

VISION

Vision on technology for a better world

ENERGY RENOVATION TOOL FOR POTENTIAL RENOVATORS

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ON A COMPLEX PROBLEM

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A **RAW MATERIAL** FOR
AROMATIC CHEMICALS?

BATTERY TECHNOLOGY
EXPLORES NEW APPLICATIONS

VITO/ENERGYVILLE HELPS KBC CUSTOMERS SAVE ENERGY



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Dear Reader,

A sustainable world won't be achieved at the drop of a hat. This transition will only succeed if all of society evolves in the same direction. And VITO is contributing to this by making the connection between research and market, between knowledge and business. Our unique position within the innovation landscape allows us to bring different partners together in sustainable research processes. This collaboration makes new technologies feasible and cost-effective. We reduce the innovation risk for companies, and strengthen the economic and social fabric in Flanders.

A topic that concerns us all is (un)healthy air. Unfortunately, air quality in Flanders seems to only ever make the news when there is a problem, i.e. if a warning threshold or limit is exceeded. In this edition of VITO VISION, we ignore the hype, and give a more nuanced interpretation of the complex interplay between particulate matter, soot, ozone, sulphur dioxide and nitrogen dioxide, and their influence on human health.

VITO brings partners together in many projects. Citizens, for example, can help perform air quality measurements in "Help Measure Mechelen". VITO/EnergyVille also makes its EBECs tool available to KBC customers who want to make their homes more energy efficient. The NuReDrain sludge granules are helping water company De Watergroep remove phosphates from our drinking water. And Remote Sensing images can make agriculture more efficient.

Together we are evolving towards a sustainable society.

I hope you enjoy this edition of VITO VISION,

Dirk Fransaer
Managing Director VITO



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COVER STORY

There are many ways to make a house more energy efficient: insulate better, install a heat pump ... The EBECs algorithms of VITO/EnergyVille provide specific advice based on the size of the house and the energy consumption of the residents. Bank-insurer KBC, Cozie's installation contractors and the energy auditors of Zero emission solutions (ZES) and Janssen Field Services (JFS) are among those already using this service.

EBECs stands for EnergyVille Building Energy Calculation Service. The tool bundles various calculation algorithms and offers tailor-made advice for renovating homes. Pieter Van den Steen, researcher at VITO/EnergyVille: "EBECs is not the first energy renovation tool on the market, but it is the most accurate. This is due to its basis in building physics and its built-in calibration module. The traditional calculations that take place for EPB or EPC certification only assess the home. They do not take into account actual energy consumption, family composition and resident behaviour. With the EBECs tool, people can enter specific data about their home and their usage habits. Based on this, the algorithms calculate the best options for saving energy, including the associated costs and anticipated decrease in the energy bill."

Lowering the threshold

In addition to its accuracy, the EBECs tool is distinguished by its ease of use. For example, people do not need to measure their homes themselves: entering the address is sufficient to determine the dimensions. "For this data, we use the Digital Flanders II High Altitude Model of Information Flanders," says Wouter Dierckx of VITO. "We calculate the volume of the dwelling, the roof surface area, the ground surface area and the facades. In this way our advice can also estimate the costs of a renovation. Pieter Van den Steen continues: "Over time, we also want to give users the opportunity to automatically forward their energy consumption data. This can be done, for example, with a smart thermostat. In doing so they can regularly obtain new advice, taking into account their specific family situation, their actual use and the most up-to-date investment costs and subsidies. We will continue to adapt the system to evolutions in the market."

Commercial partners

VITO developed the EBECs tool and is now allowing partners to market the service. KBC, among others, offers advice in its digital application Touch. "EBECs consists of a set of algorithms on which providers themselves can build an application," says Pieter Van den Steen. "KBC customers, for example, can choose from four packages. Do they especially want lower CO₂ emissions or a short payback period? Do they opt for a minimal ecological footprint or maximum energy renovation? Based on these preferences, the tool offers the best options. KBC also simulates possible financing tailored to the customer. We hope to reach a lot of candidate renovators with EBECs, because there is still work to be done to meet the 2030 climate targets."

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Pieter Van den Steen (VITO) and Karin Van Hoecke (KBC)

KBC: "EXTRA SERVICE FOR POTENTIAL RENOVATORS"

Energy renovations are beneficial to the environment and lower the resident's energy bills. KBC wants to help potential renovators with tailor-made advice. For this, the bank-insurer called upon VITO/EnergyVille. "Eight out of ten families contemplating an energy renovation complain about a lack of independent advice. We want to address this problem with VITO's EBECs tool," says Karin Van Hoecke, director of services to private individuals. "We also offer – without any obligation – various possibilities for financing a renovation." KBC is offering the tool free of charge until the end of August 2018. After this period, a fee of 40 euros will be charged.



AIR QUALITY

A CLEAR PERSPECTIVE ON A COMPLEX PROBLEM

Healthy air is a top concern for most Flemish citizens. And rightly so. Yet, current media interest often does injustice to the great complexity inherent in this problem. So for a clear perspective, we highlight five elements that are not sufficiently present in the debate.



Don't alarm. Inform!

The quality of the air in which we live and which we continuously breathe is constantly evolving. Yet the issue of air quality almost only seems to ever make the news when something happens, i.e. when maximum limits or warning thresholds are exceeded. This – quite simply – is how the news cycle works.

However, the average annual concentrations of various pollutants (ozone is a special case) have fallen considerably over the past decades. Thus broadly speaking, air quality has improved in the Flemish Region. Yet this rarely shows up in the news. Remarkable finding: the number of healthy years of life lost through exposure to particulate matter (expressed per population) fell by a factor of one and a half in the period 2005-2016. This too we hardly hear, see or read about.

Could it be that a more nuanced interpretation of the full impact of the interaction of particulate matter, soot, ozone, sulphur and nitrogen dioxide on human health is too complex, and therefore not flashy enough?

Why is it that attention to air quality has increased so much in recent years? There are several explanations for this. Since the beginning of the nineties, for example, diverse standards and targets have been

developed (for Flanders, for Europe ...), and these standards naturally generate attention when they are exceeded. In addition, scientists have gained many new insights, for example into the impact of different pollutants on human health. In VITO's extensive 3xG study, a link was recently established between exposure to particulate matter and numerous medical (risk) factors such as increased (repairable) DNA damage, inflammation of the airways, allergic reactions such as asthma and rhinitis, and stress for pregnant women.

