Towards a Dutch declaration of *energy* independence

Designing sustainable energy landscapes in South Limburg

In the coming years, we have to invest in 'climate proofing' at the same time accommodating a 'new function' in the landscape: Energy provision. The Netherlands have a long history of renewable energy; for example, the cultural landscape of Kinderdijk. Yet, the (apparent) abundance of fossil fuels has marginalized sustainable energy provision. Today, we rely on the import of fossil fuels; the Netherlands are no longer independent. Our hypothesis is that nature offers powerful strategies for coping with resources scarcity and land-use competition. The 'landscape approach to energy transition' integrates ecological process thinking and strategic landscape design. Sustainable energy landscapes are capable of increasing regional selfsufficiency; one step towards independence from energy imports.

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Paradigm shift

More than 95 percent of the total Dutch energy provision is based on fossil fuel resources emitting vast amounts of greenhouse gases. During the last years the fraction of imported energy has risen to more than 60% of the total energy provision (CBS, 2003). For many reasons, this situation is not sustainable, neither in economical nor in ecological terms. Obviously, energy can be imported to accommodate increasing demand. However, importing energy increases dependency on foreign economies.
Above all, scientific studies have revealed a significant correlation between the excessive combustion of fossil fuels and global warming, leading to changing climate and precipitation patterns as well as rising sea levels.

The paradigm shift from a fossil fuel driven economy to a society based on renewable energy requires smart solutions and responsible decisions, in particular from professionals dealing with the built and non-built environment. Sustainable thinking must become an imperative factor while designing the human environment. In doing so, spatial design disciplines can remain relevant and face their responsibility for other places as well as for future generations.

Russia	28%
Saudi-Arabia	20%
Norway	11%
Great Britain	8%
Algeria	5%
Iran	4%
Nigeria	3%
Venezuela	2%
Libya	1%
Gabon	1%
Egypt	1%

Table: Origins of crude-oil imports to the Netherlands.

Energy and landscape architecture

Recognizing the emerging challenges related to climate change and energy insecurity, one may wonder how this would affect spatial design in general and landscape architecture in particular? The answer is twofold. On the one hand, most consequences of extensive fossil fuel consumption manifest themselves in the landscape while at the same time affecting living conditions. On the other hand, we know that landscape architecture is based on the knowledge of natural processes, human behavior and aesthetic perception; all of them being affected by energy provision. It is here, at the interface between natural science and architectural imagination that lies great potential for dealing with future energy provision. Unlike other professions, landscape architects have been practicing energy-conscious design at different scales for many years.
Traditional measures of landscape design such as the utilization of natural vegetation for shading can significantly reduce energy consumption for air-conditioning. Through investigation of greenhouse gas emission sources, it has been proven that carbon dioxide is released from peat soils as they are drained for agricultural use. Large scale deforestation represents another human impact upon the landscape and compromises the sequestering of carbon dioxide through photosynthesis. Throughout the last decades scientists, architects and designers have begun to understand the manifold relations between landscape, energy and climate. Based on these experiences, landscape architects are now working closely with other professionals to develop strategies for coping with carbon dioxide emission and resource depletion.

Energy as driver of human development

Looking back in history, one can identify two periods of rapid population growth tied to energy procurement. With the development of agriculture 13,000 years ago, the amount of food and fibres that could be provided by a given area increased. Two centuries ago, the industrial revolution initiated the second rapid increase in world population which still continues. Industrialization (and modernity) was driven by fossil fuel powered machinery. Clearly, the human population does, to some extent, increase due the abundance and exploitation of fossil fuels. Reciprocally, growing populations demand more and more energy to maintain and repair the human life support systems they have created.

Windmills in Amsterdam; sustainable water management in first half of the 19th century.

Energy reflected in the environment

Although we have been aware of the stress that the human lifestyle places on the environment, man has only recently begun to realize the damage. As a result, we now question the excessive use of fossil fuels.
The ongoing exploitation of non-renewables results in a cost transfer to the environment (e.g. pollution) and to future generations (e.g. energy scarcity). It is clear that the access to relatively inexpensive fossil fuels has suppressed already existing renewable technologies throughout the past two centuries.

