphasis on innovation, and innovation thrives on diversity. This is very much reflected in the composition of our teams. Finally, in recent years we have moved more towards a client-focused orientation – a 'sharper' client focus. All of these factors play a role with regard to applications. Finding a good match is important for all parties.

How does VITO keep its employees sharp and up to date in the fast-moving and innovative fields they work in?

In a knowledge organisation, development has to be a mindset. In the annual development and feedback meetings between managers and employees 'learning and development' is a point that is raised frequently, which is why we have a very wide range of training and coaching opportunities to help enhance competences. Technical training is often very specific, so our experts travel to specialised centres, both within Belgium and abroad.

More info marianne.wens@vito.be

VITO SUPPORTS INNOVATION AND ENTREPRENEURSHIP IN SUSTAINABLE CHEMISTRY



The port of Antwerp and the surrounding region is home to a world-class chemistry cluster. Naturally this ecosystem also encompasses knowledge institutions that supply technology and innovations, as well as businesses that valorise and bring new knowledge onto the market. Antwerp's new BlueChem incubator is designed to support researchers and companies as much as possible in the further development and deployment of sustainable chemistry. They can also rely on VITO's expertise.

The new incubator is set to open its doors in spring 2020 in the Blue Gate Antwerp business park, formerly Petroleum-Zuid, situated alongside the river Scheldt to the south of Antwerp city centre. Its aim is to provide accommodation for start-ups and growth companies and to support these businesses with specific services and specialist, tailored advice. One of the BlueChem partners is VITO, which is able to draw on its wide-ranging expertise in sustainable chemistry. 'BlueChem is becoming a real ecosystem for sustainable chemistry', Bruno Reyntjens of VITO tells us. 'Obviously we want to be part of this.' VITO has already reserved an office in the 3,400 m² building due for completion in spring 2020.

The plans for BlueChem have been in the pipeline for some time now. A lot of thought has therefore gone into the ambitious project, including a feasibility study in 2012. 'The study identified a clear need in Flanders for somewhere that start-ups and growth companies can receive targeted support in sustainable chemistry', says Frank Beckx, Managing Director of essenscia Flanders, the regional division of the Belgian Federation for the Chemistry and Life Sciences Industries, and Chairman of the Board of BlueChem. 'The port of Antwerp traditionally ranks among the best in the world in the chemical industry. Our production capacity is huge and we are a strong chemical region. But when it comes to research and valorising new knowledge in the form of innovative applications, we

can and must do better.' According to Beckx there is no shortage of toplevel chemistry research in Flanders. However, the resulting knowledge is not being fully exploited. He mentions Flemish biotechnology as an example. 'Many new biotech companies have emerged from incubators attached to universities and other research institutions. That is what we want to achieve with BlueChem.'

BlueChem can accommodate around twenty companies which have the option to rent office space, laboratories or other facilities. They will become part of an ecosystem that lives and breathes innovation and entrepreneurship, where tailored advice and support is always available, in all areas from ICT to financial, from legal to scientific and technical. This is where the strategic partners come in: companies such as BNP Paribas Fortis (financing of start-ups and scale-ups and financial expertise in sustainable business practices), Deloitte (strategic advice on business development), Laga (legal support) and Port of Antwerp (assistance with pilot projects and industrial scale-up).

The idea behind this rock-solid service provision is to make it easier for young businesses to carry out their chemistry-based activities. Beckx talks about 'making life easier' for companies. 'By providing them with continuous support, we allow them to focus as much as possible on their core business: sustainable chemistry innovation.'

BlueChem's priority is therefore innovation and entrepreneurship in sustainable chemistry. More specifically: the valorisation of waste and residual streams, the optimisation of industrial processes (fewer raw materials and less energy), the development of renewable chemicals (from raw materials other than oil, such as CO₂) and sustainable products. This ties in well with the activities of VITO, which has been carrying out research in these areas for many years. 'We are currently seeing the emergence of many sustainable chemistrybased start-ups and SMEs', says Reyntjens. 'These companies need infrastructure and an ecosystem.'