Due to technological progress and the pressure of public opinion, today measurements are made much more thoroughly, accurately and – especially – more detailed. This results in maps and models with a higher information density that reveal local differences. VITO for example recently launched the new ATMO Street Model that shows air pollution down to the level of individual streets. This more accurate knowledge of local concentrations and exposure allows the impact on health to be better mapped. However, finding the direct health effects of each individual pollutant remains a major challenge.

Citizen science par excellence

Science and technology are often a remote concern. This, however, is not the case with respect to research into air quality and the corresponding

corrective measures. Since this concerns one's own living environment, citizens are prepared to gather information themselves. This is citizen science *par excellence*. The fact that the issue of air quality could become a dream test case for citizen science is the result of various developments.

One of these developments is the high information density of the pollution modelling maps containing measurement data. Because the model maps are more detailed, and therefore more local, individuals obtain a reliable picture of the air quality in their immediate surroundings, near their children's school, or along their daily commute.

Plus, cheaper and more convenient measuring devices and apps have been introduced in recent years that allow individuals to do the work themselves. At VITO, for example, the airQmap platform was developed that allows volunteers to contribute to air quality measurement at street level themselves. However, caution is required here: not all devices available on the market provide equally high-quality data.

Reliable equipment and information are a powerful lever for motivating

individuals: to participate in large-scale projects or to demand from government an effective policy to improve air quality. The citizen science project *Curieuzeneuzen* ["curious noses"] – supported by governments, private partners and the academic world – is a first if only due to its scope. Because of its high ambition, *Curieuzeneuzen* makes it clear that citizen science entails both a great opportunity and a challenge. Thanks to the free deployment of twenty thousand volunteers, an enormous amount of fine-grained data can be generated: something that scientists in other research projects normally can only dream of. On the other hand, this pile of measurement data of course must also be validated, processed and communicated according to best (scientific) practices. Only then does the participation of citizens make sense, and can we speak of citizen science *par excellence*.

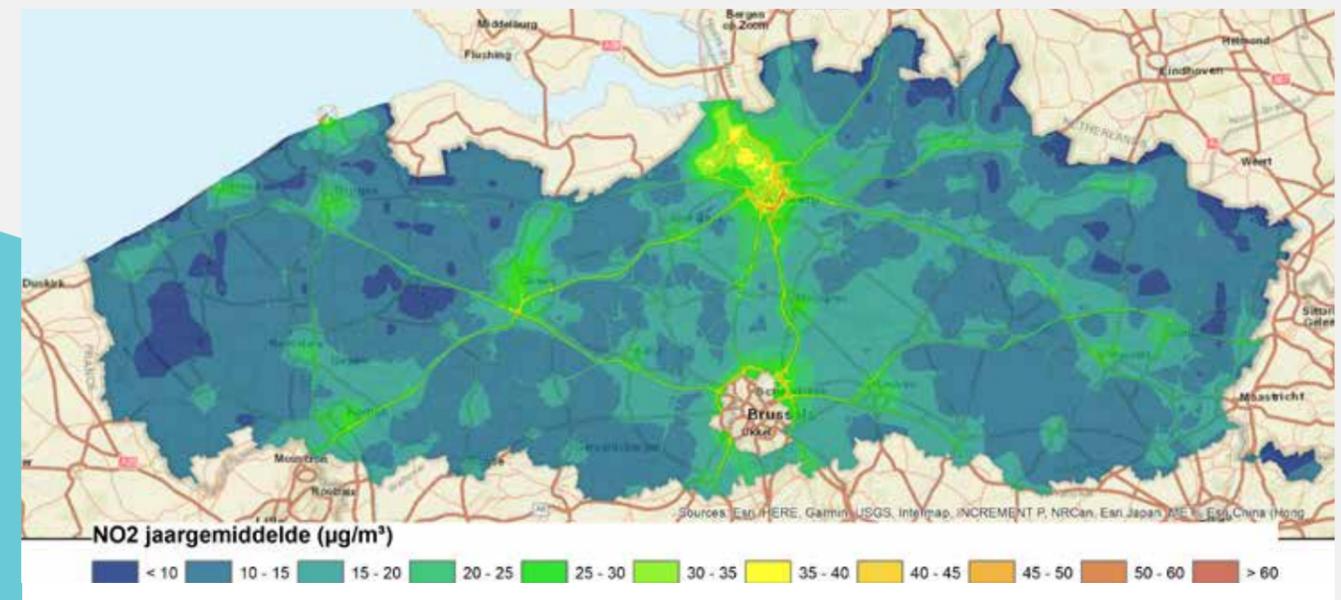
For that matter, it's nice to note that the research into air quality through citizen science also immediately puts the spotlight on the importance of science and technology in tackling social problems. This will inspire young people to choose a STEM (science, technology, engineering,

mathematics) course of studies, since the social relevance of STEM is so strongly emphasised.

Who are the polluters?

In the case of air pollution, the question 'Who or what is the source?' cannot be answered unambiguously. Point sources such as the chimneys of companies and houses, and the exhausts of vehicles are known, as are the emissions of ammonia by the cattle breeding industry. But the atmosphere is of course a dynamic whole. The spread of pollutants depends heavily on the weather, with political boundaries playing no role. In addition, chemical reactions take place in the atmosphere that can form or remove pollutants.

When looking for the source of air pollution, we would do well to make a distinction between the different pollutants. It then becomes apparent that there is no clear link between general air quality and the individual types of sources. In the case of sulphur dioxide (SO₂), for example, the emissions come mainly from heavy industry in the Antwerp and Ghent ports, and from some isolated industrial sites in the Kempen region of Limburg.



