SUSTAINABLE ENERGY TRANSITION: A NEW DIMENSION IN THE DUTCH LANDSCAPE

Position paper by ECN and WUR

PREAMBLE

The transition towards a sustainable energy system will have far-reaching consequences in many areas of Dutch society. These include changes to the living environment and landscape. In order to achieve a successful energy transition, early consideration of the spatial design of new energy landscapes and the way in which they develop is essential.

This means all parties involved coming together in a concerted effort to design energy landscapes in which people and technology meet each other in a new way. A new way of thinking is needed that goes beyond spatial integration, towards the creation of landscapes that people value and that are economically feasible. Landscapes that help ensuring that the transition to a sustainable, low-carbon future is supported and can take place rapidly.

In this paper, ECN and WUR have combined their knowledge about energy technology and landscape architecture. By doing so, we aim to contribute to the debate about what is desirable and necessary in order to ensure that the energy transition is on the right track from a spatial perspective.

CONTENT

1. THE ENERGY TRANSITION IS SET TO TRANSFORM THE DUTCH LANDSCAPE

Ever since the Dutch National Energy Agreement and the Paris Climate Agreement were concluded in 2013 and 2015, the transition to a sustainable energy system has been high on the agenda. The Netherlands is at the start of a new development in its energy supply, a development that has only just been initiated and is set to gain momentum rapidly. There is a growing understanding that the energy transition will have major consequences, both economically and socially, and that our landscape and living environment will change as a result. In the words of the Dutch Science Agenda (*Nationale Wetenschapsagenda*, 2016), 'every surface ought to generate energy'.

These changes are not new in themselves. Landscape and the living environment at large have always been subject to the dynamics of human actions. The energy supply, including energy storage and transport, are an important part of those dynamics. Think of the peat-bog lakes of the central Netherlands, the mining slag heaps of Limburg and the gas extraction plants in the north of the country: the landscape is covered with evidence of our energy consumption. Some parts of that historic energy landscape, for example Kinderdijk, have become world cultural heritage recognized by the UNESCO.

The windmills at Kinderdijk, an historic energy landscape and a UNESCO world heritage site since 1997.

What is new is that energy generation largely takes place above ground and potentially also closer to home and that a lot needs to change in a relatively short time. If the energy transition is to be successful, it is important to start thinking now about the spatial design of new energy landscapes and the way in which they will come about.

In practice, some renewable energy projects appear to enjoy little support: large-scale wind energy projects face opposition and solar parks cannot necessarily count on the support of local residents. However, the plummeting costs of renewable energy technology are now creating opportunities for design and experiential quality, visual or otherwise. Creativity and a concerted approach will be necessary in order to enable our living environment to sustain on the basis of renewable energy, indifferent from past energy transitions.

Various publications have recently called for attention to the impact of the energy transition on the landscape. They not only highlighted the need to consider the negative consequences but also the positive opportunities and how to take advantage of them. For example, in its advisory document entitled The Connecting Landscape (*Verbindend Landschap*, 2016), the Council for the Environment and Infrastructure (*Raad voor de Leefomgeving en Infrastructuur*) stresses that the transition to renewable energy offers opportunities for adding value to the landscape. It calls for early interaction with residents. The Energy Agenda (*Energieagenda*), published in late 2016 by the Ministry of Economic Affairs, called for 'an energy transition that enhances the quality of the living environment'. A separate chapter includes policy-related outlines for the 'spatial integration' of the energy transition that will be developed in more detail in the National Environmental Vision, to be published in 2019 (*Nationale Omgevingsvisie*).

Nevertheless, new questions arise. For example, is it possible to generate renewable energy 'everywhere' and 'enhance the quality of the living environment' at the same time? How should that quality actually be defined? Who decides what is attractive? What interaction is there between landscape and technology? What value do local residents and stakeholders place on that interaction and in what ways can they influence it?