BlueChem's 'chemistry campus' will include three fully equipped laboratories, as well as twelve laboratories each featuring main services and basic equipment that tenants themselves can set up according to their own requirements. Each tenant will also receive an individual budget in the form of a start-up grant from the BlueChem Kickstart Fund. The BlueChem project is being supported by the European Regional Development Fund (ERDF), the Flemish government and the city of Antwerp. The incubator will also house regular private offices as well as the offices of VITO and Catalisti, the spearhead cluster for the chemical and plastics industries in Flanders. Finally, the complex will also offer a number of meeting rooms.

The aim is not for companies to set up their business in BlueChem on a permanent basis. According to Reyntjens: 'Ideally, successful businesses will start to scale up and relocate elsewhere, for instance to another Blue Gate business park. Or perhaps to one of Flanders' many living lab projects.' Daily management of the incubator





More info bruno.reyntjens@vito.be

will be done by Leentje Croes, who is joining the project from Catalisti. 'With BlueChem we want to offer more than just an office or lab', says Croes. 'It is far too often the case that promising young businesses struggle to valorise their research, or are even forced to close their doors due to a lack of funding. Thanks to the cooperation with our partners, BlueChem can also help them with this. What is more, Catalisti provides businesses with access to an even larger network that enables companies to find one another and exchange knowledge.'



TOXICITY TESTING OF ANTIMONY COMPOUNDS

Under the European REACH legislation, every chemical compound produced or used by industry must be tested to identify any potentially harmful effects on humans and the environment. Companies often join forces to this end in associations that focus on one specific chemical element. The association then hires a specialist laboratory to carry out tests on a list of chemicals. The association for the element antimony has approached VITO to conduct these tests.

Companies and industries from around the world have set up an association to focus on the element antimony: a heavy metal with the chemical symbol Sb. The association was established more than thirty years ago and has its headquarters in Brussels. 'We identify the risks on behalf of all antimony manufacturers, users and distributors', explains Caroline Braibant of the International Antimony Association. 'These risk assessments then enable our members to comply with legislation such as the European REACH chemicals regulation.'

Antimony was traditionally used in lead alloys to make them harder and more sustainable – for instance

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in lead letters for printing works, to prevent shrinkage as a result of cooling. These days, however, the heavy metal is mainly used in batteries, LED lighting, flame retardants, and even as a catalyst in the production of PET bottles.

Red tape

'In principle, companies are required to submit a separate file for each individual chemical compound to the ECHA, the European agency that coordinates REACH', states VITO's Kristof Tirez. This involves a whole load of red tape, so the industry works together on specific elements. The application for antimony includes around ten different compounds for which the International Antimony Association is responsible for dealing with the admin.'

Three years ago, the association hired VITO to carry out a study into the presence of antimony particles in the working environment and to develop a number of protocols for further qualitative research. 'One of the key reasons for approaching VITO was its expertise in biomedical toxicology and liquid chromatography, a technique that allows a very precise distinction between different compounds', Braibant explains.

Bioelution tests

The methods used to assess toxicity include bioelution tests. These tests examine how toxic, and therefore how hazardous, a metal can be when it is dissolved in a substance such as gastric acid. 'In the case of metals, toxicity often goes hand in hand with solubility', says Tirez. 'If you ingest the substance and it dissolves, it spreads throughout the body.' In cooperation with Hasselt-based chemical analysis company ECTX, VITO carried out leach tests on ten antimony compounds in a simulated gastric environment (characterised by a high level of acidity). The elution tests were conducted in Hasselt, while VITO was responsible for identifying and accurately determining the concentration of the various 'antimony groups'. As Tirez explains: 'antimony can bond with other elements in a number of ways. We distinguish two major bonding configurations: antimony III and antimony V. This distinction is important, because it can lead to a difference in toxicity, even at the same concentration.'

VITO uses a technique called liquid chromatography to identify the different compounds. This involves using miniscule columns to filter molecules from a mixture

based on their chemical and physical properties. A mass spectrometer then identifies the compounds found in the mixture and their concentration. 'As a routine laboratory, most of our assignments consist of solely analysing metals to measure the total content per element', says Tony Brouwers of ECTX. 'But recently there has been a growing demand for speciation analysis, which involves determining differences in toxicity depending on the bonding configuration. This requires additional, often very expensive equipment and special expertise. These types of analysis can only be carried out by specialist research centres like VITO.