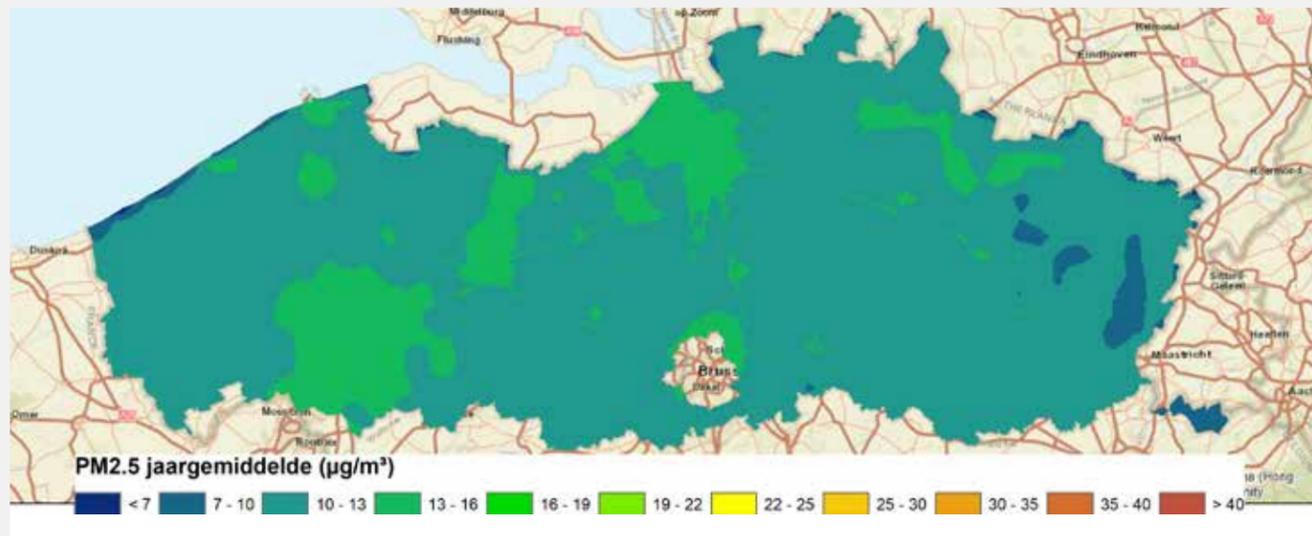
The annual averages of NO₂ in Flanders (2016).

The map with the concentrations of nitrogen dioxide (NO₂) immediately gives a completely different picture. In addition to the expected industrial hotspots, the urban agglomerations in Antwerp, Ghent and (the northern edge of) Brussels are particularly noteworthy. Moreover, most major cities are also exhibiting increased concentrations, as are the motorways and even the smaller traffic arteries.

According to the latest insights, the European standards for NO₂ would even be exceeded in street canyons in small and medium-sized municipalities. Need it also be said that road traffic is responsible for much of the nitrogen oxide emissions, and then mainly diesel engines?

The concentrations of ammonia (NH₃) again give a completely different

picture. The vast majority of these emissions come from the cattle breeding industry, more specifically from animal manure and fertilisers. It is not without reason that there are hotspots in West Flanders and in the north of the provinces of Antwerp and Limburg, regions that are known for intensive livestock farming.



The annual averages of PM_{2.5} in Flanders (2016).

In the case of particulate matter (PM₁₀, PM_{2.5}, soot, and ultrafine particles), the link with the sources is much less clear. Roughly speaking, we can state that the heating of buildings (including wood stoves) is the largest direct source of particulate matter in Flanders. In addition, industry, traffic, agriculture and horticulture also play a significant role.

The distinction between primary and secondary particulate matter is

important. Particulate matter can be blown directly into the air: think of soot particles from diesel engines, or PM₁₀ from wood stoves or from the wear and tear of roads and vehicles. But they can also be formed secondarily from atmospheric gases.

Due to the wide range of source types, the concentration of particulate matter in Flanders is generally more uniformly distributed than other pollutants. But here too the annual averages are

somewhat higher in the Antwerp and Ghent port areas and the densely populated regions of Flanders – with peaks with low concentrations near the coast and in Limburg.

There are two things to note about this. First, much of the particulate matter in Flanders comes from abroad. According to some estimates, three-quarters of the total quantity of particulate matter in Flemish air is imported – to which of

course it should be added that Flanders also exports particulate matter. Second, the different types of particulate matter may have a different impact on health. Yet, the standards are determined on the basis of the total mass of the particulate matter mix. For some years, the European limit values for particulate matter have not been exceeded in Flanders. However, if we compare the results against the WHO health standard (10 µg/m³ for PM_{2.5}) then large parts of Flanders do not comply and it is clear that further measures are needed.

This once again shows the different levels at which the problem of air pollution plays out: from local to regional and even to global. And therefore at which of the different policy levels measures can be taken to improve air quality.

Air and climate: Two sides of the same coin

An ideal environmental policy includes measures that are conducive to air quality (everywhere) and to the fight against global warming. After all, the presence of a link between the climate and air quality should not come as a surprise. However, this link is complex. Thus, sulphur dioxide is known to reflect sunlight, which causes the gas to have a cooling effect, but at the same time it can cause serious environmental and health damage: think of acid rain and toxic sulphur vapours respectively.

The removal of diesel vehicles from the fleet since “dieselgate” is having a favourable impact on local air quality due to reduced emissions of NO_x and black carbon (BC). The latter is regarded as one of the most harmful components of particulate matter.

Thus reducing BC also benefits the climate: BC after all is an important greenhouse gas component. A clear win-win for air and climate. However, promotion of this elimination of diesel (at least in the short term) is resulting in a shift to petrol cars. Due to their increased CO₂ emissions, we note here a negative impact on the climate. Total replacement of all diesel passenger cars with petrol variants would result in a halving of the NO_x and BC emissions in Flanders, but CO₂ emissions would increase by 10%. This is the paradox that presents itself for policy, but also for the individual citizen who wants to buy a new car now.

Electric cars are currently in pole position to reduce emissions from road traffic. But here too the problem of air quality does not automatically disappear. An electric car is on average heavier than a petrol or diesel car, as a result of which the emission of particulate matter via the tyres will be relatively higher. Against this of course is the fact that the electric car has no exhaust emissions. And even if it does not run 100% on renewable electricity, it is better for the air quality that the NO_x and soot are emitted by a single controllable power plant than diffused through the exhaust of many cars.



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Ozone: A particular matter

Ozone is a strange phenomenon. It is not emitted directly and is only formed in the atmosphere, especially on warm, sunny days. Ozone concentrations often peak at locations where the concentration of other pollutants is lower. Ozone after all is formed from chemical precursors such as nitrogen dioxide and volatile organic compounds, but at high concentrations of nitric oxide – close to (traffic) sources – ozone is also partly broken down.

RELIABLE DATA FOR BETTER AIR QUALITY AND MORE CLIMATE-ROBUST CITIES

Climate change affects cities more than the countryside. Large paved surfaces reinforce heat waves and increase the risk of flooding. The air quality in Flanders also remains a challenge. VITO aims with various projects to contribute to healthier air and more climate-robust cities.



"HELP MEASURE MECHELEN": INVOLVING CITIZENS IN ENVIRONMENTAL RESEARCH

A good environmental policy stands or falls by the reliability of its data. In Mechelen, VITO and the city government are calling upon volunteers to map air quality.

"Help Measure Mechelen" is part of the European research project Ground Truth 2.0. Six countries are collaborating on a case in which researchers work together with citizens and policymakers on various environmental issues. In Flanders, Mechelen is a pilot city. The chosen themes are air quality and noise.