We believe that these and other questions require urgent answers. The views expressed in policy documents as well as our own experiences, acquired through research and design practice, could hardly be clearer. The starting point is that renewable energy will (again) become a component of our living environment everywhere. By means of this paper, we at ECN and WUR aim to contribute to the debate about what is desirable and necessary to ensure that the energy transition runs smoothly from a spatial perspective.

2. ENERGY TRANSITION AND THE USE OF SPACE

In order to limit global temperature increase through climate change to 2 degrees, and preferably 1.5 degrees, energy saving and the large-scale application of renewable energy will be essential in the coming decades. Even in a relatively densely-populated country like the Netherlands, there are ample opportunities for renewable energy. Take, for example, wind energy, solar energy (power and heat), biomass and geothermal energy. The contribution made by biomass cultivated in the Netherlands is very limited and is expected to remain so. The contribution of geothermal energy is substantial, but much of the infrastructure is underground. The role of energy storage and distribution is however becoming increasingly important and technical installations are more visible. We are therefore limiting ourselves here to wind and solar energy, focusing on above-ground energy installations.

Renewable energy is crucial to combat climate change but it is also beneficial for the economy. The transition to a sustainable energy system offers ample opportunities for entrepreneurs, including the manufacture, installation, maintenance and management of energy technologies.

Public support has a major impact on the pace and extent of renewable energy implementation, as experience has shown in recent decades. This is why it is important to switch from a situation driven by policy incentives to one in which growth is based on demand. The luxury of plummeting prices and the urgent need for the energy transition mean that we can and must allow ourselves to shift our focus from a lowest-cost strategy to a strategy that combines low costs with high value for society.

Falling cost of wind and solar energy

In recent decades, the cost of wind and solar energy has fallen spectacularly and there is every sign that this is set to continue. This is why wind and solar energy will be the engine behind the Dutch energy transition.

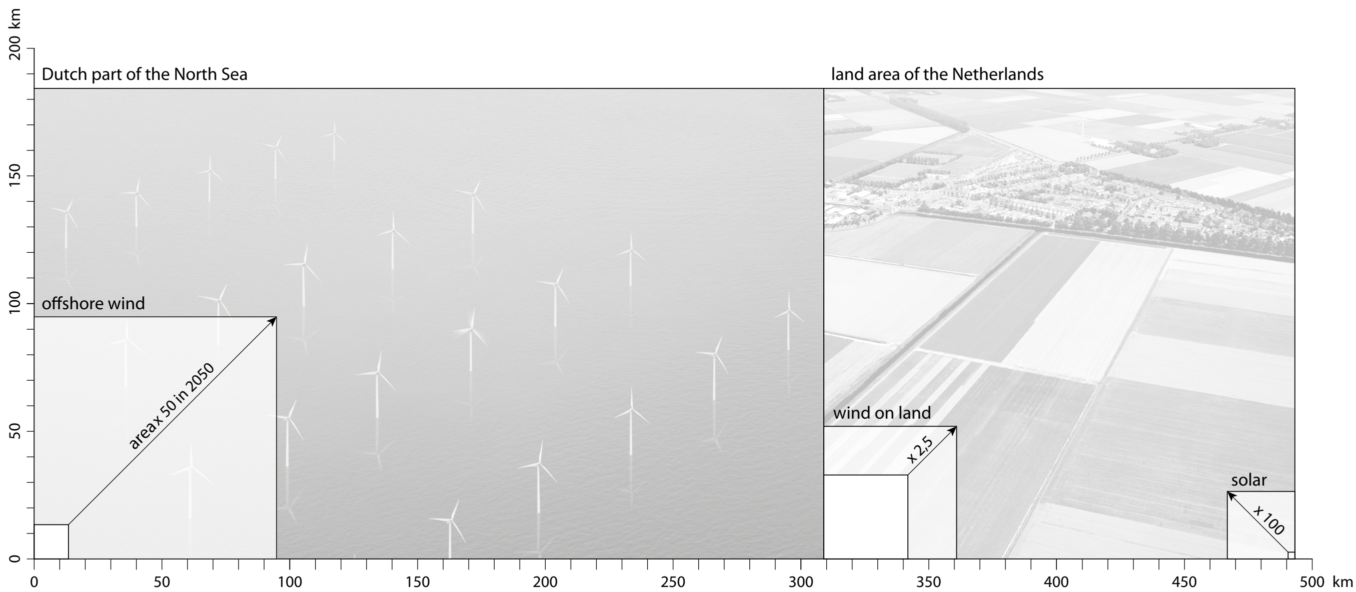
The cost of onshore generation of solar and wind power is currently between €0.05 and €0.10 per kilowatt hour (kWh). In the medium term, this is expected to fall to €0.02 - €0.04/kWh and even further in the long term. The cost of generating wind energy offshore has also fallen significantly, to around €0.05/kWh. All of this means that the cost of generating renewable energy is similar to or lower than that of generating energy using fossil fuels, even if one ignores the socio-ecological costs of CO_2 emissions.

