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SUSTAINABILITY REPORT 2012


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Contents

This symbol is often used in this sustainability report
It indicates that a detailed explanation of the project can be found at www.vito.be/sustainabilityreport2012.
So be sure to also visit our website!

Preface by the chairman

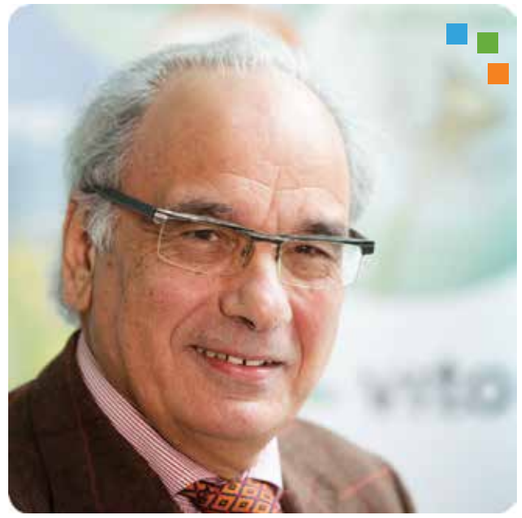
VITO proudly presents the VITO sustainability report. This report differs from the former annual report not only with respect to form, but also to content. The choice by VITO for a sustainability report shouldn't come as a surprise. All of VITO's research topics are intrinsically related to sustainable development, with cleantech as the central technological research component. Consequently, we present the themes in this report with a selection of research projects conducted in 2012. This aspect is in line with the tradition of an annual report.

Because sustainability is often associated with the three P's (People - Planet - Profit), VITO's 'Profit' is also treated, namely the financial results achieved by VITO in 2012.

In its most recent advice, the VITO Strategic Advisory Board, presided by Prof. A. De Meyer, stated that sustainability was – and indeed should be – a part of VITO's DNA. The chapter 'Sustainability in VITO' (available via the link: ***www.vito.be/sustainabilityreport2012***) explains this, with contributions related to personnel policy, Quality, Safety and Environment (QSE), as well as the feasibility study completed this year with The Energy and Resources Institute (TERI) from India on Integrating New and Sustainable Technologies for Elimination of Poverty (INSTEP). Via INSTEP, TERI and VITO aim to initiate a programme for introducing new and sustainable technologies in local village communities in India. Our goal is to help the regional society progress toward a more sustainable living environment and thus contribute to reducing poverty. The reduction of poverty is one of the most important UN Millennium Development Goals for 2015 and is included in the Rio20+ Sustainable Development Goals for 'The Future We Want' as the greatest global challenge faced by sustainable development.

As introduction, however, this sustainability report aims to present our vision on sustainability and to further explain VITO's role in cleantech and sustainable development.

With this report, VITO and the Board of Directors wish to emphasize the growing importance of VITO in Flanders and in the global transition towards a sustainable society.



The protracted economic crisis and in particular the reflections on 'zero growth' as future economic and social model are – however paradoxical this may seem – an ideal breeding ground for global reflection and action on a sustainable world view. VITO is proud to be contributing to this endeavour, and will continue doing so in the future. This sustainability report is a testimony to that aspiration.

I hope you enjoy our report.

Em. Prof. Dr. Harry Martens
Chairman Board of Directors VITO

Sustainability is part of our DNA

The crisis has made it painfully clear that our financial-economic systems are in need of renewal. And there are problems in other areas as well. The climate crisis, food crisis, water crisis, overpopulation … On a daily basis, we are confronted with these issues. Our systems are in need of a fundamental redesign. This transition, however, must be inspired by sustainability. With five new – reoriented – research programmes, all embedded in transition thinking, VITO is contributing to scientifically sound solutions for a world in transition.

Presenting sustainable development as a solution is a first step in addressing the major issues which we are faced with. This, however, is not enough. Our problems in fact are strongly interwoven with our production and consumption patterns, and the way in which these are embedded in the structure of our society. Hence, a single change or a few adaptations are not enough. What is needed is a transition.

Transition requires vision

The concept of 'transition' is often on the lips, also at VITO. But what do we mean by it? Transitions are changes to that which is referred to in the scientific literature as 'socio-technical systems'. These changes, moreover, are long-term processes; they are functional and complex. We have already experienced a number of these transitions in the past. Think of the transition from horse and carriage to an automobile with internal combustion engine, the transition from sailing ship to steam ship and – more recently – the transition from traditional farming to modern bio-industry. Transitions are not insignificant changes. On the contrary, they are transformations that reform a system at its very foundations.

Not all system innovations are dictated by the pursuit of greater sustainability. And they are not always as successful. For this reason, it is important for system innovations to be guided by strong visions on the future system.

Out of the box

The transitions at which VITO aims are indeed driven by the need for sustainability. Thus sustainability and transition thinking are decisive to the research activities pursued by VITO. To contribute to transitions in society, we at VITO understand that we must transcend the prevailing conceptual framework too. We do not limit ourselves purely to scientific research in its restricted sense and to policy support; we think 'out of the box'. And in the meantime this is now a part of our DNA.

We, for example, helped set up the FISCH initiative (Flanders strategic Initiative for Sustainable CHemistry). VITO also plays a leading role in Smart Grids Flanders and we founded the Flanders Cleantech Association.

Technology with a plus

We are also rolling out the transition approach in our research domains. We are aware of the fact that a system change can never be only technological, and that a technological change is always accompanied by changes to non-technological aspects of the system. Therefore, we also intentionally and strategically take account of stakeholder perspectives, institutional redesign and the positive interaction between valorisation in the market and sustainability goals. This sustainability report shows how VITO is putting its new vision on scientific research into practice.

5 major challenges, 5 research programmes

Climate change, food security, the scarcity of raw materials, a sustainable energy supply, an ageing population … VITO's research agenda focuses on the major societal challenges of today and tomorrow. The common thread: sustainability and transition.

Sustainable chemistry, energy, health, materials and land use: these are the five themes VITO will be focusing on in the next decade. These themes have been set out in five research programmes. They perfectly fit the mission and expertise of VITO as technological research organisation, and offer an answer to the challenges mankind and society are confronted with today and will be in the future. Each programme will build up a strong base of knowledge and skill, with added value for industry and society. This results in new and innovative research, and a comprehensive range of scientific services.

In VITO's five areas of expertise, a societal transition is taking place or is urgently needed. Smart grids, the intensive reuse of materials, a bio-based economy … All these developments require new and more sustainable technologies, but also a change in mindset. That's why VITO is working hard on sustainability and transition thinking as binding factors between the five research programmes.

About VITO

Mission

As independent and customer-oriented research organisation, VITO provides innovative technological solutions as well as scientifically based advice and support in order to stimulate sustainable development and reinforce the economic and societal fabric of Flanders.

Figures 2012

Available resources: 126 million euro
Employees: over 700

Board of Directors

Chairman: Harry Martens
Executive Board Members: Harry Martens, Dirk Fransaer, Koen Kennis, Marie Claire Van de Velde
Members: Harry Martens, Dirk Fransaer, Joris De Schutter, Koen Kennis, Pieter Marinus, Michel Meeus, Claire Renders, Ann Verreth, Ingrid Vanden Berghe, Marie Claire Van de Velde, Bartel Van de Walle
Government Commissioner: Tim Moens
Deputy of the Minister of Finance and Budget: Toon Tessier
Observers: Irène Mertens and Frank Veroustraete

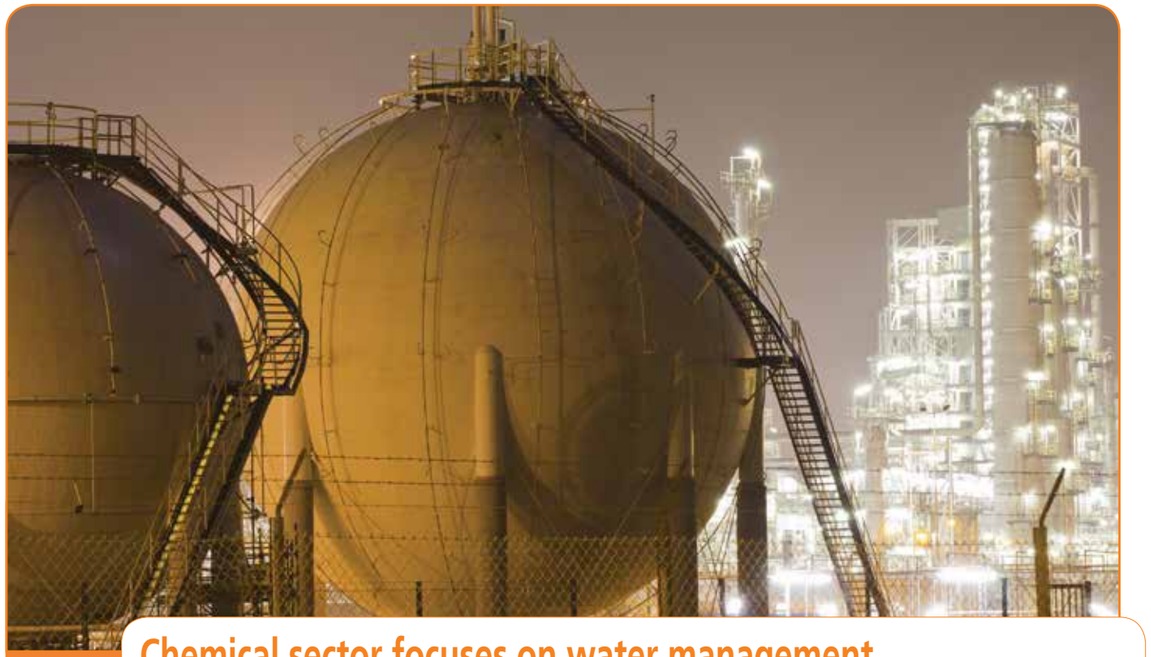
Executive Committee

Dirk Fransaer (Managing Director), Rik Ampe (Director), Roger Dijkmans (Director), Gerrit Jan Schaeffer (Director), Francis Vanderhaeghen (Director Valorisation and Strategic Partnerships until 1/12/2012), Anne-Mie Van de Wiele (Director Human Resources and General Services)

TECHNOLOGIES FOR A GREENER INDUSTRY

Industry worldwide will soon need to operate with much less: less ground and surface water, less raw materials, less energy … The way that companies deal creatively and flexibly with resources and raw materials will largely determine their future. Green industry requires innovation, newer and better technologies. Our developments, systems, processes and technologies are ahead of their time, but they are essential for tomorrow's industry.