Volunteers measure air quality
"The goal of Help Measure Mechelen is to help citizens and governments together discover how they can improve their living environment. VITO supports them in this," says researcher Stijn Vranckx. "The first step is collecting data. In October 2017 and March 2018, Mechelen conducted air quality measurements, for which VITO provided four air quality sensors. Every morning and evening, four individuals cycled along an agreed route

to measure air quality. The campaign will be repeated this summer. This series of measurements allows us to determine how air quality varies in the city. VITO processes the raw data into practical information. Measuring campaigns for noise have also been ongoing since May 2018."

Formulating policy together

The partners are now examining how they can use the information collected. Stijn Vranckx: "The initial results were presented at a discussion evening in Mechelen. People were able to ask questions of the VITO experts, the bicycle volunteers and the city official responsible for the environment. Together we examine the direction we wish to proceed. The city of course sets certain environmental goals. Via this project, residents and citizens' groups can contribute to shaping policy. The combination of researchers, policymakers and citizens leads to constructive discussions."

For other cities too

The procedure for the study was

established in the airQmap platform, which VITO is also providing to other cities. This platform allows for reliable air quality measurements at a limited cost price. Mechelen is certainly satisfied, says city official responsible for the environment Marina De Bie. "The city of Mechelen attaches great importance to good air quality. We are building new parks, restricting access to cars in the inner city, focusing on bicycles and car sharing ... In order to test the impact of our policy, we need air quality data. Via Help Measure Mechelen, we are able to involve residents in this policy. The more we cycle and measure, the more useful and reliable our data become."



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CLIMATE-FIT.CITY: CLIMATE INFO AT CITY LEVEL

More and more cities are fighting the consequences of climate change. VITO has developed a unique calculation model that offers climate information at city level and thus identifies future bottlenecks of heat stress.

Climate-Fit.City is part of the Horizon 2020 research programme. The project offers services supporting environmental experts and policymakers in their approach to climate change. "VITO models urban climates in high resolution, so that vulnerable areas become visible," says business developer Filip Lefebvre. "Using an urban climate model that uses satellite images, we draw up a basic plan: where are buildings, squares, businesses, trees, streams located? We combine this information with large-scale climatological data: how hot is it, how damp is it, how much wind is present? From this combination, we obtain small-scale climate information at high resolution. This allows us to detect the hotspots in a city. If necessary, we can even work at a resolution

of 1 metre: we then use a 3D model of the buildings in a city. This approach is unique in the world."

Climate-oriented planning

VITO also wants to offer its expertise to cities abroad. Getting a foot in the door, however, is not easy. Which is why project staff call on international partners who offer complementary services. Filip Lefebvre: "We currently focus our services on six sectors: health, urban planning, emergency planning, building energy, active mobility and cultural heritage. Our partner for 'health' links our climate information to figures on hospital admissions, for example: do cities need to invest in extra hospital capacity to deal with the effects of heat waves? Within 'active mobility', we find out which climate influences motivate people to walk and cycle more often. These are, for example, walking and cycling routes where it is not too hot and which are sheltered from the wind. Cities want to become more climate-robust. For this, they need data now about the climate of tomorrow."

Putting the model on the market

Climate-Fit.City runs from June 2017 to November 2019. In a first phase, the researchers set up six demonstration projects. "Now we are looking for new cities and partners that show interest," says Filip Lefebvre. "By the end of this project, we want to make our services commercially viable."



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Help Measure Mechelen and Climate-Fit.City are part of Ground Truth 2.0 (Grant Agreement No. 689744) and PUCS (Grant Agreement No. 73004), projects financed by the European research and innovation programme Horizon 2020.

The services that VITO offers to cities abroad focus on six sectors: active mobility, building energy, cultural heritage, emergency planning, health and city planning.



"SLUDGE CAN REMOVE UNWANTED PHOSPHATES FROM OUR WATER"

NEW ROLE FOR RESIDUAL FLOWS FROM WATER PURIFICATION

A great deal of sludge is released during the production of drinking water. Until recently, this ended up at the waste disposal site. The Interreg project NuReDrain aims to change that: "We convert the sludge into adsorbing granules that extract phosphates from our surface water."

In 2014, VITO and drinking water provider De Watergroep launched the OperAqua project. The goal: identify uses for sludge from water treatment plants. Various possibilities were tested in the lab. One option jumped out: the conversion of sludge into filter granules that can remove phosphates and other substances from surface water.

Useful granules

"OperAqua was a forerunner to the current NuReDrain project," say VITO researchers Jef Bergmans and Bart Michiels. "The technological focus has remained the same: convert a residual flow – sludge – into an economically useful material. The sludge takes the form of filter granules that can extract unwanted substances from surface water. In practice, this is done by grinding sludge into granules. When the granules are dry, they are treated thermally. In doing so, we seek a balance between stability and removal capacity. The granules may not disintegrate in water, or be so hard that they lose their adsorbing effect."

The name NuReDrain (Nutrients Removal and Recovery from Drainage Water) refers to the drainage water of farms, which often contain many phosphates. We are able to remove these phosphates with our granules."

Pilot installation

If the test results are positive, the granules will initially be used mainly by De Watergroep. The water company collects surface water in large reservoirs to produce drinking water. If the water contains too much phosphate, it leads to algae growth. Jef Bergmans: "Algae extract a lot of oxygen from the water and disrupt the water treatment process. With the NuReDrain granules, we can pre-treat river or canal water. Since the beginning of April 2018, we have been testing the principle in a pilot installation at De Blankaart water production centre. Some eighty kilos of granules remove the phosphate from the water. When the adsorbing granules are 'full', we replace them with new ones. This year we want to thoroughly test our materials in realistic conditions."

Circular economy

Over time, NuReDrain hopes to integrate the filter granules into a circular process. The researchers are examining whether it is possible to separate 'trapped' phosphates from the granules. This would allow the phosphate to be used again in agriculture. Ideally, this would happen without damaging the granules, so that the filter material could also be reused. "In addition, we

are also exploring new applications," says Jef Bergmans. "For example, the filter granules can also be used to remove arsenic or other metals from water. And the production process also works with sludge of a different origin. The technology offers many possibilities, which we hope to show with our demonstration projects."