Of course, the large-scale application of wind and solar energy calls for additional provisions, including measures to stimulate demand, storage and conversion of power into heat and ultimately also into fuels. If the cost of generation is low enough, this is unlikely to be much of a deterrent.

Space taken up by wind and solar energy set to grow enormously

The Dutch solar power sector has the ambition and the opportunity to grow in the decades ahead from more than 2 GW peak capacity now to over 100 GW peak capacity by 2050. This will allow an amount of electricity to be generated that at least matches total Dutch electricity consumption at the moment, even though much of the solar energy will not be directly used for electricity but converted or stored. Based on potential future performance, this kind of capacity roughly amounts to a surface area of around 600-700 km², albeit partly on roofs and water. By way of comparison, this is roughly half of the surface area of the province of Utrecht.

According to the National Energy Agreement, current wind capacity of approximately 4 GW will need to increase to more than 10 GW by 2023 (4.3 GW of it offshore and 6 GW onshore). Towards 2050, ambitions remain high, and the same applies to solar energy. On the Dutch part of the North Sea, it is expected that at least 50 GW of wind capacity will be installed. With its capacity factor of more than 50%, and in combination with solar energy, this will be sufficient to cover much of the (increasing) Dutch need for electricity. Through conversion into heat and fuels, it can also make an important contribution to other energy consumption. It is more difficult to make predictions about the increase in wind capacity onshore, but it is expected that 15 GW will be feasible. From an economic perspective, wind turbines are ininteresting and in demand, but much will depend on the extent to which we succeed in positively connecting wind energy with the quality of the living environment.



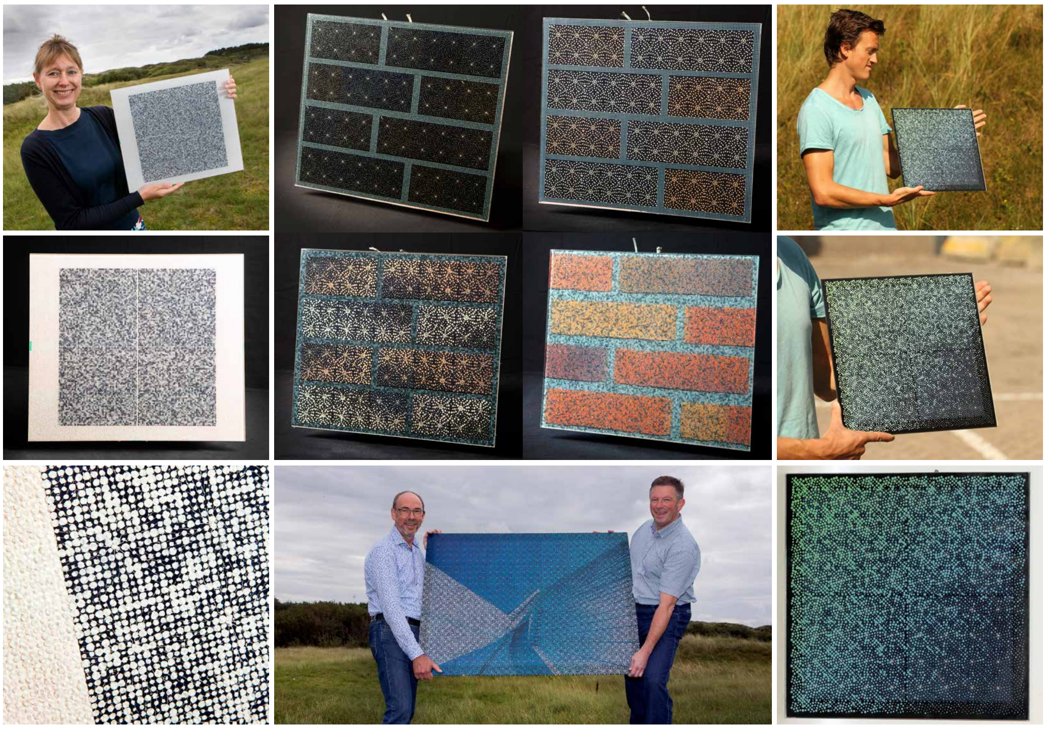
Expected space taken up for solar and wind energy in 2050 compared to now, as a proportion of the Dutch land and sea surface.