Transformations between configurations

On the instructions of the International Antimony Association, VITO produced a detailed report on the solubility of various antimony compounds in a simulated gastric environment. During this process, Tirez and his colleagues also looked for potential transformations between bonding configurations. 'Do the antimony III compounds remain the same in an acid solution or do they become antimony V? These are important questions that need to be taken into account in the

ECHA application.'

What is the next step? Tirez: 'the antimony association will combine the results and proceed on the basis of a worst case scenario, in other words the compound with the highest solubility. This approach ensures efficiency and cost effectiveness, while reducing the need for experimental testing in animals. The research can then be used to help determine safety limits and threshold values for use in industry and distribution on the European commercial market.'

Tony Brouwers (ECTX) views the cooperation with VITO as a success, despite the fact that the companies were operating as two separate entities. 'We were responsible for the bioelution tests, while VITO carried out the sample analyses. It might not sound like the ideal working method on paper because it can get complicated if things go wrong. But since I had already got to know VITO's researchers, laboratories and set-up in recent years, I was confident that we could bring this big



project to a successful conclusion.'

With this research, VITO has further enhanced its reputation as a specialist technology partner, this time in the field of chemical and biomedical analysis. 'And it has done so by providing a niche service that is not available to the industry on the commercial market', says Tirez.



More info kristof.tirez@vito.be

CROPSAR GUARANTEES CONTINUOUS CROP MONITORING

Many satellite crop monitoring systems operate within the visible spectrum. This means that they are 'blind' in cloudy weather, resulting in large gaps in the observational data produced and making it difficult to monitor agricultural crops. With CropSAR, VITO has developed technology that monitors the status of agricultural fields, regardless of weather conditions.

For a number of years now, VITO has provided farmers with precisionagricultural technologies via online applications such as WatchITgrow and mapEO which better enable them to monitor their land and crops and thus increase their yields. The data behind the technology is delivered by remote sensing sensors on aircrafts, drones or satellites. The advantage of the latter is that they are constantly orbiting around the Earth and cover large areas of land surface. However, one disadvantage of satellite crop monitoring is that observations are frequently interrupted by cloud cover.

This the case, for example, with the Sentinel 2 satellites within Copernicus (the European Commission's earth observation programme). Each location on the Earth is observed at least once every five days by one of these satellites, producing large amounts of objective data on crop growth and productivity.

Farmers, authorities and insurers

'The problem is that a significant proportion of the land area is often hidden under cloud cover', according to VITO's Kristof Van Tricht. 'This is inconvenient, particularly in periods of rapid crop changes (for example during spring growth). As a result, farmers using WatchITgrow can miss key stages in the growth cycle of their crops.' The gaps in the data also create difficulties for other users such as authorities and insurers. 'If a heavy storm has just passed and it is still cloudy, it is impossible to determine how much damage crops have sustained.'



A Sentinel-1 multi-temporal speckle filtered image of April 2019 (left) and a Sentinel-2 image (right) of 13 April 2019 containing clouds obscuring the view © contains modified Copernicus Sentinel data 2019, produced by VITO Remote Sensing

Small gaps can be 'closed' by extrapolating the measurements and observations. However, this solution does not extend to larger gaps. That is why VITO introduced a new approach three years ago: combining visual observations with radar data generated by other satellites that also cover the Earth's entire surface (the Sentinel 1 satellites). Van Tricht: 'Radar waves pass diagonally through the clouds. A small part of the beam is reflected onto the ground, through both vegetation and soil, meaning that the signal can tell us something about the status of the agricultural crops. However, these reflected waves are not easy and straightforward to interpret.'

Deep learning

Nevertheless, this is precisely what VITO Remote Sensing has achieved thanks to hypermodern AI technology such as *deep learning*. 'We have a huge supply of images of cloud-free land area produced using both optical and radar waves', explains Van Tricht. 'We "fed" these into a deep neural network, an algorithm which then searches for patterns and links. Once the algorithm was trained, we applied it to the gaps in the visual observations caused by clouds.' This proved to be a success, as the algorithm was able to accurately close the gaps. The 'CropSAR' technology has been operational since spring 2019, also within WatchITgrow, the VITO Remote Sensing online information platform that provides farmers with a smooth and efficient agricultural plot monitoring solution. 'The new technology ensures continuous crop production monitoring, regardless of cloud cover', according to Van Tricht.



More info kristof.van.tricht@vito.be watchitgrow.be