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We are used to strict building codes in the Netherlands. Legislation, permits and schedules of requirements dictate how a building is constructed. Nine times out of ten, the building remains unchanged until we deem it fit for demolition. The new main building of the Netherlands Institute of Ecology (NIOO) took a very different approach that can best be described as 'evolutionary'.

The office cum laboratory serves as a testing ground for eco-technology systems, where innovation and experimentation are given room to grow.

A building that breathes life

Learning from nature

The Netherlands Institute of Ecology, one of the research institutes of the Royal Netherlands Academy of Arts and Sciences (KNAW), studies the effect of nature in all its many forms. It is, therefore, only fitting that ecological processes and the dynamics of nature themselves influenced the design and construction of their new premises. The brief was to design a building that is comfortable and functional but that also blends into the surrounding environs. A tall order? With vision, creativity and perseverance, anything is possible.

Cradle to Cradle

Some years ago, NIOO decided to merge activities from two of its locations into one new sustainable building. NIOO director, Professor Louise Vet, was inspired by the Cradle to Cradle (C2C) principles and wanted to take the design and construction of their building one step further than the most sustainable buildings built to date in the Netherlands. Sustainability is generally measured by energy efficiency; the C2C concept, however, poses new criteria. The question is not what can we do to

limit environmental damage, but rather how can we make a valuable contribution to the surrounding environment? The C2C guiding principle is that production should be waste free. In the cradle to cradle model, everything we make and leave behind is regenerated as raw materials for use in the natural environment or in new products. The other two main principles are: use solar energy and celebrate biodiversity. The designers were instructed to keep as close to this philosophy as possible.

Process

NIOO-KNAW did not restrict its choice of architect and construction company to what you might term 'green' parties. According to Louise Vet, involving mainstream architects and builders in the process has a significant social impact. "You widen the circle of expertise and set an inspiring example for others." Having secured a European tender, NIOO-KNAW teamed up with **Claus and Kaan Architects**, and commissioned the design of a 'smart' building, one that is light and airy, ergonomic, easy to navigate and innovative in sustainable solutions. ►



A diverse design team was put together under the leadership of **Archisupport**, which included the construction company **Bouwbedrijf Berghege**, **DGMR Engineer Consultancy** and **DWA installation and energy consultants** (the complete list of participating parties can be found at the end of this article). With the advice and financial support of **Agentschap NL** (formerly SenterNovem) and the **Province of Gelderland**, the design team got down to work, employing an approach that combined learning as you go along and implementing what you have learnt.

Having clarified the design brief, the next stage was to tackle the construction process, which posed a new set of questions and sparked fresh discussions. Not least of all from those commissioning the building. Which materials should we use, what kind of flooring, how do we generate energy, how do we close the wastewater circuit, and what do we do with the residual heat? Louise

Vet was keen to share her take on things with her collaborators and welcomed their input. In its capacity as construction contractor, **Bouwbedrijf Berghege** regularly discussed the project with the builders so the entire team got a strong sense of the dos and don'ts of sustainable construction. To support this process, **Bouwbedrijf Berghege** created a newsletter and a construction file (www.berghege.nl). Another aspect quite unique to this project is that all the parties came together in a workgroup to coordinate communication on the design and construction.

Energy

Efforts towards energy efficiency cover two areas: reducing consumption and sustainable production, both of which lead to a reduction in CO₂ emissions. A great deal of progress has been made in recent years in energy efficient construction. Take for example, the sustainable lighting concept. Following **DWA's** advice, the building uses presence

detection and daylight regulation switching. This is a system that regulates the artificial brightness according to the amount of daylight at a particular given moment. The newest LED lighting is also being used where possible, inside the building as well as on-site. Furthermore, a hybrid ventilation system is installed. The design encourages natural ventilation and thermal migration through the walls. Mechanical ventilation is only enabled based on CO₂ detection.