Read more: **www.vito.be/sustainabilityreport2012**



Chemical sector focuses on water management

In Belgium chemical companies use approximately 750 million m³ of water per year. Water, however, is becoming increasingly scarce. Hence, industry throughout Europe is looking for solutions to use water ecologically and efficiently. The water sector and the chemical industry unite in the European forum ChemWater.

ChemWater is developing a long-term vision and strategic actions for realising optimum industrial water management. ChemWater is financed by the European Commission under the Seventh Framework Programme. The project resulted from the collaboration between the European Technology Platform for Sustainable Chemistry SusChem and the European Water Platform WssTP. VITO is a part of this research group together with the Dutch research centre TNO, Suez Environment, Veolia and the European Chemical Industry Council Cefic.

Inge Genné of VITO: "The European chemical industry is a large consumer of water and a major technological player. For this reason, it is very important that ChemWater unites the chemical process industry and the water sector. Together with our partners, we analyse mechanisms to facilitate market uptake of better materials, technologies and processes. ChemWater offers a new perspective: 'chemistry for water', alongside the more traditional 'water for chemistry'. Thus, the chemical sector is able to provide significant stimuli for innovation related to water technology and management: advanced water treatment and process intensification using new separation processes, nanotechnology, industrial biotechnology, nanoelectronics and so on."

E4Water: economical, ecological and efficient

An actual result of the strategic partnership between SusChem and WssTP is the large-scale research project E4Water. E4Water stands for 'Economically and Ecologically Efficient Water Management in the European Chemical Industry'. In this project, nineteen partners from nine European countries are developing demo projects to create, test and validate new integrated approaches, methodologies and process technologies. The goal: making water management in the chemical industry more efficient and more sustainable.

VITO is one of the main research partners in demo projects at the companies Solvic, SolVin and Procter & Gamble. The choice for these cases resulted from an intensive dialogue with stakeholders, which in turn ensures the relevance of the demonstrations for the chemical industry. It is expected that the demonstrated technologies and processes could reduce the water consumption of an average company by 20 to even 40 percent. The amount of wastewater should decrease by 30 to 70 percent, and energy use by 15 to 40 percent.

Recognising the water problem

In Europe, intensive research is being conducted on water cycles, but this is often extremely fragmented. In order to better structure the research into sustainable water management, the European Commission, within the framework of the EU 2020 flagship initiative 'Innovation Union', will establish this year the European Innovation Partnership (EIP) on Water. With this EIP, Europe aims to bridge the gap between science and the application of innovative solutions in practice.

Inge Genné: "The EIP on Water is a major step towards rationalising and bundling European research. It is also a powerful signal that Europe recognises the water problem. VITO is an active participant in this partnership, as member of WssTP, via ChemWater and via the EIP workgroup within Cefic."

www.chemwater.eu
www.e4water.eu

Testing grounds for sustainable water management

Can chemical company Solvay reduce its water footprint and thus conserve drinking water? An E4Water demonstration project shows how this is possible.

New research project targets more efficient water cycle

Sustainable water management is also a hot topic in Flanders. In the Flemish Innovation Partnership (VIS) project The Blue Circle®, VITO aims together with other Flemish partners to make industrial water recovery methods more efficient and to valorise the concentrate flows.

Currently no sustainable solutions exist for the processing of streams with a high concentration of inorganic salts (chlorides, sodium, sulphates, nitrates …). A broad, interdisciplinary vision is needed to tackle industrial water management efficiently and sustainably.

The VIS programme The Blue Circle® is investigating the technical and economic feasibility of further processing inorganic concentrate flows. The method: recovering more water, and subsequently purifying and processing these flows. The ultimate aim is to recover valuable chemicals and nutrients.

de blauwe cirkel

Algae opening door to green chemical industry

Algae are increasingly seen as a valuable, renewable raw material for the future. And there are also major opportunities in it for Flanders.

Algae as renewable raw material are an interesting alternative to petroleum-based derivatives. They contain a variety of valuable substances that are difficult to produce synthetically: proteins, polyunsaturated fatty acids, oil, but also dyes and antioxidants. Moreover, algae absorb CO_2 and nutrients. And it is not only the chemical industry that is following the latest developments in algae research; the food, animal feed and pharmaceutical industries as well as the energy sector are also interested.

Flemish Algae Platform

Various Flemish research centres, knowledge institutions and companies are initiating algae research and demo projects. The Flemish Algae Platform was established to coordinate and streamline these initiatives, and to correctly inform stakeholders concerning algae and algae cultivation. The platform started in 2009 as a voluntary initiative on the part of several players in the Flemish algae world. VITO was one of them.

Bert Lemmens of VITO: "Until last year, the Flemish Algae Platform has functioned thanks to the voluntary contribution of the initiators. Since the end of 2012, the Flemish Algae Platform is being financed via the new FISCH competence pool. This allows us to better promote algae and better channel the initiatives. We also represent Flemish algae research abroad, and we present a vision to support a relevant Flemish policy."

Major player in algae research

VITO is a leading party in the study of algae with a focus on the harvesting, medium reuse and downstream processing. VITO for example coordinated the MIP project 'Algae for Chemicals Production and Emission Abatement' (ALCHEMIS) that was completed at the end of 2012.

VITO is also working with Thomas More Kempen (formerly KH Kempen) on the ERDF investment project Sunbuilt for the construction of a test site for cultivating and using algae.

Rene Wijffels, Professor in Bioprocess Engineering at Wageningen University: "Our university has been conducting research into algae for many years: into production as well as biorefining. In Flanders, VITO is a major player in algae research, and for this reason, we are combining forces in the framework of a doctorate. For example we are working together on optimising biorefining techniques. This will allow us to efficiently obtain high-grade components such as proteins from algae, with a minimum of energy: a promising study."

ALCHEMIS enables sustainable algae production

Is sustainable algae production economically feasible? This was the focus of the project ALCHEMIS, with the support of the Environment and Energy Technology Innovation Platform (MIP).

Sunbuilt: algae as producer of 'green' raw materials

For the ERDF investment project Sunbuilt, VITO and Thomas More Kempen (formerly KH Kempen) joined forces to develop and apply techniques to cultivate and use algae.

Producing bioplastics from waste streams

A new generation of bioplastics could enable textile components being produced from waste streams. VITO is developing a fermentation process to produce these bioplastics. They are an inexpensive and sustainable alternative to plastics obtained from petrochemical sources.

Bioplastics are used as plastic shopping bags or even as carpet at trade fairs. They are usually made of natural products such as starch extracted from potatoes or maize. Thus, depending on the raw materials being used, this can result in competition with food production. By using waste streams, however, bioplastics can become a sustainable alternative to plastics obtained from petrochemical sources. Agricultural products are not needed in this case. Even CO_2 can be used as raw material.

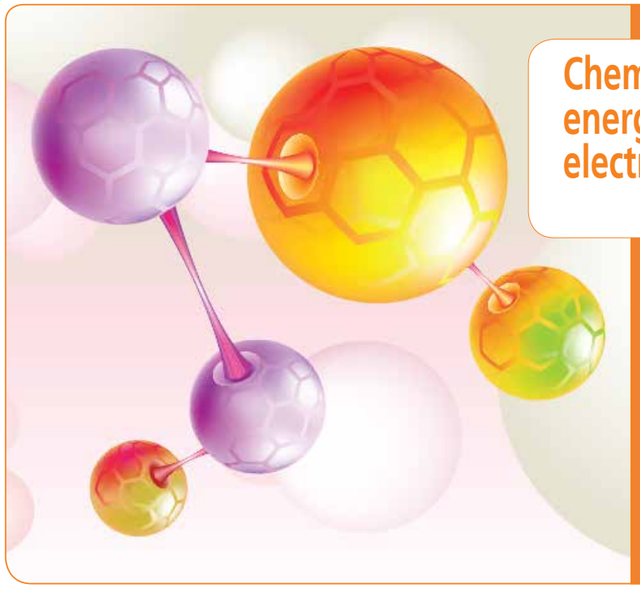
Fermentation process

Linsey Garcia-Gonzalez of VITO: "As part of a MIP project, we are developing a fermentation process for the production of bioplastics. Our starting point is industrial waste streams. We are studying which waste streams could be suitable for the production of bioplastics and where these streams might be available. Candidates include CO_2, but also glycerol from the biodiesel industry."

Optimisation of the fermentation process is not an easy task. A major challenge is properly dosing the hydrogen during the reaction. Linsey Garcia-Gonzalez: "Hydrogen is needed for the formation of the biopolymers, but when combined with oxygen, it can result in an oxyhydrogen reaction. To make the fermentation process technically feasible, we need to show that we can remain below the explosion level."

Textiles and dyes

The processing of biopolymers into textiles is also being studied, as is their market potential. For this project, VITO is working with three industrial partners: Beaulieu International Group, KH Engineering and Tessenderlo Group. The MIP project will be completed at the end of 2013.



Chemical reactions with higher energy efficiency via microbial electrochemical synthesis

Achieving the same reaction with less energy and fewer raw materials is one of the challenges faced by green chemistry. Microbial electrosynthesis is one such smart technology. Fuel and chemicals are produced from diluted wastewater and even from CO_2.