Industrialisation (and later modernity) induced an anthropogenic, large-scale transformation of what were until then regenerative landscapes. Consequently, many of today's Dutch landscapes can be depicted as 'fossil fuel' or 'industrialized' landscapes with high energy input for food and fibre production, infrastructure, housing and water management (e.g. pumping). Many people refer to the Dutch countryside as cultural or recreational landscape. However, most of the present landscapes are simply (non-sustainable) energy landscapes. One can not only find traces of resource extraction but most of all, and far more visible, traces of excessive energy consumption. Among the omnipresent elements of the fossil fuel based energy landscapes we see massive highways, high-voltage power lines and large-scale monocultures.

It is not the intention of this article to discuss the value of today's landscapes. Rather, it is to encourage a critical view on the landscape we are living in today before negotiating the measures of sus-

(Non-sustainable) energy landscape in the South of the Netherlands reflected in extensive infrastructure, highly fragmented landscape and large-scale chemical production.

Similarities between spatial distribution of natural vegetation in Senegal (left) and settlement patters in 1850's Limburg (right). The location of plants and villages is primarily driven by resource availability.

tainable energy transition and assessing the consequences attached to them. Possibilities for a sustainable energy transition involve, above all, balancing energy provision with other land uses, such as food production, waste treatment, flood control, preservation of biodiversity and provision of housing.

Energy as prerequisite for evolution

Every process requires energy. Energy scarcity has triggered many ingenious solutions in the natural world; evolutionary concepts reach from symbiosis to biorhythm. Identifying new strategies for how to deal with resource depletion and increasing competition for remaining resources in the human systems requires, first of all, a thorough understanding of the complex human energy and material systems. Only if we can disentangle the complexity of the human environment, we can apply new design strategies derived from natural systems. In Kalundborg, Denmark, for example, complex material cycles and energy cascades (from high quality to lower quality energy) have been studied extensively. The cities highly efficient energy and material systems have, partly by chance, evolved over more than twenty years. One may question to what extent ecological reasoning has contributed to this development; as many similarities have been identified between this human ecosystem and natural systems. The successful evolution of what has been coined industrial ecology in places like Kalundborg allows us to remain optimistic and to advance ecological concepts and strategies toward a spatial application in the landscape.

Energy transition: learning from nature

Ecology constitutes one of the relevant natural sciences guiding the path towards a more sustainable world. Ecology is not only relevant because it deals with the environment, energy and resources, but also because of its integrative and regenerative approach, reflected in 'system thinking' and 'process ordering'. Due to long-term evolution, nature has designed highly efficient systems integrating energy flows and material cycles, for example, photosynthesis. Because ecological systems are self-organizing and regenerative systems, the very processes that take place in nature can offer a starting point for the design of more energy-conscious landscapes.

Since the dawn of the twentieth century ecologists have created an extensive list of ecological concepts describing the relationship between organisms and their environment. At the beginning of the 21st century, we are now in a fortunate position where we can not only learn about ecological systems but also from natural processes and the spatial organisation of ecosystems in order to adapt the landscape.

From renewable resources to sustainable systems

In principle, two periods can be identified in the discussion on energy transition. Firstly, all kinds of technologies based on renewable resources have been discussed within the scientific community and the broader community. Only with the rising demands for a socially fair, environmentally friendly and economically feasible future, the focus has shifted towards more sustainable systems. This is primarily due to the fact that some of the renewable technologies, although reducing greenhouse gas emissions, harm the environment as well as humans. One example of this is the *Three Gorges Dam*, a massive water reservoir in China. The construction of which has led to the relocation of entire cities with more than 1.4 million inhabitants. Looking at this example, it becomes clear that we should not only strive to maximize the mere energy yield, but try and balance energy generation with other environment services such as human well-being and recreation. It is our conviction that the transition towards more self-sufficient and renewable energy systems can be accomplished without compromising other crucial land uses, biodiversity or landscape experience. This is what we refer to as the sustainable energy landscape.