3. NEW ENERGY TECHNOLOGIES CAN ENHANCE OUR LIVING ENVIRONMENT

Planning, designing and building as part of an intensive partnership between all stakeholders: this calls for optimum use to be made of all opportunities currently offered by renewable energy and everything that is still to come. Technology developers are already working to increase the possibilities for large-scale and aesthetic integration of technology into our living environment and are happily engaging in dialogue with landscape designers and technology users.

Solar panels as visually appealing building elements

Buildings offer numerous opportunities that are currently still largely untapped. For example, solar panels are rapidly being developed into energy-producing components for use in construction. They will be one of the building blocks for the sustainable energy system: solar panels either unobtrusive and functional or very visible and decorative components of our living environment. The development of solar panels in various colours rather than just black or dark blue further expands the possibilities.

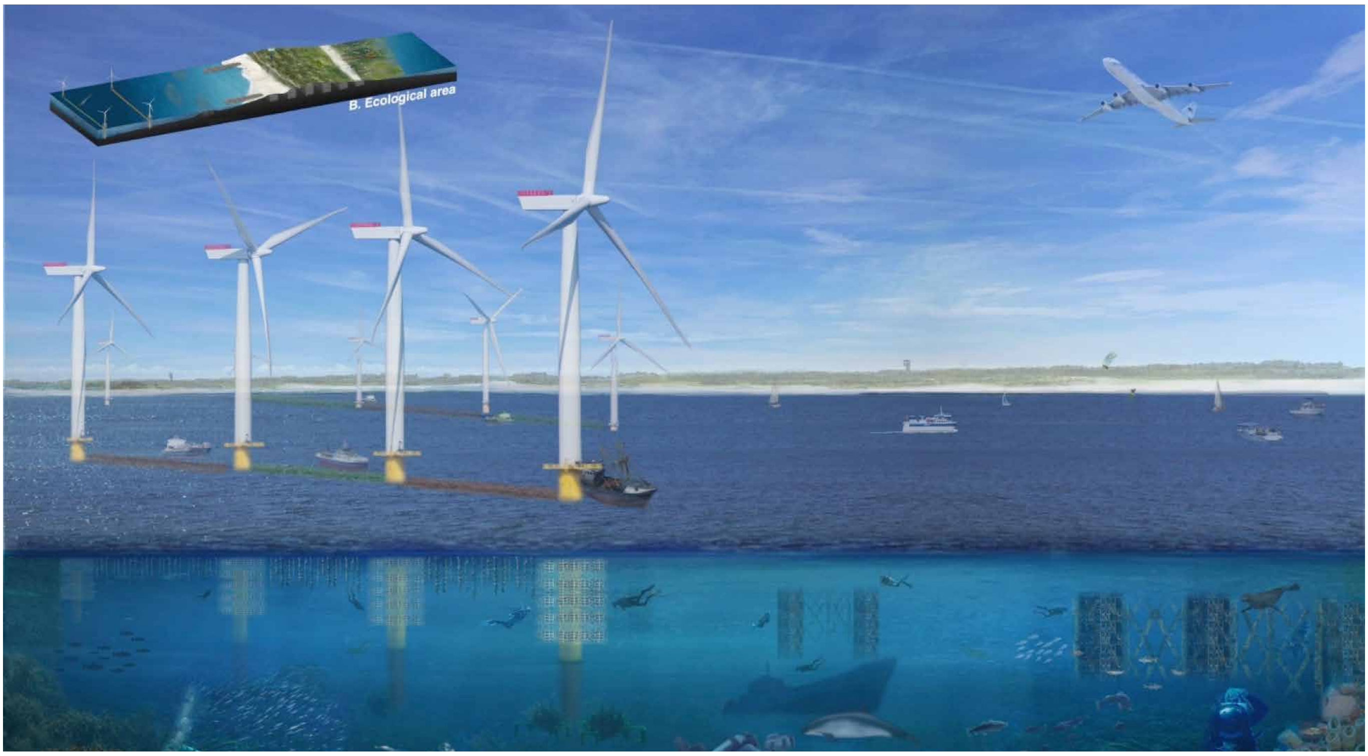


Examples of visually attractive, energy-producing construction elements with a printed design.

Solar energy in particular promises numerous innovations to simplify integration within our living environment. Work is already underway on integrated design strategies that not only focus on energy production but also take account of aesthetics and ecology through the use of colours and shapes that reflect the flowing lines and natural elements in the landscape.

Offshore wind farms allow for multifunctional use of space

The development of wind turbines is heading in two different directions: for onshore use, the development focus is on reducing the impact on the environment, whereas for offshore turbines the emphasis is on maximising production. Turbines for use onshore have grown in size over time while continuing to comply with noise standards. They may already have reached their maximum size. Offshore wind farms benefit from large turbines and they are therefore expected to further increase in size. Offshore wind farms have an increasingly important role to play in creating a positive impact on flora and fauna in the North Sea. Efforts are being made to identify opportunities for multifunctional use of space, for example in combination with the development of nature, fish and mussel farming and seaweed cultivation.