The production of chemicals requires large amounts of energy and raw materials. Hence, VITO is studying bio-electrochemical systems or fuel cells that produce chemicals from waste streams. This is not only much cheaper and more sustainable; electricity can also be generated in the process. This type of fuel cell could play a major role soon in sustainable chemistry. This technology has much potential, especially for the purification of wastewater.

Microorganism as catalyst

How does microbial electrosynthesis work? **Deepak Pant** of VITO: "If we replace the catalyst in an electrode by a microorganism, and inject electrical current, the organism absorbs CO_2 or other substrate, which is reduced. The result: the electrically driven production of diverse biofuels or biochemicals such as hydrogen and ethanol. The electrodes developed by VITO are extremely well suited to such electrochemical reactions."

"Microbial electrosynthesis offers a unique opportunity to cleanly and efficiently produce high-grade chemicals from wastewater and CO_2. Ethanol, for example, can easily be integrated in the existing energy infrastructure as renewable fuel. In addition, it can serve as raw material for the production of other chemicals."

Enzyme cocktail

In other bio-electrochemical systems being developed by VITO, the enzymes rather than bacteria transfer electrons to the electrode. This results in the conversion of chemical energy into electrical energy.

"We are also studying the mechanisms of atmospheric CO_2 sequestration by making use of an enzyme cocktail," says Deepak Pant. "This would allow us to produce carbonated water and methanol without needing to inject outside energy. Since both chemicals have a high commercial value, this line of research is promising."

Professor Bruce Logan of Penn State University: "We have been working with VITO on bio-electrochemical systems for a number of years now. This has resulted in an electrode made of activated carbon developed by VITO: state of the art. This type of electrode is not only much cheaper than existing electrodes containing platinum. It is probably also the key to making the production of microbial fuel cells economically viable."

Patent leads to breakthrough in process intensification

For certain chemical reactions in the pharmaceutical industry, 6,000 litres of solvent is needed to obtain a mere 50 kilograms of product. Thanks to 'Volume Intensified Dilution' (VID), a patent-pending VITO technology, the same productivity is obtained using significantly less solvent.

In order to prevent undesirable secondary reactions, a number of chemical reactions must take place in a strongly diluted environment. Due to the high amount of solvent used, they are very expensive and have a negative impact on the environment. VITO recently developed a technology designed to make this type of reaction much more efficient: 'Volume Intensified Dilution' or VID.

Efficient and flexible

Roel Vleeschouwers of VITO: "By filtering the reaction mixture with a membrane, we are able to recycle solvent and at the same time create a diluted reaction medium, without wasting enormous amounts of solvent. Presently we are succeeding in making reactions 40 percent more efficient with this technique. And we believe that some reactions could even achieve an 80 percent improvement in efficiency."
The membranes developed by VITO are also compatible with the standard reactors used in the chemical industry. The membrane can be integrated with reactors at lab scale as well as with larger production installations.

Broad application

The technology, currently in an experimental stage, has opened up perspectives. The membranes for example could also be used to recycle catalysts in chemical reactions. Here again, the initial results are promising, says **Dominic Ormerod** of VITO. "A number of chemical reactions that previously were considered unproductive, are again in the spotlight. Once the technology is perfected, there will be many possible applications."

Peter Van Broeck of Janssen Pharmaceutica: "VID is a good example of process intensification. While the technology is still in the research phase, it seems highly likely that the process can be scaled up. The technology is promising, not only for the pharmaceutical sector, but also for the chemical industry."

The sustainable management of chemicals

Determining the health impact of chemical substances is part of VITO's expertise. For its research projects, the European Chemical Industry Council Cefic has been calling upon this expertise already for seven years. The research aims to yield functional applications that raise the sustainability of the chemical sector to the highest possible level.

USING SCARCE SPACE WISELY

All the major societal challenges like environmental contamination, global warming and food supply shortages have a spatial component. Which waterways are turning green with algae? How does consumption in the European Union affect deforestation worldwide? How can we organize our cities to improve air quality? Space is a natural 'raw material', one that needs to be dealt with carefully. VITO is contributing to sustainable land use with advanced computer models, sensors and measurement platforms.

Read more: **www.vito.be/sustainabilityreport2012**

Combining sensor platforms yields a comprehensive view of water quality

VITO is developing a monitoring system that combines automated sensors on unmanned vessels with remote sensing: SAVEWATER. Making the data accessible is also included in the system. The project is being conducted in collaboration with the European Space Agency (ESA).

Water companies faced with water contamination due to algae generally make use of *in situ* monitoring to determine the status of their water reservoirs or lakes. They measure the different parameters directly in the water. This approach is not sufficient, however, for large water reservoirs or lakes, because it does not provide a complete and detailed picture. Waterway managers, dredgers and port managers need measurements that cover an entire area in detail.

VITO is developing an integrated monitoring system that combines *in situ* measurements from unmanned vessels with images from remote sensing. This system and the corresponding service is called SAVEWATER. The European Space Agency and diverse users from the water sector support the project.

The best of both worlds

Piet Seuntjens of VITO: "SAVEWATER combines the best of two measurement techniques. Remote sensing systems quickly generate images of the water surface and surroundings across large surface areas. Satellite navigation is used to guide the unmanned vessel that, based on the remote sensing images, autonomously travels to contaminated locations to perform *in situ* measurements: measurements of the distribution of algae at depth, and of the temperature and the level of acidity of the water, which also have an impact on the presence of algae."

The end user thus receives measurements with greater relevance: improved remote sensing images, processed data and metadata, and specific information for users. ►

Webservices

"To increase the accessibility of the products to the end users, we are also creating web services," says Piet Seuntjens. "Depending on the application, specific data, maps and models can be consulted to obtain the desired information from the system."

Water companies as well as the authorities that manage swimming ponds are looking forward to the results of SAVEWATER. The system is already being tested together with the Dutch Rijkswaterstaat, the Directorate-General for Public Works and Water Management. Based on these results, VITO will work with ESA to plan and implement a demonstration project.

César Bastón Canosa, ESA Engineer: "By eliminating the limitations of *in situ* measurements and remote sensing images, SAVEWATER creates an entirely new level of information for monitoring water. The system also allows us to bring our remote sensing products closer to users. Thus ESA is very enthusiastic about SAVEWATER."

Aqua Drone®: new generation measurement platform

High-performance environmental measurement systems: better integrated and more intelligent. This evolution can be seen in Aqua Drone®: an unmanned mobile measurement platform designed to make the monitoring of rivers, basins, docks and coastal waters more efficient and more accurate. VITO demonstrated the unmanned vessel in water for the first time at the beginning of 2012.

All systems ready for launch of PROBA-V satellite

In 2008, Belgium was given green light by the European Space Agency (ESA) for developing the vegetation satellite PROBA-V. The satellite is launched in May 2013. VITO is responsible for processing the images.

Which agricultural regions are threatened with drought?

To detect on a global scale the agricultural regions that are at risk of drought stress, VITO developed the 'Agricultural Stress Index System' or ASIS. ASIS filters basic remote sensing information and focuses on agricultural regions and the growing season. The project was initiated at the request of the Food and Agriculture Organization of the United Nations (FAO).

Drought is one of the main causes of food shortages. Each year, harvests are lost in different locations in the world due to lack of rainfall. The consequences for local residents are dramatic. To identify the impact of drought and respond appropriately, objective information about agricultural crop conditions is indispensable. FAO asked VITO to develop a new drought stress index system based on satellite data. This system aims to provide a clear picture of where the drought risks are located.

Drought bulletins

Roel Van Hoolst of VITO: "ASIS is part of the 'Global Information and Early Warning System' (GIEWS) of FAO that provides information on food security in developing countries. A traditional way to monitor vegetation with satellites is via the 'Normalized Difference Vegetation Index' (NDVI). ASIS is more focused: the system compares the actual situation with historical observations and limits itself to the growing season and agricultural regions. Thus, only information specific to agriculture is obtained."

The data on which ASIS relies, consists of available remote sensing images: the Metop-AVHRR ten-day synthesis images that are processed by VITO. "We add value to these images by focusing on the information relevant to agriculture," says Roel Van Hoolst. "Our system processes the remote sensing data and delivers the end products to FAO. Based on these maps, drought-stress hotspots can be detected throughout the world. For these agricultural regions, the satellite data is combined with socio-economic data such as figures on population density, the market and the availability of food. FAO prepares bulletins using this integrated information that are made freely available and represent important input for policy makers."

How does our consumption impact global deforestation?

According to a study conducted by VITO at the request of the European Commission, 10 percent of global deforestation is associated with consumption in the European Union. In this project, VITO examined international trade flow models and formulated proposals to combat deforestation due to consumption.

Africa is learning how to use remote sensing images

VITO personnel is teaching African end users how to monitor their agricultural crops using remote sensing. Generating remote sensing derived products is one thing; working with them efficiently and effectively is an additional step.

VITO has been providing remote sensing products to its African partners since a number of years. These are mainly images with low spatial but high temporal resolution that can be used to monitor the evolution of vegetation. These images allow local experts to monitor the status of agricultural crops. However, it is not always clear how to properly interpret and effectively use this geodata. For this reason, VITO sets up specific training programs in several African countries.

Agrometeorological bulletins

How does one derive ready-to-use information from technical images? The VITO coaches focus on various aspects of using geodata. **Carolien Tote** of VITO: "We offer our trainees software to process the time series. We show them how to work with the software and how advanced analysis techniques can be used in agrometeorological bulletins. These bulletins are issued every ten days in many developing countries. They compare the present vegetation indicators with the historical averages. We teach how the evolution in the vegetation indicators can be processed, visualized and analysed throughout the entire growing season. This often results in much more interesting information."