Sustainable energy landscapes

According to ecological theories, the capacity for sustainable energy provision is determined by geographical location, climate and geology, and is therefore limited. This knowledge highlights the urgent need for also improving the overall energy efficiency as we compete more and more with other countries for the remaining non-renewable resources. Energy transition does not only focus on the generation and storage of energy but also intends to improve energy efficiency through the use of advanced technological and ecological means. Material cycling, energy cascading and second generation biomass production are among the many valuable concepts which are now being investigated for their spatial consequences. Designing sustainable energy landscapes is to envisage an environment which yields, stores, cascades and saves energy by means of advanced spatial planning and improved land use practices.

Landscape strategies for South Limburg

Case-studies and literature research demonstrate that ecological concepts such as biorhythm and niches have been applied successfully in spatial planning. Time-sharing concepts and vertical layering of functions are only two strategies with direct consequences for the spatial composition and quality of the landscape. In order to identify additional ecological concepts for mitigating resource depletion and balancing fierce competition, we have selected South Limburg as a case study. The region of South Limburg has a history as energy provider to the entire Netherlands. However, with the closing of the coal mines in the early 1960's the region not only suffered thousands of job losses but also became highly dependant on energy imports from other parts of The Netherlands and abroad. Today, about 98 percent of the energy demand in South Limburg is provided from outside the region.

In January 2007, we invited a group of international master students to join us rendering a more sustainable future for this unique region in the south of the country. (Participating students: Claire Oude Aarninkhof, Arjan Boekel, Nejc Florjanc, Pieter Foré, María Galdón, Kees Neven, Bas van de Sande, Martijn Slob and Tijmen van Straten; Tutoring Regional Atelier: Ir. Rudi van Etteger, Prof. Dr. Jusuck Koh and Sven Stremke M.A.)

Clearly, our mission drivers were the depletion of fossil fuel resources, increasing CO_2 emissions, the dependency on energy import and the economic shortfall of the region. The assignment was to design sustainable landscapes increasing the regional self-sufficiency in terms of

The transformation to sustainable energy landscapes can be guided by small interventions: Plantation of willows and other energy crops in the Maasvalley. Photograph of the site in 2007 and visualization for 2035.

energy. The scope-of-work included a wide range of energy related issues ranging from potential energy savings, assimilation, storage, transportation, consumption and re-use of energy to the exploration of added values on a regional scale.

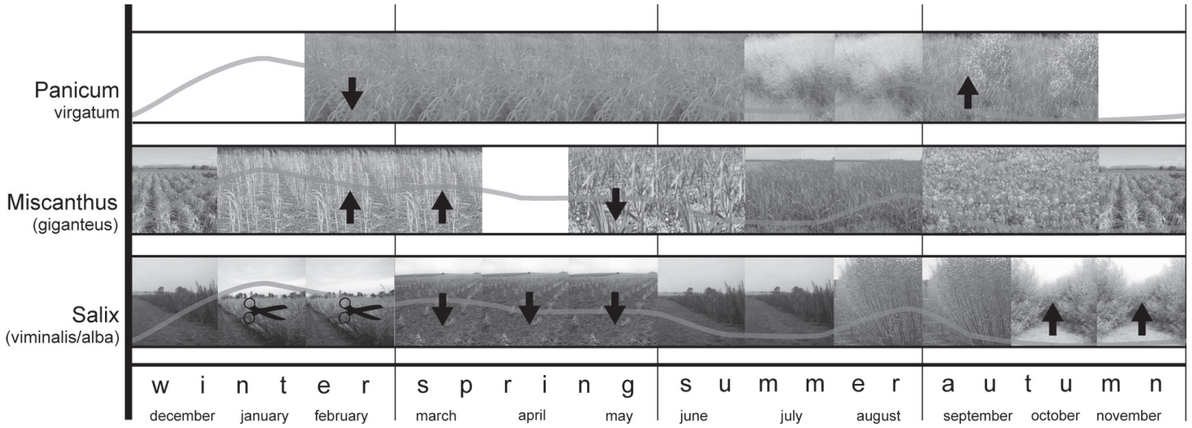
Throughout the design atelier, the participants visited the area, conducted interviews and met with a large number of representatives from regional initiatives such as the *Minewater* project in Heerlen, *Interessegemeenschap Kleine Landschapselementen*, and *Regional Centre of Expertise*. Speaking with Limburg's farmers and representatives from medium scale enterprises such as the *Gulpener Brewery* was especially helpful to understand the relevant developments and concerns of the stakeholders. During the design process, the group split up into three smaller working units investigating the *Maasvalley*, *Heuvelland* and the *Parkstad* in-depth. These three subregional areas all have unique qualities, and different approaches were suggested. Based upon the understanding of inherent landscape qualities as well as human activities, each of the 'subregional' teams composed strategic landscape visions supported by a set of landscape strategies for the transition.