Large market

The basic technology for the filter granules came about in the context of OperAqua. The process is being further refined within NuReDrain. The emphasis is now on practical possibilities. Bart Michiels: "On the one hand, we are looking for ways to produce our granules cost-efficiently and on a large scale. We want to increase production from a few kilos to one hundred to five hundred kilos. In addition, we are also further examining what the market for granules might be. The filter granules offer a lot of potential in agriculture and horticulture. Think of greenhouse farms that collect and purify all their spray water. VITO/Vlakwa is coordinating the NuReDrain project, consulting with potential partners and promoting filter technology to agricultural organisations and policymakers. In the near future, we plan, among other things, case studies in greenhouses and agricultural fields." NuReDrain is financed by the Interreg North Sea Region Programme and by the provinces of Antwerp and West Flanders. The project will run through the end of 2019.

DE WATERGROEP: "PREVENTING ALGAE GROWTH IN RESERVOIRS"

De Watergroep purifies surface water into drinking water at the De Blankaart water production centre in Diksmuide. The NuReDrain research project, of which VITO is also a part, can facilitate this process, says process engineer Rika Jenné.

"At De Blankaart, water comes from the Yser, among other places. The centre contains a large reservoir that allows us to produce drinking water year round. If the water in the reservoir contains too much phosphate, we have problems with algae growth, which makes the production of drinking water more difficult. We then have to add more chemicals and our filters get clogged."

Testing yield

"With the filter granules from the NuReDrain project, we want to extract phosphate from the surface water before it ends up in our reservoir. Because it concerns large flows – we collect some 4 000 cubic metres of water per day – we built a small pilot set-up for NuReDrain. This enables us to test whether we can achieve a good yield for phosphate removal. We are also determining the practical requirements for a filter installation. In the long term, this technology offers many opportunities for the circular economy."



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BASED ON SATELLITE IMAGES

REMOTE SENSING MAKES AGRICULTURE MORE EFFICIENT



© Landscape images - Guido Sweron for Toerisme Voerstreek vzw

Late frost, a dry spring, acidic soil ... Many factors can interrupt agricultural processes. Remote sensing supports traditional agricultural information with data from satellite images, providing more insight into the agricultural system.

Remote sensing is a technique for collecting data through observation from a distance. VITO uses satellite and other sensor images in research projects for various sectors. "The latest generation of satellites delivers very detailed images," says Anne Gobin of VITO. "The Sentinel satellites of the European earth observation programme Copernicus provide us with global data on a daily basis. For more flexibility and higher resolution, we use drone images. We process all of this data into useful information with which we offer various services."

Smart farming

Remote sensing is used, among other things, to study agricultural processes and make them more efficient. Anne Gobin: "Smart farming combines classic agricultural information, such as soil and growth data, with sensor measurements and satellite images. This allows us to monitor crop development during the growing season."

From these data we can, for example, determine whether the crop is growing optimally and whether its management can be fine-tuned. This is valuable information for a farmer."

Remote sensing is also used to make crops more resilient to climate change. The 'greenness index' of a plot is determined based on satellite images: does it match the expected situation? Climate risks such as a period of drought or flooding can lead to crops falling behind.

"In addition, we also use remote sensing to protect the landscape," says Anne Gobin. "With satellite imagery, for example, we can monitor whether the function of fields changes, or retain valuable elements such as tree rows and hedges. Using this information, policymakers can take targeted measures."

Expanding services

As the quality of the satellite images continues to increase, remote sensing is being applied on an ever larger scale. The technology fits perfectly into the big data story, which links together as much data as possible. VITO wants to expand its services in the coming years.

"On the one hand, more and more commercial applications are emerging from our research. Think of the growing number of companies that offer agricultural monitoring. They often rely on drones, but a synergy with satellite images is certainly possible," says Anne Gobin. "On the other hand, there are also opportunities to enter into public-private partnerships. Satellite images can contribute a lot to policy support research. Even if this remains something for the future: we first have to carefully examine the data processing chain so that we don't make promises we can't meet. When you are able to link statistics and data to satellite images, this does not always mean that you can sketch a coherent story. But the input of a spatial component often gives added value."



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IN PRACTICE

In Voeren, a picturesque municipality near Tongeren, VITO uses remote sensing to protect the landscape.

Voeren is proud of its unique hedgerow landscape. The region attracts thousands of visitors each year who walk among the fields and rows of trees. But bushes, hedges and solitary trees are increasingly being cut down to create larger and easily workable fields. Historic grasslands have to make way for highly productive grasslands for cattle breeding.

Farmer as landscape manager

"More than 70 percent of the land in Voeren is managed by farmers. The agricultural sector thus plays a crucial role in protecting the landscape and nature," says Anne Gobin of VITO. "Remote sensing allows us to monitor how the landscape is evolving and what its characteristics are. How big are the plots, where are trees or hedges? You will see much more on orthophotos and satellite image time series than if you were to directly look on site. The information is used to devise new strategies for landscape management, in collaboration with farmers."

Advice for stronger agriculture

Remote sensing can also strengthen agriculture itself. Anne Gobin: "Monitoring crops via satellite images shows how productive they are. We measure the growth characteristics and add other data such as soil information or the way in which the farmer manages the plot. By regularly comparing satellite images with each other, we gain more insight into the plot. We can also measure differences between the plots, and can formulate recommendations based on these data. This makes agriculture stronger and more resilient."

PILOT FACTORY PUTS NEW TECHNIQUES FROM THE LAB INTO PRACTICE

WILL WOODY BIOMASS BECOME A RAW MATERIAL FOR AROMATIC CHEMICALS?

While the European chemical industry may be growing, it is losing global market share. This is due to strong growth in emerging countries and a loss of competitiveness. To reverse this trend, the sector wants to bring new, innovative products and processes to the market. The choice of alternative raw materials and greater raw material flexibility can give European chemistry a second wind. In this context, VITO is developing a pilot factory to test technologies that convert wood and lignin into usable aromatics.

40 percent of the chemicals in Europe are aromatic. Aromatics are present in petroleum, but also in lignin, a substance that occurs naturally in most types of biomass. "The chemical industry in Europe uses 47 million tonnes of carbon from fossil fuels each year. The biomass potential of European forests is about 100,000 million tonnes of carbon per year. This offers opportunities," says VITO researcher Kelly Servaes. "Moreover, the production process from biomass to aromatics has room for improvement. Currently, biomass flows are completely broken down into syngas (*synthesis gas composed of carbon monoxide and hydrogen, ed.*). With this, for example, methanol is

made. In nature, we often see that compound molecules already have interesting functionalities. It is more efficient to break down biomass into chemically usable building blocks and to use these directly. We can extract essential oils from algae for the cosmetic industry. And we extract lignin from wood."