A trial is being conducted with the company **Suncycle** to develop a new generation of energy-producing solar cells. The solar collector in the form of a sphere is cheaper and more efficient than traditional solutions and also provides heat. On the NIOO site, water will be used to check the cooling of these solar cells, the warm cooling water can then be used to heat greenhouses and bioreactors. A collection of thermal solar panels stores the sun's heat using unique High ▶



Temperature Storage (HTS). Besides the solar heat, the HTS also stores the excess heat from the building and the greenhouses. At a depth of 300 meters, the temperature storage is located in much deeper geological strata than ever before. The depth allows excess heat produced during the summer to be stored for use the following winter. This innovative pilot project application developed by **DWA and IF-Technology**, produces energy savings of 70% to 80% and the **Province of Gelderland** and **Agentschap NL** have earmarked funds to launch it as a pilot project. The stored heat is delivered through pipes in the floors to the interior (concrete core activation). Energy savings will increase in the coming years as

new technologies like solar energy plants and solar cells are refined and applied on a larger scale.

Material

Claus and Kaan Architects had to meet a number of stringent material specifications. The building had to be people and environmentally friendly, made from renewable raw materials and economically produced without any harmful emissions. The hull is made of durable concrete without any artificial additives and no sealant, solvents or such like were used in the process. They also took into consideration products that carry quality marks such as FSC and PVC-free certified materials. Using materials such as wood, glass, steel, ground

limestone and granular debris creates a streamlined building with an open and natural appearance. As **DGMR** puts it: "The design and choice of materials exude sustainability. No more needs to be said. The building speaks for itself".

The flooring, notably in the laboratory, posed a particular challenge with regards to the set criteria. A common application of epoxy resin had to be rejected on account of its harmful effects. Eventually the architect came up with the solution of polishing the concrete floors, which though labour intensive, was a relatively simple procedure. The end result is a beautiful, tight-fitting floor that enables optimum distribution of heat and cooling energy through the concrete.

Water

The approach to recycling is most visible in the water circuits. The objective is to purify the waste water so that it can be discharged locally and is indeed of the same quality as drinking water. In connection with this, the client found a connection to the sewers unnecessary. Building permits, however, do not allow this. So, while there is a sewer, NIOO would prefer not to use it. There are three different water circuits: rain water, domestic water (including water from laboratories) and waste water from the toilets. ►



After purification (see below) the streams flow into a helophyte filter. Helophytes are aquatic plants such as reed and cattails, which remove contaminants from the waste water, thus reducing the ecological impact. The purified water then flows into a pond and the open ditches in the surrounding area. Another option is to pass water through the soil, pump it up and reuse it for flushing toilets, for example.

Waste = food

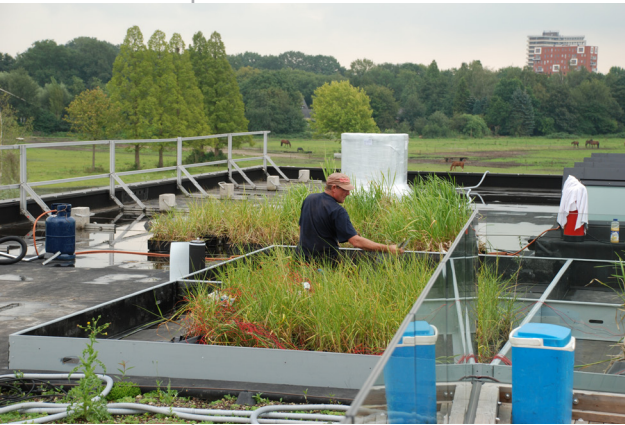
A truly complete recycling process is one that generates no waste. In treating all waste as food, you create an ecological system that mirrors those found in nature. This is one of the main principles of the Cradle to Cradle philosophy.

Based on this principle, a system is being developed for the NIOO building that retrieves valuable nutrients from faeces. This work is being carried out in collaboration with a commercial company, **DeSah BV**, an algae production company **Ingrepro** and **Wageningen University**. The system begins with the toilet. Vacuum toilets, a unique concept in an office building, use a minimal amount of groundwater. The biomass is then passed into a fermenter, where part of it is converted into biogas, thereby linking the sanitation system to the energy system. The final stages of water purification will involve an alga cultivation system and a helophyte filter. NIOO and WUR scientists study the ability

of algae to purify water (human pathogens, pharmaceutical rest products, metals). By harvesting the algae valuable minerals such as phosphates are recovered to be used as agricultural fertilizers.