Knowledge exchange

"Our first training activities began in 2003," says **Sven Gilliams** of VITO. "These were organized in the framework of the ESA-financed 'Global Monitoring for Food Security' (GMFS) project. This programme makes satellite images available to support food monitoring activities in West, East and Southern Africa. We work closely with regional and national agricultural institutes from Kenya, Senegal, Niger, Mali, Mozambique, Ethiopia, Sudan, Malawi and Morocco. The GMFS project ends this year, but the project has provided a strong basis for other VITO projects in Africa and new training initiatives."

Mouhamadou Bamba Diop of the Senegalese Centre de Suivi Ecologique (CSE): "Our agrometeorological bulletins have improved considerably thanks to the training activities. We now use remote sensing images in a more efficient way for monitoring our agricultural areas. I believe that within a few years, CSE itself will be able to give support to other institutes in the region. Thus, the partnership with VITO is extremely important, not only for our institute, but also for Senegal and West Africa."

Improving air quality with spatial planning

A high barrier along the Leuven ring road improves the air quality of an adjacent neighbourhood, and green buffers along the Antwerp ring road have a similar effect. In narrow streets surrounded by high buildings, trees can have a negative effect. "We can partly tackle local air pollution with the right spatial actions." That is the conclusion of CLIMAQS.

Air quality models are essential tools on which to base climate and air quality policy. Existing models, however, are often complex to use, resulting in their underuse in setting policy. Improving and validating existing computer models for simulating the atmosphere at regional level: this was the aim of the project 'Climate and Air Quality Modelling for Policy Support' or CLIMAQS. In this project, strategies were also developed to efficiently deploy models in support of policy on climate and air quality.

Motorways and street canyons

Stijn Janssen of VITO: "Flanders is confronted with high concentrations of air pollution. Until now, the Flemish administration conducted mainly a general policy to address pollution above Flanders. The municipal or local scale was subject to less attention. Improved air models, however, sometimes show large local differences in air pollution. For example, the concentration of nitrogen dioxide outside cities such as Antwerp or Brussels is around 30 micrograms per cubic metre, while in the cities, this rises to 45 micrograms and more. Hence, the local scale is very relevant to air quality."

When we zoom in on a city or urban region, the differences are also immense. Motorways and street canyons are true hotspots of air pollution. Street canyons are city streets flanked on both sides by a contiguous row of (high) buildings, creating a 'canyon'. "The cause of air pollution in street canyons is the high concentration of traffic in combination with a lack of ventilation," says Stijn Janssen. "We have also studied the effect of trees on air quality. In street canyons, trees appear to block the supply of fresh air. While trees do purify the air, their aerodynamic effect that limits ventilation is much stronger. Thus in street canyons where there is also a lot of traffic, trees can decrease air quality. So in those cases, it is wise to take decisions from an air pollution perspective: reduce traffic or plant less trees."

Intelligent spatial planning

Conclusion? We can combat air pollution locally with spatial interventions and smart measures related to mobility. VITO researchers for example studied the impact of urban development on the air quality of the Vaartkom, a new district in Leuven. "We investigated the effect of sound barriers along the Leuven ring road. The amount of traffic related pollution in the area decreased by up to 8 percent. It remains extremely important to address air pollution at its source, but we can also contribute to air quality with spatial measures. Smart spatial planning can noticeably increase the quality of life in cities."

CLIMAQS was supported by the Flemish Agency for Innovation by Science and Technology (IWT) and was executed under the direction of VITO by a consortium consisting of the KU Leuven, the University of Antwerp and the Royal Dutch Meteorological Institute (KNMI).

climaqs.vito.be

Soil carbon flux models increasingly more accurate

Throughout Europe, soil organic carbon levels are decreasing, with negative consequences for soil quality. To quantify organic matter in European soil, VITO developed carbon flux models. These models are becoming increasingly accurate. Interest is increasing from diverse policy domains.

The decrease in the soil organic carbon levels is especially due to land use and land management such as intensive forest and farming techniques, the conversion of grasslands into farmlands, and the conversion of peatlands and woodlands to other land use. The consequences are drastic: soil fertility and quality is decreasing, which in the long-term can lead to soil degradation. What's more, the decomposition of organic matter in the soil is contributing to increased CO_2 concentrations in the atmosphere. Higher temperatures and favourable soil moisture conditions accelerate the process of biodegradation.

Accurate over time

To obtain a better overview of the soil organic carbon levels, VITO developed spatial-dynamic computer models or carbon flux models. These enable a good assessment of the influences of climate, land use and management. The project was carried out for the European Commission and was followed by a project for the Flemish Government. **Anne Gobin** of VITO: "Our models have proven their usefulness in the meantime. Regional studies demonstrate the importance of accurate input variables, such that the models always need to be adapted in function of the goal of the study."

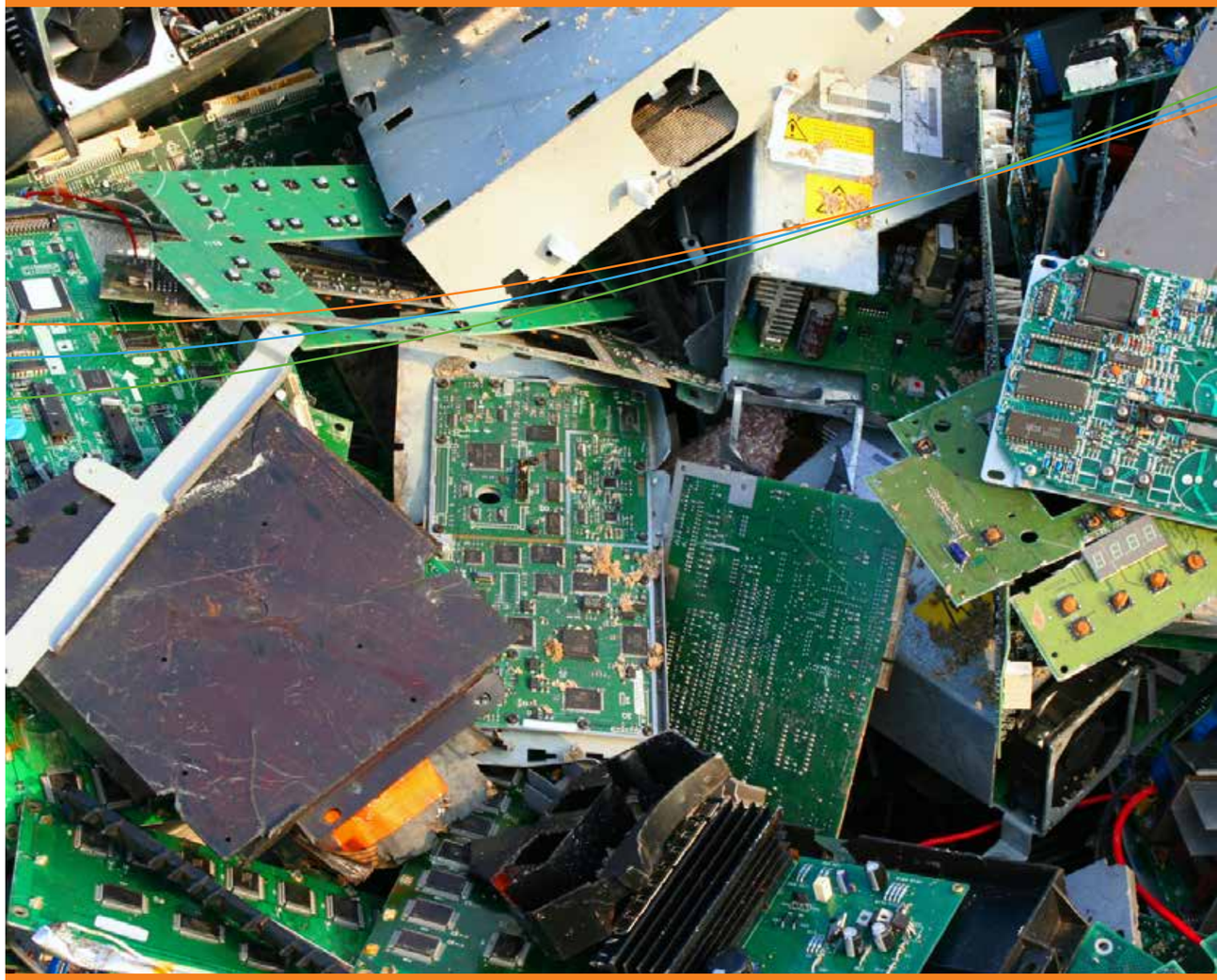
From agricultural to climate policy

"Soil organic carbon levels are extremely interesting for agriculture and forestry policy, environment policy, climate policy and energy policy," says Anne Gobin. "In Flanders, for example, a minimum carbon content percentage has been established per soil type to maintain the soil quality of farmlands. Our models assist in developing scenarios per soil type for, for example, crop rotations that contribute to optimum management of organic matter."

Organic matter in the soil also plays an important role in the European Nitrates Directive. Organic matter influences residual nitrates in the soil. The link between carbon content and the climate is clear. "The carbon reserve in the soil is very large and dynamic; the question is how to optimally manage this reserve. It always comes down to the fact that a widely accepted policy needs accurate models for impact and scenario analyses," concludes Anne Gobin.

Martien Swerts of the Land and Soil Conservation unit of the Flemish Government, Environment, Nature and Energy Department: "VITO's carbon flux research can help identify the impact of biofuel production on food supply and ground quality. The removal of biomass for energy production can have a negative impact on the functioning of the soil. A number of proposals are being discussed at European level to reduce the undesirable side effects of biofuel production. Thus, the VITO research will certainly be useful."

SMART USE OF MATERIALS



To meet the challenges of growing resource scarcity and increasing raw material prices, we need to intelligently use our (raw) materials. The goal: a green economy that is less dependent on imported raw materials, with closed material cycles. The efficient use of raw materials in production processes, and the reuse and recycling of materials – both inspired by life cycle thinking – are the focal points of a new VITO research programme.