Larger test quantities needed
Biomass with lignocellulose, such as wood, straw and grass, emerged from various studies as the best choice for the production of bioaromatics. Much progress has been made in this area in recent years. In the context of regional and European projects, VITO is studying various processes that convert wood and lignin into a complex mixture of bioaromatics. This mixture is further purified to usable aromatic fractions of monomers, dimers and oligomers. Finished products include for example phenolic resins, epoxy resins and high-grade antioxidants for the cosmetic or pharmaceutical sector.

"The applicability of most technologies has already been demonstrated in the lab. But the amounts of bioaromatics generated in this way – from a few grams to a few kilos – are expensive and often too small for thorough application testing. As a result, companies are

losing interest and development is lagging. When we make a bioaromatic, we have to know if it is usable. Which is why VITO, together with the Flemish Environmental Holding (VMH), is developing a demo production line of a usable size to produce bioaromatics from wood or lignin," says Kelly Servaes. "The first step is to set up a pilot factory so that we can demonstrate existing conversion technologies on a relevant scale. We also offer companies the opportunity to take further steps in their own development process, and illustrate the technical-economic feasibility of a demo factory. In this project, VITO is acting as an enabler that can close the gap between universities and industry."

Extra investments

For development of the pilot factory, a project was submitted to the European Regional Development Fund (ERDF), the Flemish

Department of Economy, Science and Innovation, and the Province of Antwerp. VITO itself will invest around two million euros. "The design and construction of the pilot factory is occurring in collaboration with Jacobs België NV. The project is also actively supported by Catalisti, the Flemish spearhead cluster for chemistry and plastics," says Kelly Servaes. "Several companies have already expressed interest in the pilot factory by signing a letter of intent. New industrial parties that want to follow the project up close are still welcome."

In order to successfully demonstrate the lignin-to-aromatics value chain, a depolymerisation reactor alone is insufficient. In the longer term, additional investments are needed in equipment for the pretreatment of biomass (wood/lignin) and purification/fractionation of lignin-based bioaromatics. Which is why VITO is already seeking additional

financing through national, inter-regional and European investment channels. "The project is part of the BIORIZON collaboration, in which VITO, the Netherlands Organisation for Applied Scientific Research (TNO) and the Energy Research Center of the Netherlands (ECN) are looking at how they can convert lignin and sugars into bioaromatics," adds Kelly Servaes. "The totality is a good example of open innovation."



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"LIGNIN HAS POTENTIAL AS A SUSTAINABLE RAW MATERIAL"

Many companies are expressing interest in sustainable raw materials to produce aromatics. The Italian R&D company AEP Polymers, which develops chemicals from bio-based fuels, has been collaborating with VITO for several years on the use of lignin.

Andrea Minigher, Director of Business Development at AEP: "Since 2015, VITO and AEP have been partners in the SmartLi project (Smart Technologies for the Conversion of Industrial Lignins into Sustainable Materials). VITO is focusing on membrane technologies for the pre-treatment of lignin-rich flows. AEP is assessing whether the quality of lignin can affect important properties of epoxy and polyurethane formulas, such as adhesion or flammability. For AEP, lignin certainly has potential as a sustainable raw material. The new pilot factory being developed by VITO appears to be promising for future projects."



IS YOUR HOME HEALTHY?

SENSORBOX MEASURES AIR QUALITY INSIDE THE HOUSE

Air quality meters for houses have been on the market for some time. But many devices are unreliable or offer limited possibilities. At the request of the Environment Department, VITO is developing a Sensorbox that collects and processes large amounts of data. The results are reliable and show the influence of residents' behaviour on air quality.

Air quality in homes is just as important as the quality of our outdoor air; in fact, the 'indoor air' is even more susceptible to contamination. Harmful substances can accumulate between our walls. Because we spend on average ninety percent of our time indoors, attention to indoor air quality is a must.

"In homes with little ventilation, the behaviour of residents plays a greater role," says Borislav Lazarov, researcher at VITO. "Drying clothes in the living room increases the humidity. Builders sometimes insulate inner walls with materials that are actually intended for insulation of outside walls. If these contain flame retardants, harmful fumes are released. In new homes we

sometimes see residents turning off the automatic ventilation system because they find it too noisy. With our new Sensorbox we want to examine how the behaviour of residents influences air quality."

Combining data

A Sensorbox contains various sensors to measure substances in the indoor air. The data are transmitted to a central server at VITO. There they are supplemented with characteristics that the residents provide concerning their home and activities. The unique aspect about this project is the in-depth data processing that VITO carries out. Borislav Lazarov: "In the analysis, we take into account the influence that different parameters exert on each other. Sensors for gaseous substances can incorrectly indicate a change in a concentration when the humidity rises. Thanks to our expertise, we are able to deal with all these influences." The data processing always remains within the limits of the GDPR privacy legislation. A limited selection of data is immediately visible on the Sensorbox screen. A blue, green, orange or red lamp on the Sensorbox clearly

indicates the air quality. The system also contains an alarm for carbon monoxide.

Network of sensors

In the longer term, the wide-ranging data processing is particularly important. If a Sensorbox is placed in hundreds of homes, patterns can become clear. "This can provide interesting information for policy-makers," says Borislav Lazarov. "How much ventilation does a house need? And does it have to work automatically? Which behaviour can lead to moisture problems? A Sensorbox identifies the behaviour of residents and can give tips for proper ventilation."

The current boxes are owned by the Environment Department, which is financing the research. After the study, it will be decided whether the project will be followed up. "The three demo boxes must show that the concept works," concludes Lazarov. "The ultimate goal is to develop an extensive Belgian sensor network."

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VITO RESEARCHER IN THE SPOTLIGHT

Vera Meynen works as a materials researcher for the University of Antwerp. She is also connected to VITO through a strategic collaboration: "You can achieve much more by combining expertise."

Your expertise lies in materials research. What exactly does this mean?

I specialise in the surface modification of different materials. Together with VITO, I work on projects concerning membranes, catalysts and waste upcycling. Our first collaboration revolved around membrane functionalisation: we made hybrid membranes with organic and inorganic fractions to filter solvents. This technology has become true platform technology in the meantime. We also use it, for example, for its antifouling properties in water filtration.

How did you as a University of Antwerp researcher end up at VITO?