Design for an offshore wind farm in which energy generation helps increase biodiversity and can be combined with aquaculture and various types of water-based leisure.

Identifying opportunities for multifunctional use of space

There are all kinds of opportunities for combining functions, often in conjunction with other developments, such as declining population in certain regions and climate adaptation. Similar to energy transition, these challenges have an impact on the living environment and the landscape. It is definitely worth the effort to identify ways of coupling functions. In addition to the offshore examples referred to above, opportunities include water storage with floating solar panels, new energy functions in disused farms and the development of nature together with the construction of artificial solar islands.

Design for a solar island in the Buiten-IJ, created using dredging spoil from the Amsterdam canals. The solar island could supply the Zeeburger island with renewable electricity and create a habitat for flora and fauna.

4. TERMINOLOGY: LIVING ENVIRONMENT AND LANDSCAPE INSTEAD OF SPACE

The term 'spatial integration' is often used in the attempt to identify a place for new technologies in the landscape. In our view, this term is inadequate. One reason for this is the sheer magnitude of the task; in the long term, it will involve a fundamental transformation of our living environment and landscapes in particular.

The second reason is that the term integration, or more specifically the Dutch term '*inpassing*', has a negative connotation. It is as if new technologies naturally undermine specific qualities in the landscape. As if it is something that needs to be kept to a minimum, if not completely prevented.

A third reason for not using the term spatial integration is because the concept of 'space' is very abstract, despite the fact that it currently plays a dominant role in communication about the energy transition. People do not live in 'space' and are therefore not affected by interventions in 'space'. This is quite different when it comes to our physical living environment– urban and rural landscapes –; this is not abstract but very tangible and will therefore facilitate meaningful discussions.