Read more: **www.vito.be/sustainabilityreport2012**

Entire life cycle determines the sustainability of products

Does biodiesel made from rapeseed oil result in improved sustainability? To answer this question, we need to examine the entire chain, from the seed planted in the ground to the biodiesel that goes into the tank and is burned. This approach is called 'life cycle thinking'. And it is a major source of inspiration for VITO's research projects.

How can we use materials – raw materials, finished products as well as waste – as efficiently and environmentally friendly as possible? This requires an approach that takes into account all phases of the life cycle of a product and of the products being replaced. From raw material extraction through the production process and the use phase to disposal, incineration, recycling or reuse: at each stage, raw materials are consumed, emissions are generated, waste is produced and land is used.

Dirk Nelen of VITO: "We study the environmental impact of a product in all phases of its life cycle. Take the example of producing biodiesel from rapeseed oil. Biodiesel production eliminates the need to extract crude oil, but raising rapeseed requires fertilisers and the use of machinery. The sustainability equation then begins to look a lot less positive."

Closed loop recycling

Life cycle thinking also plays a role in material cycle closure. It then especially concerns the use of raw materials. "A product life cycle can be closed in a smart way by using less raw materials and redeploying raw materials through reuse and recycling," says Dirk Nelen. "A life cycle analysis allows us, for example, to determine what type of waste or waste stream is best to use as secondary raw material. Waste that results in the lowest amount of additional emissions in the production and use phase is the best choice."

Risks related to health and safety must also be considered. Thus nanotechnology, for example, can contribute to sustainable materials management, because product performance is significantly increased with a minimum use of materials. Nano-based products, however, can also have an impact on health. Hence, toxicological studies and preventative measures are needed to limit or avoid contact with nanoparticles during processing, use and recycling.

Flatscreen TVs given second life

The transition from classic TV sets to flatscreen TVs has resulted in new challenges. Flatscreens differ strongly in construction and material use. And they can contain dangerous substances such as mercury. In order to recover as many materials as possible from old flatscreen TVs, new and safe recycling techniques and routes are needed. The research project PRIME is looking into this.

From landfill to materials and energy source

The fact that waste does not really exist was proven by Group Machiels with its project Closing the Circle. Group Machiels is Flemish pioneer in sustainable management of materials, energy and infrastructure. The aim is to valorise the Remo landfill site in Houthalen-Helchteren through maximizing the recycling of materials, and to convert the energy potential of the recycling residues into sustainable electricity and heat.

Read more: www.vito.be/sustainabilityreport2012

Sustainable building blocks for biobased plastics

The emergence of a new generation of biobased materials could strongly reduce the environmental impact of food packaging. They can be made from plants and are biologically degradable. VITO is participating in two of the EU's Seventh Framework Projects on bioplastics: PlasmaNice and Succipack.

Limburg recycled goods shops work on a better future

How can recycled goods shops better respond to new challenges, such as the restructuring of traditional material supply chains (from raw material to waste) into material recycling (material remains material)? And what role does the social aspect play? To determine this, the Limburg recycled goods shops together with ten major stakeholders initiated a participative transition project. VITO facilitated the process.

New construction materials methodology for buildings

In our houses, we need to use less energy, insulate better, cut down our water use, and use environmentally-friendly materials. But which construction materials are truly sustainable? And how can these materials be compared for use in a specific application such as thermal insulation for an exterior wall? With the new construction materials methodology, we soon will be able to measure the environmental impact of hundreds of construction elements and choose materials based on better insight.

Windows in wood or PVC? Parquet or laminate floor? Brick or concrete supporting walls? Which choice is best for the environment? Construction materials easily make up 10 to 30 percent of the environmental costs of a house. And the relative impact of this will become even more important, because new buildings use increasingly less energy due to stricter energy guidelines. Building developers and architects need to limit the environmental impact of building materials already during the design phase of construction products and buildings. To do this, however, it needs to be possible to compare the total environmental impact of materials in a specific construction application. Thus high time for a good measuring instrument.

The Public Waste Agency of Flanders (OVAM) asked VITO, KU Leuven and the Belgian Building Research Institute (BBRI) to develop an assessment methodology and calculation tool. The environmental impact of a number of element variants can be compared in this way: different wall, roof and floor constructions for example. The research employed a quantified method based on a life cycle assessment (LCA).

More Flemish, more Belgian

Roos Servaes of OVAM: "Foreign evaluation methodologies such as the Dutch 'NIBE's Basiswerk Milieuclassificaties' (Basic Reference Sustainability and Healthy Building) and the English 'Green Guide to Specification' do not meet the needs of Flemish and Belgian construction scenarios. Transport distances, production methods, the energy mix and supplies of raw materials are often different from those in other countries. To develop an assessment methodology for our context, we needed a method to calculate the environmental impact of ready-to-use building elements. To gain insight, we met with Flemish and federal policy makers and all stakeholders. Together we outlined how we could determine and compare environmental impact within the Flemish-Belgian construction context: from raw material extraction and production to maintenance, but also including the disposal of building elements at end of life."

Climate, particular matter formation and eutrophication

The environmental impact of a building has an effect in many areas: climate change, acidification of the soil, water pollution, ozone depletion, exhaustion of natural raw materials, toxicity, particular matter formation, land use, and so on. All of these environmental impact categories were included in the methodology.

Wim Debacker of VITO: "The chosen impact categories are compatible with the latest changes to the European standard for sustainability evaluations of building products. It was not an easy task to determine this precise impact for all specified categories, and to discover a method to compare environmental indicators with one another. In order to grade these various impact types, so that an architect or builder only needs to deal with one total score, we converted each individual environmental impact into euros. For this valuation exercise, we were able to make use of existing guidelines by the European Commission. We obtained the environmental data for the diverse materials from a Swiss database, which we then adapted to the Belgian situation."

Once the environmental impact of ready-to-use materials was calculated, VITO made further calculations up to the level of the building element. The result is a database with the environmental profiles of 115 frequently used building elements: different variants of exterior and interior walls, flat and sloping roofs, windows and interior carpentry.

A new life for construction and demolition waste

More than 40 percent of all waste produced in the European Union is construction and demolition waste. In the context of a European project, VITO aims to valorise this waste stream. Besides the more common recycling options using concrete aggregates, VITO has also succeeded in recycling one of the problematic streams, cellular concrete, so that it can be reused as secondary raw material.

In the European Union, 500 to 1,000 million tonnes of construction and demolition waste (C&DW) are generated yearly. This makes it one of the largest waste streams in the European Union. According to the European Waste Directive, at least 70 percent (based on weight) of non-hazardous construction and demolition waste must be recuperated by 2020.

Cellular concrete

Together with Jacobs Beton, a company specialising in the recycling of construction and demolition waste, VITO is focusing on the recycling and reuse of cellular concrete. Cellular concrete waste is a major problematic stream within the building sector. The most familiar form of this is the white-grey, lightweight breeze or cinder block. This VITO study fits in the European Seventh Framework Project 'Innovative Strategies for High-Grade Material Recovery from Construction and Demolition Waste' (IRCOW). In this project, research organisations and companies are searching for innovative strategies to reuse and recycle construction and demolition waste. The goal: use of the secondary raw material for high-grade applications such as new concrete structures.

Sulphate leaching

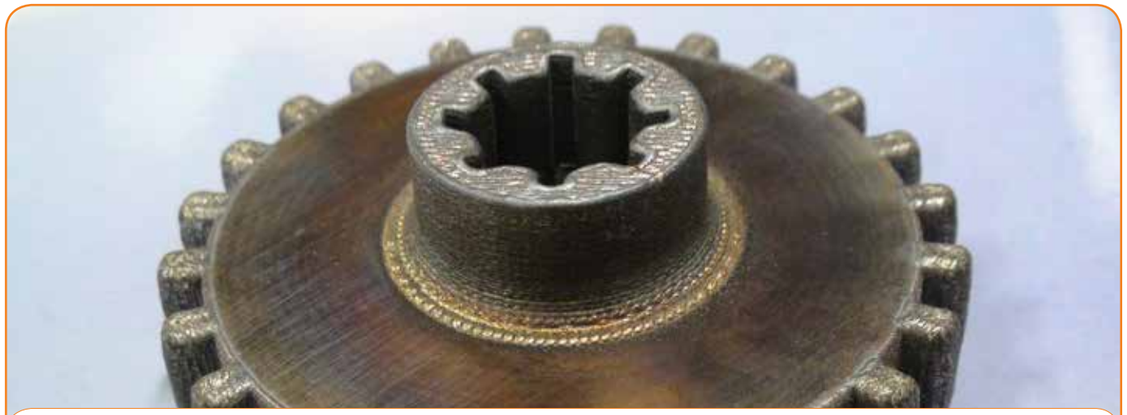
Mieke Quaghebeur of VITO: "The major disadvantage of cellular concrete is sulphate leaching, which makes its environmental impact extremely large. Until recently, it was not known how to reuse this material after it had served its original purpose. Now, however, together with our industrial partner, we have succeeded in reducing leaching by 90 percent. One of the applications is the use of recycled cellular concrete to replace sand in insulating screed, but insulating concrete is also a possibility."

Waste collection facility in the port

From this study, a pilot project also grew for the recuperation of construction and demolition waste. Together with the Antwerp Municipal Port Authority, Jacobs Beton and Brijsse Minerals & Recycling (BMR), VITO is now constructing a waste collection facility in the Port of Antwerp. This pilot project is also being supported by the Public Waste Agency of Flanders (OVAM), the Federation for Ready-mix Concrete (FedBeton), the Federation of Recycling Aggregate Producers (FPRG), the Federation of Environmental Companies (FEBEM) and the Flemish Construction Confederation (VCB). **Kris Broos** of VITO: "Inland navigation vessels will be able to make use of the waste collection facility in the Port of Antwerp to dispose of their cargo waste. What is special here is the fact that the waste collection facility is being constructed largely of the recycled stony fraction of construction and demolition waste. Our aim is to place the spotlight on valorisation of this waste stream." **www.ircow.eu**

Kurt Jacobs, Business Manager at Jacobs Beton: "Collaboration with VITO meant significant added value for Jacobs Beton. Thanks to the partnership in the framework of the IRCOW project, we have developed many possibilities for the reuse of cellular concrete. Hence, we no longer need to dump this 'waste product', and we are able to double production."