Biodiversity

The NIOO-KNAW building has a green roof. That goes without saying given that roof vegetation filters water and air and aids temperature control. However, NIOO is taking it one step further. Together with **Wageningen University** research is being conducted into how green roofs can contribute to sustaining the variety in species of plants and animals. The Ministry of Agriculture has awarded NIOO-KNAW an incentive prize to ►



develop this project in the interests of saving endangered species of plants listed under the European Habitats Directive. At the same time the roof is also a site for the company **Plant-e** to experiment with technology that

generates power from living plants.

Outside the building biodiversity is encouraged in a variety of ways, together with bodies such as Heg en Landschap (hedge and landscape foundation), the Dutch Butterfly Conservation and the Netherlands Society for the Protection of Birds. There are diverse green hedges, a bat cellar and the bicycle parking will serve as a bee hotel for – endangered - solitary bees.

Integrated approach

Materials, water, energy, waste, and vegetation: these are not separate entities. According to Bouwbedrijf Berghege, what makes the NIOO-KNAW project so special is that they are not striving to be the first, the best, the smartest or the most innovative in one specific aspect of sustainability, but to integrate a range of aspects. This poses a complex challenge, or course, but it also brings great rewards. Linking the sanitation system to an algae production system is a unique process and promotes the effective use of what was previously billed as 'waste'. A floor without plasticizers has also been shown to optimize the concrete core activation system. The benefits of a green roof are being combined with the principles of biodiversity. Residual- and summer heat is stored long-term for future use. These are examples of eco-effective design where the focus is not only on making efficient use of separate systems, but also on creating

an effective link between the systems and residual flows. The extent to which this integral vision has been achieved in the Netherlands is second to none.

A building that breathes life

The NIOO building will never be 'finished'. There will always be room for improvement and experimentation in the future. The building mirrors the dynamics found in nature and will continue to adapt to new understandings and new technologies. To aid the development of eco-technology, NIOO-KNAW is encouraging companies to implement their ideas and applications for environmental sustainability and the Cradle-to-Cradle method.

Learning from nature

Global ecosystems are endangered by rapidly growing demands for food, fresh water, timber, fiber and fuel. Biodiversity is lost at an alarming rate by expanding economies that ignore environmental degradation. There is an increasing need to change from a linear, resource destroying, take-make-waste economy towards a circular economy. But crises create room for innovations. Nature can teach us valuable lessons for the transition towards a different economy. After all, our planet has functioned for more than 3 billion years without us in a sustainable way. As ecologists we preach and practice that sustainable innovations, inspired by nature, are the promises and challenges of the future. ►





Participating organizations

Commissioned by:	Royal Netherlands Academy of Arts and Sciences (KNAW) (property owner). NIOO-KNAW (user)
Management:	Archisupport
Architect:	Claus and Kaan Architects
E+W advisor:	DWA, advice on technical installations
Advisor on Building Physics:	DGMR, building physics, fire safety and sustainability Advice on environmental issues
Structures advisor:	ARUP
Contractors:	Bouwbedrijf Berghege
Mechanical engineering contractor:	Burgers Ergon
Electrical engineering contractor:	Imtech
Sustainable greenhouse design:	Lek Habo Groep

Integrated projects with third parties

Sustainable roof systems:	Local water treatment:
Consolidated	NIOO-KNAW Aquatic Ecology
WUR - Hydrology	WUR-Environmental Technology
NIOO-KNAW Terrestrial Ecology	Water Board Vallei and Eem
High Temperature Storage:	Ingrepro (algae)
IF Technology	Landustrie/DeSah BV (vacuum toilets)
DWA	Ecofyt (Helophyte filters)
Agentschap NL	Biodiversity/site design:
Province of Gelderland	NIOO-KNAW
Solar cells:	Stichting Heg en Landschap
Suncycle	Koninklijke Ginkel Groep
Wepro	Wageningen Milieuoverleg
Power from plants:	Dutch Butterfly Conservation
Plant-e B.V.	Netherlands Society for the Protection of Birds