The landscape strategies were than applied and tested, visualized and presented to the public. Based upon the extensive site analysis, interviews, and public debates we have then rendered a number of more prescriptive design guidelines which can help in the design of energy-sufficient landscapes in other regions. Clearly, most of the landscape strategies as well as the design guidelines are rooted in the core values of our profession: the understanding and appreciation of the landscape consisting of built and non-built areas. However, we hope they may also represent powerful ideas and scientific reasoning to inspire spatial designers, architects and planers.

The relevance of the 'ReEnergize South Limburg' design atelier to the present debate on climate change and resource depletion has been acknowledged by the International Federation of Landscape Architects (IFLA) during their 2007 conference in Kuala Lumpur, Malaysia. The students' submission 'Vitalizing Maasvalley' was selected as the most innovative European contribution. María Galdón, Claire Oude Aarninkhof and Martijn Slob received the IFLA jury award.

Landscape approach to design

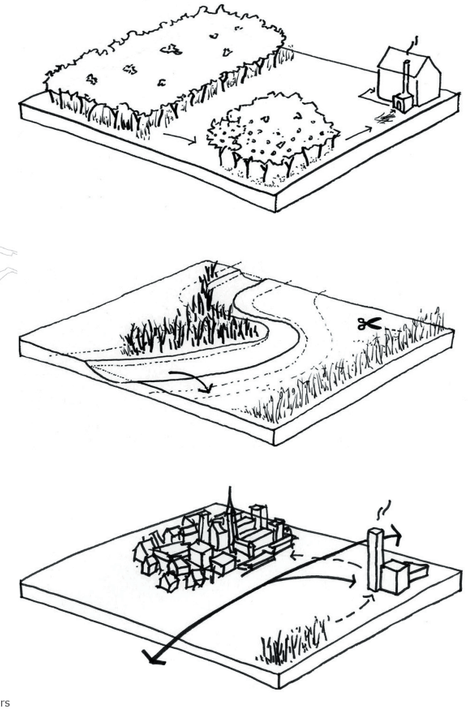
Developing an integrative and regenerative approach to landscape design is one of the research objectives of the landscape architecture program at Wageningen University. It is important to stress that our research is not limited to energy transition. It embraces other, essential challenges such as the adaptation of Dutch landscapes to climate change and the preservation of cultural landscapes. The emerging landscape approach to design is one way of learning from our environment. It describes the entire landscape as overlapping patches, each with numerous indispensable natural processes. The landscape approach allows us to recognize the growing impact of mankind on the natural ecosystems and our responsibility to future generations. By definition, the landscape approach aims to integrate spatial thinking with the knowledge of natural and human-driven processes. Based on the current research activities, we hope to advance well-described ecological concepts towards more explicit landscape strategies and design guidelines. The symbiosis between the understanding of processes and creative spatial thinking can form a solid basis for the landscape approach to render solutions for a more sustainable landscape.



Biorhythm applied; landscape strategy for short-rotation biomass plantations in the Maas floodplains.

Energy-conscious landscapevision for the Maasvalley (2035)

In the case of South Limburg, it has been estimated that more than 50 percent of the energy demand can be provided from within the region by 2035. The students have envisaged a sustainable landscape which integrates with the core qualities of this national landscape. Their design proposals also identify added values such as improved flood control and minimized soil erosion. The Dutch government as well as many cities and municipalities have articulated their objectives increasing energy efficiency and provision of renewable energy. Energy-conscious landscape design can render pathways for more self-sufficient and robust regions; a roadmap towards a Dutch declaration of *energy* independence.



Design guidelines for placing of biomass plantations in the landscape.