Pieter Jaeken, Antwerp Municipal Port Authority: "The Port of Antwerp wishes to emphasize sustainability and innovation. Hence, we were happy to meet the request of VITO to apply innovative technologies at the port for recycling construction waste. The Port Authority and VITO collaborated on the waste collection facility. And we are very proud of the result."



Laser cladding: efficient and wear resistant

Producing wear and corrosion resistant components using as little material as possible: that is the aim of the European AMCOR project in which VITO is participating. The key technology is laser cladding, a technique within additive design that is causing a revolution in the manufactured goods industry.

In the context of the project 'Additive Manufacturing for Wear and Corrosion Applications' or AMCOR, a Seventh Framework Project of the European Union, a consortium is working on developing wear and corrosion resistant materials. The research group, under the direction of The Welding Institute from Great Britain, consists of fourteen European partners. There are two other Flemish partners in addition to VITO: gear producer VCST and drilling company Denys.

Material efficient

The key technology used in the project is laser cladding. **Filip Motmans** of VITO: "Layers of metal are added via a laser-welding technique. By gradually adding material, layer by layer, we are able to produce very complex designs and high-grade components. One of the many benefits of laser cladding is that very little material is lost. Unlike standard production processes such as grinding and milling, no material is removed from a metal mass. The opposite in fact takes place."

Functional materials

Laser cladding has other benefits as well. This technique allows industrial components to be produced with specific material properties such as wear or corrosion resistance. "Thus we can add functional graded materials to drilling heads or hydraulic shafts for example," says Filip Motmans. "These can be metal matrix composites, in which the metal serves as a sort of binding agent to retain ceramic particles. Ceramic particles such as carbides are very hard, and increase the component's wear and corrosion resistance. Our system combines laser cladding with among others robotic and computer numerical control (CNC) positioning and 3D scanning techniques. Because of this, we are able to perform laser cladding from various orientations and make very complex three-dimensional designs."

Industrial application

The next step of the AMCOR project is demonstrating the industrial applicability of the technique. Filip Motmans: "We will be demonstrating the technique to gear producer VCST and drilling company Denys among others. But laser cladding also offers possibilities for sectors not represented in the consortium."

Peter Brown of The UK Welding Institute and Project Manager of AMCOR: "While we are living in a time of considerable technological progress, the manufactured goods industry is still confronted with the problems of wear and corrosion. The AMCOR project aims at changing this. We are searching for the answer in laser cladding, a technique VITO has accumulated much expertise in. I am convinced that many companies will be impressed by the results of the AMCOR project."

Wear sensors with additive design

The monitoring of wear or defects in buildings, pipelines and even dikes is gaining in importance. Here again, additive design has much to offer. This technique, for example, allows to build sensors into construction components.

SUSTAINABLE HEALTH BEGINS AT THE SOURCE

Air pollution, noise pollution, food, cosmetics ... even laptops and TVs can have an impact on our health. Therefore, VITO is increasingly paying attention to toxicology, environmental monitoring and biomonitoring, and the modelling of complex environmental health issues. Furthermore, VITO is contributing to improving medical treatments.

Read more: **www.vito.be/sustainabilityreport2012**

Europe measures pollutants among its residents

Europe aims to better identify our exposure to pollutants and its possible effects on health. Seventeen European countries took part in a large-scale biomonitoring programme, DEMOCOPHES. The goal: to develop a uniform approach to measure environmental contamination in humans.

Until recently, environmental measurement networks were the primary means used to measure the impact of environmental pollution. With human biomonitoring, people take over the role of 'pollution detector'. Human biomonitoring literally means 'measuring in the person'. This means that pollutants are measured in blood, hair or urine samples. Additionally, research on the health effects of these substances is also included.

This measurement technique has been in use internationally since the 1980s, but different methods were used in the various European countries. Various research methods were used or the campaigns focused on participants of different age groups. Consequently, the study results could not be compared. For this reason, a protocol to harmonise human biomonitoring was developed within the European project 'Consortium to Perform Human Biomonitoring on a European Scale' (COPHES). This protocol was then put into practice with the DEMOCOPHES programme.

Biomarkers in hair and urine samples

Elly Den Hond of VITO: "With DEMOCOPHES, the aim was to measure concentrations of a number of polluting substances among the European population in a harmonised way. It was the first study using such approach that allowed the results of the different countries to be compared. Each of the seventeen participating countries used the same method, with the same selection of pollutants, letters, participant characteristics, sample collection techniques, measurement techniques, statistics, interpretation guidelines and communication strategy." VITO guided the countries in the data management, statistical analysis and interpretation of the results.

In each country, 120 mother-child couples participated in the study. Hair samples were taken from both mother and child to measure mercury levels. A sample of morning urine was also collected to measure levels of cadmium, cotinine, phthalates, and possibly bisphenol A and triclosan. We call these measurements 'biomarkers': pollutants or degradation products that are measured in biological matrixes, for example in blood, urine or hair. These biomarkers indicate the level of exposure to specific substances for a given person.

Laboratories compared

To validate and harmonise the measurements of the European member states, the different laboratories conducted comparative analyses. Video conferences were used to train and coach the countries in refining their measurements. **Stefan Voorspoels** of VITO: "The Belgian laboratories obtained good results for all biomarkers. For phthalates, VITO performed measurements for a number of countries, because only a few laboratories have the certificate required to analyse these substances. Hence, several European countries were unable to find a suitable partner to perform these analyses with the required quality. Phthalates are often used as an additive in plastics to ensure their flexibility and durability. They can however disrupt the hormone balance and are a risk factor for cancer, asthma and allergies. For this reason, it is important that they are monitored properly."

From results to recommendations

VITO coordinated the Belgian part of DEMOCOPHES and performed measurements on mothers and children. Via questionnaires, VITO also collected data on the home environment, smoking habits, eating habits, social class and hobbies. Combining all this information with the measurement data revealed some clear links, for example between mercury content in mothers and children, and fish consumption: people who eat more fish, especially sea fish, had a higher mercury content in their body. Mothers who often eat canned food had higher levels of bisphenol A in their urine. High concentrations of cotinine and cadmium were measured in mothers who smoke and children exposed to smoke from others. All countries are now starting a communication campaign to inform participants and policy makers of the project's results.

www.eu-hbm.info/democophes

Ludwine Casteleyn of the Center for Human Genetics at the KU Leuven and Project Coordinator of COPHES: "COPHES and DEMOCOPHES are a first important step in the direction of a harmonised European biomonitoring programme. In the future, however, we aim to further expand the number of measured substances and the population groups examined. The goal is a more representative picture of exposure among the European population. We are also looking for possibilities to link human biomonitoring to programmes measuring the health of the population. While there are many challenges here, there is significant scientific and political interest in the project."

How unhealthy are flame retardants?

Many products contain flame retardants: TVs, computers, clothing, building materials, car upholstery, curtains ... Although they already exist for quite some time, we still don't know much about how these chemicals enter the human body and what their effects are. VITO is examining these issues in a project that focuses exclusively on flame retardants: INFLAME.

Flame retardants are very useful; without the protection they provide, damage in case of fire would be much higher. But what is the extent of their use in everyday consumer goods and building materials? Are they migrating from products into the environment and people? How are they absorbed in the human body? And do they constitute a risk to health? INFLAME, a European Marie Curie project, aims to answer these questions.

Noninvasive techniques

Stefan Voorspoels of VITO: "Mobile phones, laptops and tablets contain many of these substances. Does this mean that those who often use these latest technological innovations are subject to higher exposure? To determine this, we will apply noninvasive techniques. An example of this is the analysis of urine and hair samples. In contrast to a blood sample, noninvasive techniques are also better suited for application to children, since they are less drastic. The disadvantage is that concentrations of the contaminants examined in hair and urine are usually much lower than in more-often-measured blood samples."

New contaminants

Hence, it is a major challenge to obtain the same information from hair and urine as from blood samples. "Current technology allows us to detect increasingly lower amounts," says Stefan Voorspoels. "From the moment that levels in noninvasive samples are validated with levels in the blood, the same conclusions can be drawn from noninvasive analyses as from more traditional (invasive) biomonitoring techniques. In a follow-up project, we also aim to investigate the applicability of noninvasive samples to a broader range of new worrisome contaminants."

Air quality prediction system shortly goes live

How can we predict air quality in highly polluted areas or hotspots? And how can we communicate this information to policy makers in a user-friendly way? That is the goal of the European Life+ project ATMOSYS: a policy support system for air quality in hotspot areas. VITO is developing the system together with the Flemish Environmental Agency (VMM).

Air quality in Flanders has improved drastically in the past twenty years. Yet Flanders does not meet the European standards for among others particulate matter and nitrogen dioxide. To monitor the situation, VMM is performing analyses in more than sixty automatic measurement stations. In the framework of the Life+ ATMOSYS project, VMM and VITO aim to increase the number of measurements and make access to the data more user friendly. The goal: an advanced and extensive forecasting system for air quality, and an internet platform that publishes the results.