Finally, it is not only visual perception that matters. The perception of sound and smell also plays a role and deserves attention. For these reasons, we argue for the discussion about the energy transition conducted primarily in terms of the living environment and the landscape rather than space.

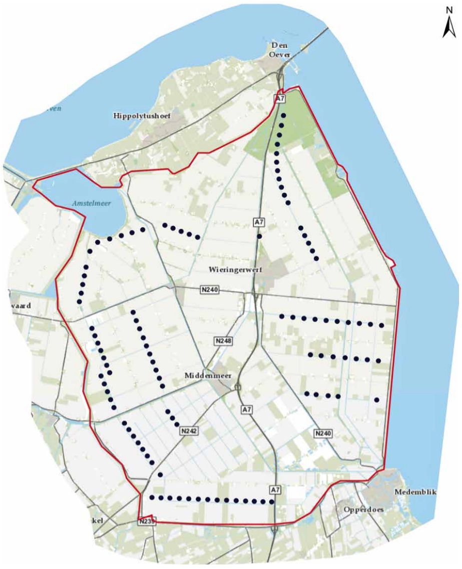
5. THINKING IN TERMS OF DIFFERENT TYPES OF ENERGY LANDSCAPE

The extent to which the energy system influences the living environment and the landscape varies significantly depending on the type of technology, the size of the system and its location. If we take into account the spatial claims of renewable energy and the possibilities to combine energy with other land uses, five different types of energy landscapes can be distinguished.

Distinction between five types of energy landscapes based on spatial characteristics.

(1) International energy landscapes as depicted in the recent animation 2050 – An Energetic Odyssey, which details the joint construction of new offshore wind farms in the North Sea with the primary aim of electricity generation. Offshore wind farms are connected to each other and linked to participating countries. They provide energy needed for industries and densely-populated coastal areas.

(2) National energy landscape such as the port area of Rotterdam or the Wieringermeer depicted below. Here, generation, conversion and/or storage of energy are the most prominent form of land use. Depending on the supply of renewable energy sources, national energy landscapes generate more energy than is needed locally. This energy is transported and used elsewhere in the country.



Windpark Wieringermeer **is an initiative in the Wieringermeer polder that aims to realize a major wind farm. The existing wind turbines will be upscaled, solitary turbines removed and a large wind farm realised in robust lines within the landscape. The rows of dots refer to the location of turbines and emphasise the contours of the Wieringermeer polder. Announcement by Windpark Wieringermeer of 7 May 2015,** ***Gov. Gazette*** **2015, 12719.**

(3) Local energy landscapes are areas where renewable energy sources fulfil local demand, such as on the islands of Samsø in Denmark and Texel in the Netherlands, as well as the De Kwekerij solar park in Bronckhorst (in the Dutch Achterhoek region). Renewable energy technologies are carefully implemented into the existing landscape, in co-creation with local stakeholders and experts. This type of energy landscape is mainly found in rural areas with relatively low population densities. Recently, the first studies have been conducted into the potential role of small and medium-sized business parks in the development of local energy landscapes (see e.g. National Perspective Energy and Space).

(4) Infrastructural energy landscapes are the fourth type of energy landscape. They are characterized by the transportation of gas/biogas, heat and electricity via narrow, linear corridors that comprise power lines and pipelines. Infrastructure energy landscapes often separate other types of land use, but are an essential component of a sustainable energy system. So far, this type of energy landscape received too little attention. Sustainable energy transition offers opportunities to reorganize parts of the existing system of high-voltage power lines and, where possible, combine it with other functions, such as energy generation and the development of nature.

Design for an infrastructure energy landscape in Noord-Brabant in which high-voltage cables are combined with PV panels and the redevelopment of heathland.

(5) Finally, we have **artistically-designed objects** that not only generate energy, but also have an educational or recreational function. One example are the ‘solar trees’ in Oss and Nijmegen. These interventions may vary from small art objects to larger land art installations. Some of them may develop into landmarks that, among others, express local identity.

Solar tree alongside the N329 at Oss.

