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LEARNING FROM NATURE: NEED, CHALLENGE AND IMPLEMENTATION OF ECO-TECHNOLOGY

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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. When we talk about crises it is not a financial crisis we should worry about, but the loss of resources and life on earth. 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. Ecologists can preach these wise lessons but it is even better when they practice them. Sustainable innovations, inspired by nature, are the promises and challenges of the future. In this lecture I will present an overview of some eco-technological applications, including Plant Microbial Fuel Cells, in our new sustainable building.

CLAUS EN KAAN ARCHITECTEN

A building that breathes life

Early January 2011, the Netherlands Institute of Ecology (NIOO), one of the research institutes of the Royal Netherlands Academy of Arts and Sciences (KNAW), has merged its activities from two of its locations into one new sustainable building. The NIOO studies the effect of nature in all its many forms. It is, therefore, only fitting that ecological processes and the dynamics of nature themselves have influenced the design and construction of their new premises.

Cradle to Cradle
Inspired by the Cradle to Cradle (C2C) principles the design and construction of the building was taken one step further than 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 principles are the closing of cycles, the use of solar energy and the celebration of biodiversity. The designers were instructed to keep as close to this philosophy as possible. The office cum laboratory now serves as a testing ground for eco-technology systems, where innovation and experimentation are given room to grow.

Process
Having clarified the design brief, the next stage was to tackle the construction process. Which materials could be used, what kind of flooring, how to generate energy, how to close the wastewater circuit, and use the residual heat? Efforts towards energy efficiency cover two areas: reducing consumption and sustainable production, both of which lead to a reduction in CO2 emissions. The building uses presence detection and daylight regulation switching. LED lighting is being used where possible. Furthermore, a hybrid ventilation system is being 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 produces energy savings of 70% to 80%. 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. Using materials such as wood, glass, steel, flax, ground limestone and granular debris creates a streamlined building with an open and natural appearance.

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. In connection with this, the NIOO 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.

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-KNAW building that retrieves valuable nutrients from faeces (in collaboration with a commercial company, DeSah BV and Wageningen University). The system begins with the toilet. Vacuum toilets, a unique concept in an office building, use a minimal amount of water. The biomass is then passed into a thermophylic 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 will have a green roof. That goes without saying given that roof vegetation filters water and air and aids temperature control. However, NIOO-KNAW is taking it one step further. Together with Wageningen University research is being conducted into how different green roofs function and contribute to sustaining the variety in species of plants and animals. The prior Ministry of Agriculture supports this project in the interests of saving endangered species of plants listed under the European Habitats Directive. The site is being constructed in harmony with the surrounding environment, where biodiversity is encouraged in a variety of ways. The site will offer prime conditions for scientists and companies to experiment with technology that generates power from living plants!

Integrated approach

Materials, water, energy, waste, and vegetation: these are not separate entities. The challenge lies in the integration. The NIOO-KNAW is 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 the energy system is a unique process and promotes the effective use of what was previously billed as ‘waste’. The benefits of a green roof are being combined with the principles of biodiversity. Residual 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.

A building that breathes life

The NIOO-KNAW 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 and scientists to implement their ideas and applications for environmental sustainability and the Cradle to Cradle method. Plant Microbial Fuel Cell technology is being implemented by Plant-e on the roof and further up scaling will be encouraged. NIOO is looking forward to it!