Focus on elemental carbon

A major improvement in existing air quality systems is the addition of a geographically distributed emissions inventory of elemental carbon. **Lisa Blyth** of VITO: "One highlight of the system is its focus on elemental carbon (EC). This pollutant is a better indicator for contamination resulting from traffic than total mass PM, more specifically for the presence of diesel soot in the air. The existing measurement data from the extended telemetric network of VMM is sufficient for determining the background air quality in Flanders. For specific hotspots, however, this is insufficient. For this reason, VMM performed additional measurements in cities, and measurements were also taken alongside a busy motorway. These campaigns complemented the existing measurement data of VMM, which allowed us to evaluate our air quality models."

The campaign in cities started in July 2011. Air quality was measured in Ghent, Bruges, Antwerp and Ostend for one year, always at three different types of locations: a street canyon, an urban location and a regional road. In addition to EC, VMM measured the concentrations of nitrogen dioxide and particulate matter at all locations. In April 2012, a highway campaign was launched at the exit of the E40 motorway in Affligem; the campaign ran for six months. Here VMM focused on concentrations of particulate matter and black carbon. The latter is a good indicator for soot emissions from traffic and is closely related to EC.

"The measurement campaigns resulted in a good overview of fluctuations in air quality: work days versus weekend, school periods versus holidays, winter versus summer, and so on," says Lisa Blyth. "Aside from using this valuable information to gain further insight into the air quality in our hotspots, this data is also being used to validate our model simulations. We also measured concentrations of pollutants at varying distances from the motorway. This allowed us to develop a model to determine the spread of particulate matter to adjoining zones."

Web application

VITO is developing a web application to make the air quality models more user friendly. This will allow end users to analyse the results themselves. Lisa Blyth: "Once the final air system is operational, it will predict air quality for several successive days. Trends over an entire year, for example, can also be analysed. To display hotspots in sufficient detail, the regional spatial model is being expanded with a high-resolution model. The system also includes a tool to validate the model output according to the current guidelines of the Forum for Air Quality Modelling in Europe (FAIRMODE) initiative from the European Commission's Joint Research Centre. This guarantees end users that they indeed are consulting reliable data." ATMOSYS will first be applied to Flanders, but later can be used for hotspots throughout Europe.

www.atmosys.eu

Is jogging good for the brain?

It has been known for a long time that physical activity is good for our brains. But why? And what is the effect of air pollution? In a joint research project, the VUB (Free University of Brussels) and VITO examined the difference between joggers in the city and in the countryside. The outcome was striking.

The main building in Thor Park, where EnergyVille will roll out its activities

E-mission Plan for Genk South

Early 2012, the city of Genk launched the 'E-mission Plan', an action plan to reduce emissions and the effects of harmful substances around the industrial area Genk South. Nico Bleux of VITO is coordinator: "Last year, we involved companies, doctors and neighbourhood residents. This is already showing results." Genk aims to improve its air quality to exceed the average air quality in Flanders by 2020.

In recent years, Genk has taken many initiatives to reduce environmental emissions, odour and noise in Genk South. This was needed since Genk South is the fourth largest industrial zone in Flanders, and has a number of residential areas nearby that suffer the effects thereof. An integrated approach was needed; therefore, the E-mission Plan was launched.

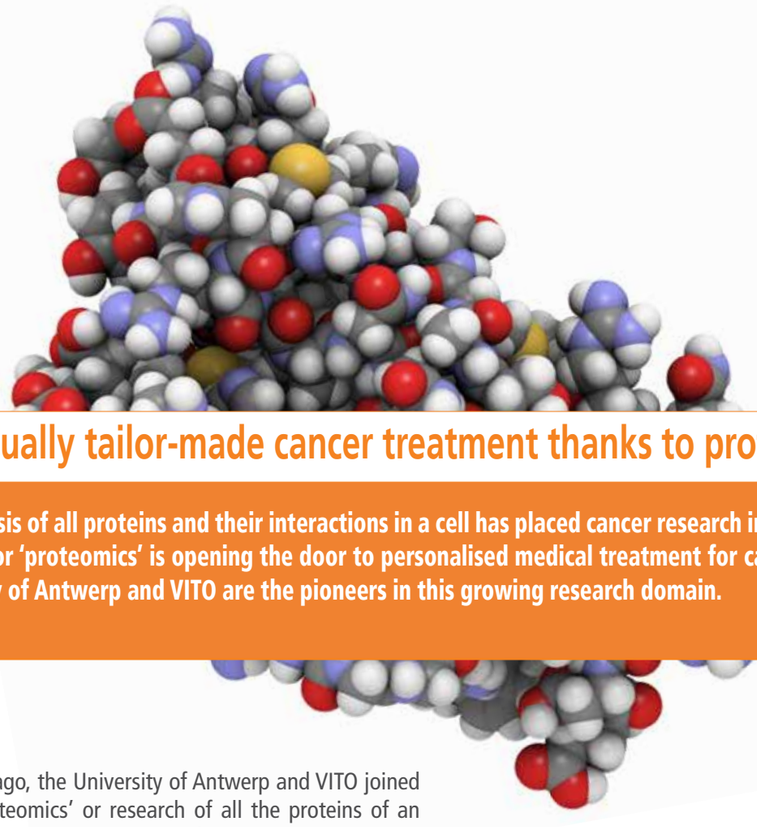
Creating involvement

Nico Bleux of VITO has been coordinating the E-mission Plan since March 2012. Awareness raising, tackling the source of the air pollution, research, communication … These are only a few of the actions contained in the E-mission Plan. "Last year, we involved the different governmental departments, doctors, companies and neighbourhood residents in the action plan. Which also created the needed support base. Moreover, for the first time in a long time there is a general improvement in air quality in Genk South. However, there is still much work to do."

New actions

The Flemish Government will also be initiating a number of new actions this year that build on the results of the human biomonitoring campaign. "Here again, we expect help from the companies in Genk South," says Nico Bleux. "The actions of this new plan in turn will be included in the E-mission Plan for Genk South. In short, the E-mission Plan is a dynamic project that tackles problems via a step-by-step approach. The goal: to raise the environmental quality to the Flemish average as quickly as possible. For the longer term, we are also working on a global vision for the industrial zone Genk South, analogous to Thor Park where EnergyVille and other energy-related companies will be located."

Wim Dries, Mayor of Genk: "The E-mission Plan allows us to better combine the strengths of different players. We cluster more than fifty actions on different fronts. That is exactly the reason why a central coordinator is indispensable. The knowledge, expertise and extended network of VITO represent a large added value."



Individually tailor-made cancer treatment thanks to proteome research

The analysis of all proteins and their interactions in a cell has placed cancer research in high gear. Proteome research or 'proteomics' is opening the door to personalised medical treatment for cancer. In Flanders, the University of Antwerp and VITO are the pioneers in this growing research domain.

Two years ago, the University of Antwerp and VITO joined forces: 'proteomics' or research of all the proteins of an (part of an) organism is now performed together in order to better understand life at molecular level. This in turn should result in quicker diagnoses of diseases and improved treatments and drugs. The research partners have already made significant progress in recent years. Expectations are high, especially with regard to cancer treatments.

Personalised medicine

Inge Mertens of VITO: "Tumour cells appear to modify the character of immune cells, thereby allowing the tumours to grow undisturbed. We are investigating this mechanism based on cell cultures provided by the University of Antwerp. The cause probably lies with the proteins excreted by the tumour cells. By analysing these proteins, we learn more about the behaviour and growth of tumours and new therapies can be developed."

In the end, proteome research should result in a new type of medicine based on the characteristics of the specific tumour and the individual patient. "Today cancer is treated using standard therapies," says Inge Mertens. "By tackling the proteome responsible for tumour growth, the patient receives targeted, personalised treatment. Another benefit is that for specific cancers, the proteome can be detected in urine and saliva. This allows a diagnosis to be made without a biopsy or blood sample, thus noninvasively."

Kidney transplantation

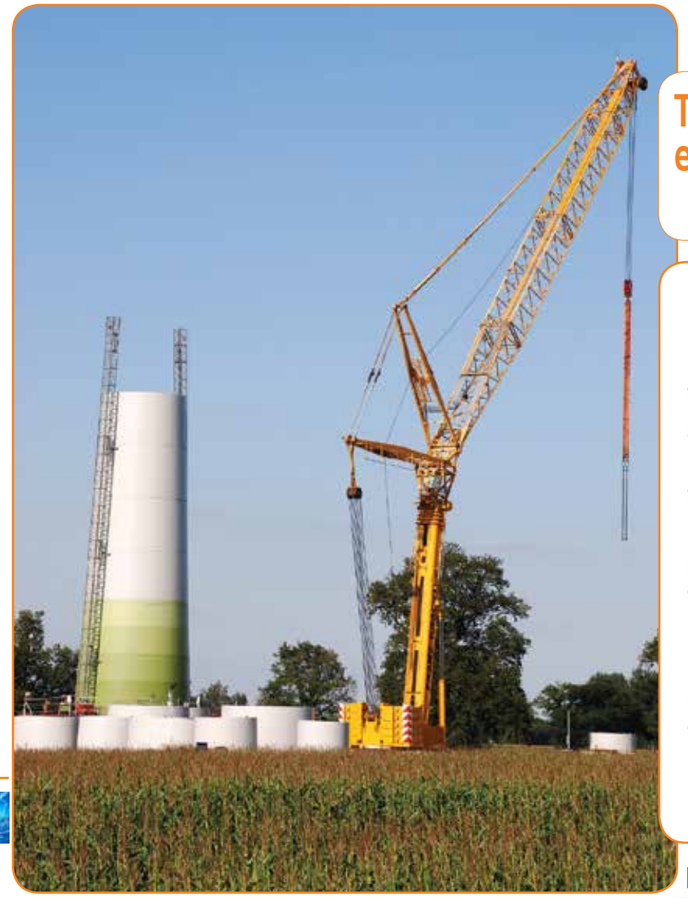
VITO is currently concentrating its proteome research on colorectal cancer, the most common form of cancer in Belgium for both men and women. Inge Mertens: "Our technology, however, can also be used for other diseases. The success rate of kidney transplantations, for example, can also drastically increase. Thanks to collaboration with several European clinical and academic partners, we are also studying how we can prevent the rejection of transplanted organs."