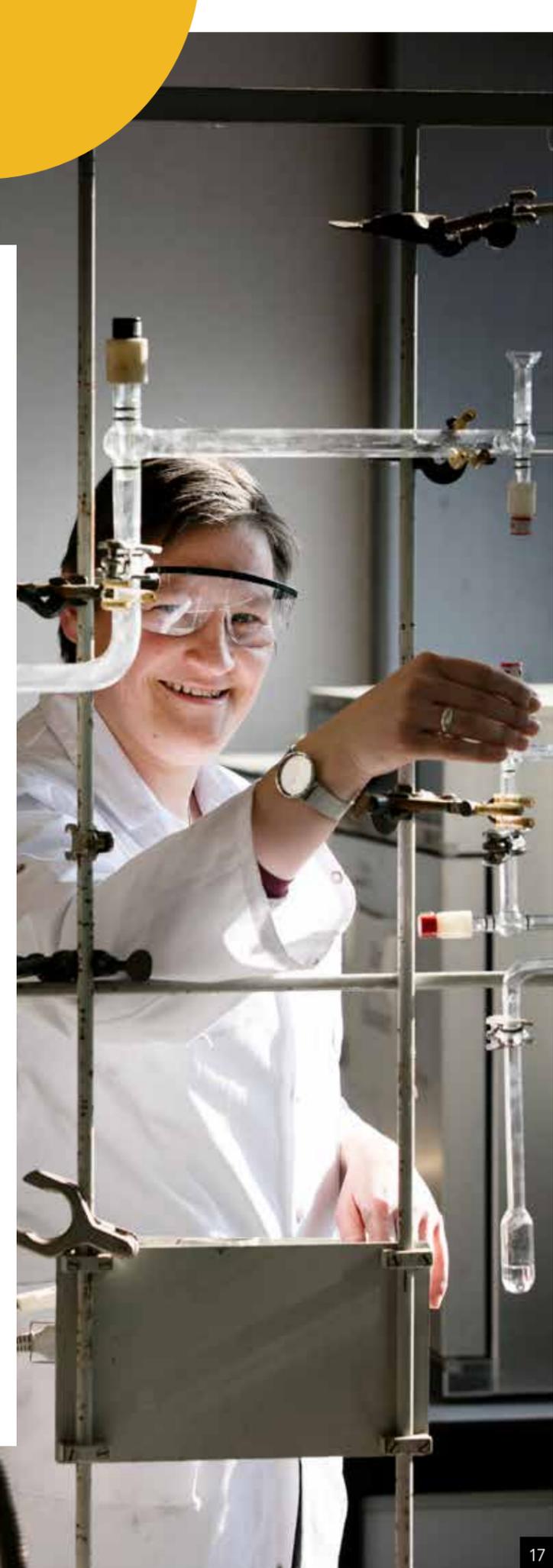
My education is in chemistry with a specialisation in materials research, but I've always had an eye for the application side. Which is how I ended up at VITO. VITO views technology much more from an application standpoint: what can we use this method for? One person can never gather enough expertise to conduct both fundamental technical and application-oriented research. A collaboration is thus a win-win situation for both parties. The membrane technology that we developed together already has many applications: solvent filtration in pharmacy, purification of surface and wastewater, filtering of olive oil ... I enjoy seeing how my materials research leads to specific technological applications.

What does your collaboration with VITO look like in practice?

I have had a cooperation agreement with VITO since 2006. It was renewed and expanded in 2017. My salary is paid by the University of Antwerp, but one day a week – about 20 per cent of my time – I work at VITO. My VITO colleagues mainly come to me with technical problems regarding material modification. For me, these technical challenges are often an inspiration for new fundamental research. In recent months, the strategic cooperation between VITO and the University of Antwerp has been further expanded and even more of my colleagues are starting to work with VITO. It's going well: everyone does his or her thing and recognises the expertise of the other. We achieve the best results with open innovation. I hope that we can continue to work together in this way for a long time.

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BATTERY TECHNOLOGY EXPLORES NEW APPLICATIONS

Electrical energy storage is a vital element in the integration of renewable energy sources. Researchers at VITO/EnergyVille are developing new storage materials and technologies, improving existing solutions and collaborating on new battery systems.

MORE SUSTAINABLE SHIP DESIGN WITH BATTERY MODULES

Modern shipbuilders are trying to reduce noise, CO₂ emissions and water pollution. One solution for some ships is electric propulsion.

Electric motors are particularly suitable for ships that cover many short distances, such as ferries and icebreakers. Batteries don't allow you to stay at sea for days. The EU project NAVAIS, of which VITO is also a part, is examining the conditions that would facilitate electric propulsion for ships.

Challenges

"VITO is working on three challenges within NAVAIS," says Peter Coenen, senior researcher Battery Technology. "The first is thermal management. Batteries require a constant ambient temperature of around 20 degrees Celsius. But on ships, it can be very hot or very cold. The thermal conditioning of a battery is therefore important. VITO is designing calculation models

that examine how batteries will react in the tropics or at the North Pole."

"A second aspect is the aggregation of battery modules. A ship can have different sizes of batteries on board. They each have their own battery management system (BMS). In the case of multiple batteries, that BMS will be modular. But a captain needs a single number that indicates how much power and autonomy the ship still has. VITO therefore is developing an algorithm to merge battery modules."

Super-fast charging

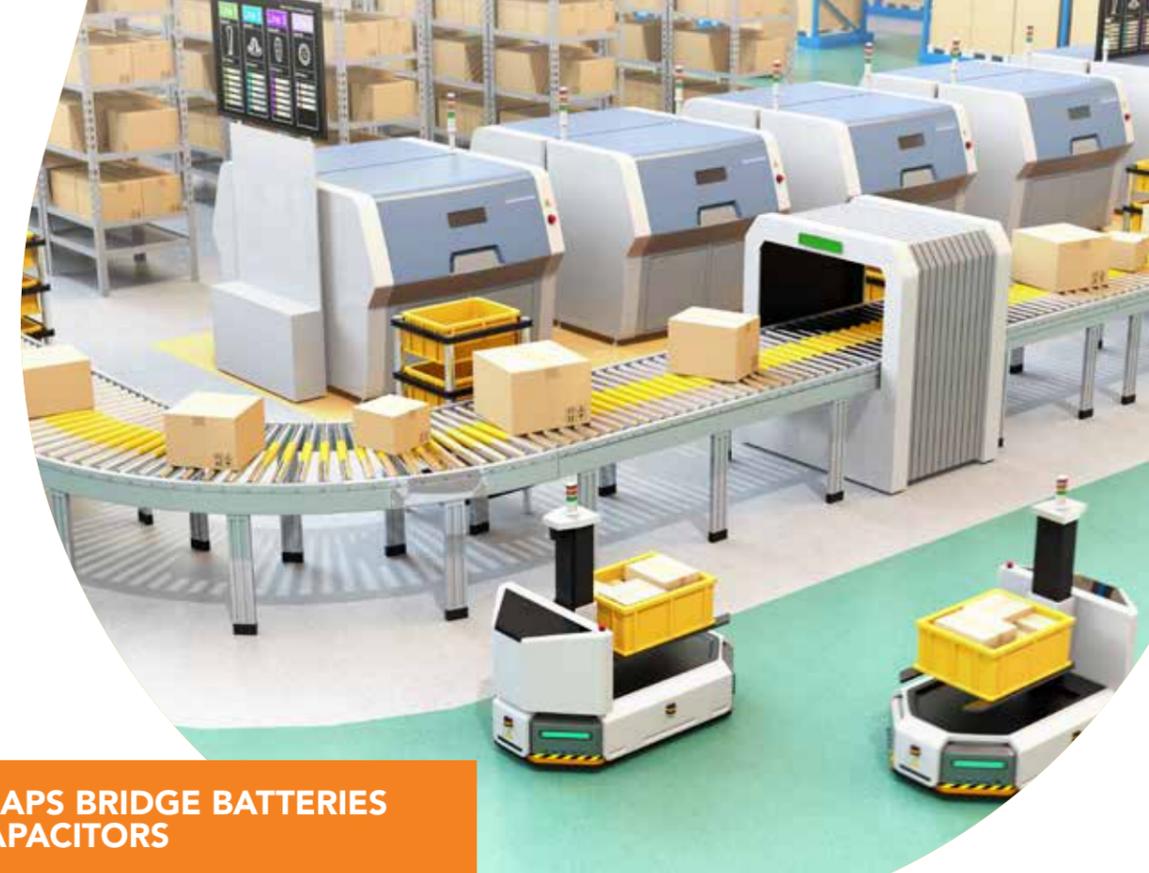
A third research topic is the speed at which batteries can be charged. A typical ferry makes a crossing of half an hour and is then at the dock for ten minutes before departing again. The battery needs to be charged in these ten minutes. But with most batteries, charging takes longer than the use. "To prevent shipbuilders from having to install super-large batteries, we

are working on faster charging technologies," says Peter Coenen. "The hard part is that a battery can be damaged if you charge it with too much power. By simulating the electrochemistry of a battery, we can determine the maximum allowable current."

Modular design

The faster charging technology is part of a new method of designing ships. Traditionally, a shipbuilder waits for a customer request before designing a ship. Only after the customer approves the design, the shipbuilder can make an offer. Thus a lot of time and money is spent designing ships that may never be built.

"At NAVAIS we are developing a method that divides vessels into modules. These modules allow a shipbuilder to design faster and cheaper," says Peter Coenen. "The European Commission hopes to keep the European shipbuilding sector competitive with this approach. The project includes some fifteen partners, including Dutch shipbuilder Damen. Damen's employees should be able to use the new design process within four years."



ULTRACAPS BRIDGE BATTERIES AND CAPACITORS

Traditionally there are two ways to store energy: in batteries or in capacitors. The new 'ultracap' technology, which VITO helped develop, combines the best of both: it offers the energy storage of a battery and the life of a capacitor.

Batteries and capacitors each have their advantages and disadvantages. A capacitor can store less energy than a battery, but its capacity is greater and the lifetime much longer. Capacitors are therefore perfectly suited to frequent short trips, for example with hybrid city buses. Every time the bus accelerates and decelerates, the energy is discharged and recharged. A capacitor can sustain this cycle about a million times. A battery can store more energy, but can handle at most five thousand charging cycles. The KIC project HYDEALIST

aims to combine the benefits of both systems.

More energy, longer life cycle

"HYDEALIST was inspired by the French company NAWA Technologies. It managed to build ultracaps that can store three times more energy than the traditional versions, without sacrificing useful life cycle," says battery researcher Peter Coenen of VITO. "Ultracaps are ideal for automated guided vehicles (AGVs): these are driverless vehicles that can, for example, retrieve parts in a warehouse. Conventional batteries for AGVs have to be replaced every two to three years. The new compact ultracaps can easily last ten years."

VITO's role

Within HYDEALIST, VITO is responsible for the integration of the ultracaps in the AGVs. Like batteries, the ultracaps

are combined in a package. An energy management system manages the operation of the caps and lets you know when they are (almost) empty. "The project extends over three years. Prototypes of ultracaps for AGV vehicles should be available by the end of 2019," says Peter Coenen. "There is also a commercial plan to use them in forklifts. Many more applications are conceivable in the longer term. The new ultracaps close the gap between conventional capacitors and batteries."



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ONEPLANET@VITO: A SUSTAINABLE VITO AND BEYOND



The Sustainable Development Goals (SDGs) of the United Nations are exceptionally ambitious: freeing humanity from poverty and re-orienting the planet towards sustainability. VITO supports the realisation of the SDGs and has formulated its own objectives for eight of the seventeen goals.

VITO as an organisation plays an exemplary role and aims to be a leader in sustainability. This is already evident in practice. For example, we are replacing diesel-powered service vehicles with electric and hybrid vehicles. VITO employees will test various options for climate-neutral mobility. We are experimenting with electric pool cars for business trips, e-tickets for public transport company De Lijn, a wide range of company bicycles, bike-sharing systems such as Blue-bike, and a compensation scheme for the CO₂ that we emit while travelling by air.

Within OnePlanet@VITO, all employees are encouraged to propose initiatives. In this, VITO looks at sustainability in the broad sense, in line with the SDG framework. We always try to involve six elements based on the traditional three Ps: people, planet, well-being, partnership, justice and dignity. All initiatives are supported scientifically. A sustainability dashboard shows the effects of our actions, allowing us to measure our impact. In the meantime we have gathered more than 40 ideas for quick wins, and want to launch five pilot projects before the end of 2018.

Quick wins

Quick wins are rapidly implemented initiatives whose effects can also be measured rapidly. We realised several of these in 2017. For example, at most VITO facilities, paper towels in toilet areas have been replaced by air blowers. The result is a saving of 12 000 euros per year, zero waste and still clean and dry hands.

For business trips, employees can choose a sustainable alternative. For instance, VITO offers bicycle leasing for commuting to and from work. Electrification of the vehicle fleet has resulted in a 20 percent reduction in the purchase of diesel fuel, and decreased CO₂ emissions. The province of Antwerp's Mobiscan gives us a new, up-to-date view of how many VITO employees are coming to work by car, bicycle or public transport. This is the start of the Climate Neutral Mobility pilot project.

Three pilot projects

We have already launched three pilot projects that support our ambitions: we are working with Green Deal on our purchasing policy, we used 21 percent less printing paper in the past year in the pursuit of a paperless office, and we aim for a climate-positive campus that contributes to greater biodiversity in its surroundings.



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