Filip Lardon, Professor of Experimental Oncology at the University of Antwerp: "To shape personalised medicine, we must increasingly draw up 'identity cards' for different types of cancers. And proteome research is invaluable in this endeavour. It provides us with important information on the behaviour of a tumour, the affected organ and the entire body."

ENERGY SYSTEMS OF THE FUTURE

Climate and environmental issues have intensified the worldwide need for innovation in the area of energy production, distribution and transport. VITO took up the challenge and committed itself to smart energy systems that can optimally handle the variable generation of renewable energy. The challenge is immense, but the studies, services and technologies of VITO show it is possible.

Read more: **www.vito.be/sustainabilityreport2012**



Towards 100 % renewable energy in Belgium by 2050

Can Belgium make a full transition from fossil fuels to renewable energy by 2050? A study by VITO, the Federal Planning Bureau and research agency ICEDD, shows that it is possible although the goal is extremely ambitious. The investment requirements are huge, but the transition to renewable energy would generate 20,000 to 60,000 new jobs in Belgium. Moreover, considerable savings are possible since it would no longer be necessary to import fossil fuels.

Converting the Belgian energy system fully to renewable sources will not be easy. Belgium is a small country with limited renewable energy resources, an energy intensive industry and an energy consuming residential sector. Nevertheless, it is technically possible for Belgium to reach 100 percent renewable energy by 2050. This is shown in a study conducted by VITO, the Federal Planning Bureau and ICEDD. The full transition to renewable energy by 2050, however, will not be an easy task.

One goal, multiple paths

Wouter Nijs of VITO: "We developed a reference scenario, and several alternative scenarios to reach the goal. The reference scenario describes how our energy systems would look if the policy choices of today were retained. The renewable scenarios are based on different amounts of solar panels, windmills and biomass to be used on a large scale. Another scenario investigates the effect of importing (green) electricity on a large scale."

For each alternative scenario, a radical transformation is needed in nearly all of our economic sectors. "Solar energy, wind energy, biomass and geothermal energy would need to grow substantially, especially between 2030 and 2050," says Wouter Nijs. "The electricity sector, however, would need to make a full transition already by 2030. After 2030, the expansion of producing green electricity continues. Therefore, the electrification of our energy system would be required. Hydrogen production, the use of heat pumps in buildings, and electric vehicles would then need to increase substantially. To make this possible, our current electricity production would need to triple by 2050."

Why investing is worthwhile

The researchers calculated that Belgium would need to invest an additional 300 to 400 billion euros in the period to 2050 in order to make a transition to a 100 percent renewable energy system. The investments are enormous, but a thorough switch to renewable energy would also bring many benefits. Belgium would no longer be dependent on imports of fossil fuels. The climate, our living environment and our health would also benefit from a transition to renewable energy. Finally, the impact on employment is also large. Compared to the reference scenario, the renewable energy scenarios would create 20,000 to 60,000 full-time jobs by 2030.

When including both the investments and the fuel import savings, annual expenditures on the energy system would increase by approximately 20 percent. "This prognosis of course depends especially on the evolution in fuel prices over the next 40 years," says **Jan Duerinck** of VITO. "And if the profit gained from decreased emissions of greenhouse gases is included, some scenarios yield a net positive effect of up to 10 billion euros per year from 2040."

What measures are needed?

What measures can Belgium and its three regions take to make the transition to renewable energy? "A clear and straightforward policy framework for renewable energy forms the basis for further actions," says Wouter Nijs. "Concerning energy efficiency, Belgium especially will need to renovate its existing buildings more quickly. An intelligent network is also needed to combine the centralised and decentralised generation of energy, and to coordinate the supply and demand of energy. The promotion of electrical mobility and the use of heat pumps could put the electrification of our society in motion. Further research is required, however, including technological research such as that taking place in EnergyVille. This is the only way that we will be able to form a realistic picture of how a 100 percent renewable future might look, what impact this ambition has, and what Belgium could gain from it."

Interfaces to make smart grids run smoothly

For smart grids to operate as they should, their building blocks need to work together. An immense challenge: unlike a traditional electricity grid, in smart grids not only does demand for electricity vary, so does supply. Standardised interfaces are being developed to intelligently manage energy consuming devices.

Energy-neutral buildings based on geothermal energy

If Flanders is to realise the goal of constructing buildings in an energy-neutral way by 2020, geothermal energy will be part of the solution. Promising is the intelligent combination of active building elements, geothermal energy, and thermal energy storage for heating and cooling large buildings. The Smart Geotherm project being implemented by VITO and KU Leuven, and coordinated by the Belgian Building Research Institute (BBRI), aims to realise the immense market potential for geothermal applications as quickly as possible.

New model clarifies link between transport and land use

What impact will road user charging, infrastructure investments, population growth and the economic crisis have on the transport of persons, traffic congestion and the corresponding emissions? VITO is studying the interaction between transport and land use via the ATLAS model.

Long traffic jams, growing urbanisation … Transport and spatial planning are two major challenges faced by Flanders. Since both challenges are strongly related, they are preferably tackled together in an integrated approach. People's choice of location and economic activities strongly determine our transport flows. The opposite also applies: accessibility is a factor in determining where people and companies locate.

Laurent Franckx of VITO: "The 'Assessing Transport and Land Use Scenarios' or ATLAS model developed by VITO describes these interactions. The model provides input for formulating predictions concerning future transport, which allows a mapping out of the evolution in our traffic flows." The development of the ATLAS model is being co-financed by the Flemish Environmental Agency (VMM).

From road user charging to infrastructure work

Inge Mayeres of VITO: "The ATLAS model consists of two integrated components: a spatially dynamic land use model, and a transport model for which we use the data of the Flemish Traffic Centre. The model is set up in such a way that both components can be deployed independently or together. This allows us to determine the impact of policy choices and demographic and economic evolutions on land use, transport flows and their emissions and energy consumption. Included here are road user charging, population growth, the economic crisis, infrastructure investments and so on."
VITO will run the first simulations using the ATLAS model during 2013. It will be an interesting tool, especially for policy makers.

Cost-effective valorisation of waste heat on port site

The Antwerp petrochemical industry generates some 1,000 MW of residual heat with a temperature higher than 80 °C. Currently, all of this residual heat is being wasted. Yet this energy could be used to heat industrial processes, buildings or many other applications. The Antwerp Port Authority, VITO and other partners have been studying possible ways to valorise this residual heat. The project was supported by the Environment and Energy Technology Innovation Platform (MIP).

While the Antwerp petrochemical industry has taken considerable efforts to increase its energy efficiency, low-grade energy is still being lost. The recovery of this residual heat provides a solution to further increase this efficiency. However, many factors still influence the actual application.

Technical and economic feasibility

Johan Van Bael of VITO: "How can low-grade industrial residual heat best be valorised? How much energy can be saved in this way? Which obstacles prevent the valorisation of industrial residual heat? And what is the best business model to be used? To answer these questions, we examined the technical and economic feasibility of a number of concepts to valorise residual heat. In this project, we studied the possibilities of district heating, heat-exchange between companies, delivery of heat to the horticulture sector, conversion of residual heat into electricity, and the production of demineralised water using a heat-driven process."

District heating

"Of all the concepts examined, district heating appears to be an interesting approach to valorising high amounts of low-grade residual heat," says Johan Van Bael. "The urban area close to the port is a large potential market for low-grade residual heat. If this potential can be unlocked, district heating with industrial residual heat could be an economically viable alternative to other heating sources."
A subsequent phase will examine whether the city of Antwerp can be equipped with heating networks.

Paul De Rache, Chief Engineer Energy Projects of the Antwerp Port Authority: "The Antwerp port companies have been making efforts for years to increase their energy efficiency, but a collective approach was lacking. To valorise residual heat, however, collaboration among companies, or between port and city, is vital. The MIP project has initiated this. Moreover, the feasibility study of VITO shows that the concepts can be realistic and economically viable."

Smart heat pumps for smart energy grids

To make the switch to renewable energy on a large scale, we need not only to adapt our electricity grid. Smart grids or intelligent networks are not possible without intelligent appliances such as heat pumps that react to the supply and demand of electricity. VITO examined how heat pumps could run as much as possible on green energy.

VITO IN FIGURES

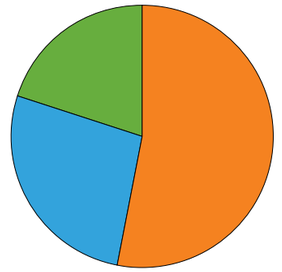
Implementation of the budget 2012 (kEUR)

Expenditures	2011	2012
Salaries	58 317	69 082
Operating means	29 805	28 693
Depreciation	16 235	26 638
Total	**104 357**	**124 413**

Revenue	2011	2012
Own revenue:		
- Other revenue	76 830	79 608
- Financing reference tasks	9 626	12 445
Subtotal	86 456	92 053
Grants	16 815	34 311
Total	**103 271**	**126 364**

Result	2011	2012
Balance to be carried forward	-1 086	1 951

VITO's total costs in 2012 were 124.4 million euro, of which 55.5 % were salaries, 23 % operating means and 21.5 % depreciation. Financing was 63 % revenue from contracts for industrial research or from specialised services, 10 % revenue from the Flemish Government for reference tasks, and 27 % from grants from the Flemish Government, so 'own revenue' amounts to 63 % of the total revenue. The financial year was concluded with a positive balance of 1.95 million euro.



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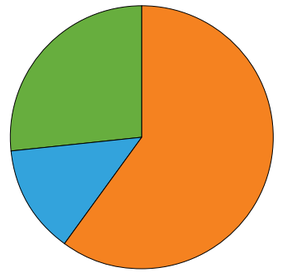

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