The proposed distinction between different types of landscapes can foster energy transition. Every type of landscape calls for different design strategies, governance and funding models. This typology is therefore useful for designing policy instruments and identifying stakeholders that should participate in decision-making processes around energy related interventions.

6. CO-CREATIVE DESIGN FOR ENERGY TRANSITION

Aside from the terminology we use to express the implications of the energy transition, it is clear that renewable energy sources can only partly be ‘integrated’ in our urban and rural landscapes. In some places, renewable energy technologies will form a new layer in the existing landscape. What matters is that this new layer ought to add quality. The question is how this can best be achieved.

Design-based strategy inspired through dialogue

In order to tackle this issue, it is important for project and technology developers, landscape architects and other environmental designers to interact and learn from each other. It is also essential that planning processes are designed and structured in such a way that residents and users can participate in discussions on energy transition and its consequences for the landscape and living environment.

By approaching energy transition from a design perspective, we can examine how the different possible solutions are valued by people and how they may affect the quality of the living environment keeping in mind economic viability. This in turn will facilitate the transition to a sustainable, low-carbon future that is welcomed by many.

Innovative designs must be aligned with the wishes formulated by local residents in a process of dialogue. This calls for optimum use of the opportunities already offered by renewable energy and what is still to be developed, taking account of users’ wishes. It involves achieving faster progress by connecting demand from society, opportunities for the business community and government ambitions to each other and creating sustainable energy landscapes.

Issues to consider at different levels

From a procedural point of view, the energy transition is an additional function that needs to be taken into account in (standard and innovative) approaches to designing our living environment. Particularly in view of the fact that the consequences can vary significantly at local level, it is important to strive to achieve procedural justice in the planning process and a fair distribution of benefits and burdens. This can, for example, be achieved by allowing the region to share in the revenues from a renewable energy project.

Another issue at play is that the challenge of the transition is initially determined on a national scale (or even higher), but that specific projects are realised at a much lower level. At national level, the relative merits of contributing to energy saving and different types of renewable energy are considered. But it is only at lower levels that it becomes clear how difficult or easy it is to achieve these contributions and this information can result in reconsideration at national level. It is therefore essential that this kind of information is shared between different levels.

This can result in unexpected wins or setbacks. Occasionally, bottom-up initiatives achieve more renewable energy than would be necessary based on general objectives. In other cases, projects prove to be less easy to achieve at local level and general targets need to be reconsidered as a result.

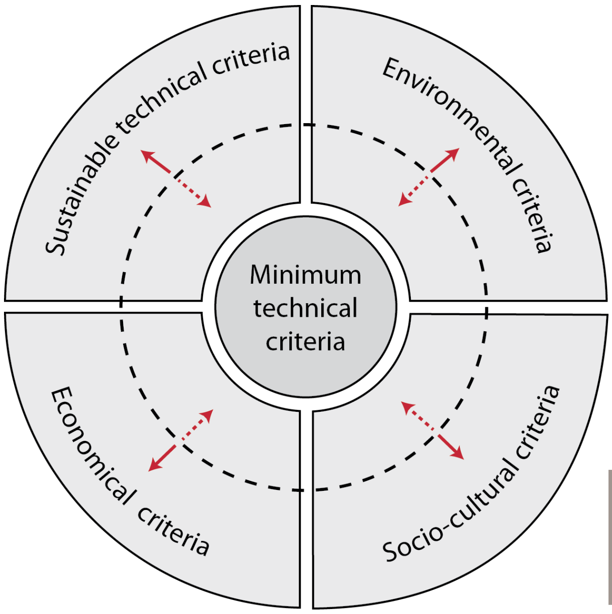
In the energy transition, many of the options for making our energy system more sustainable are interlinked: for example, the consequences of onshore wind turbines for our living environment can be mitigated by placing more wind turbines offshore. Equally, greater realisation of concepts for solar and wind energy that can be effectively integrated within 'smart' local grids could reduce the need for large-scale electricity infrastructure. Especially in view of these considerations at the national and international levels, it is important to have a good understanding of the opportunities and potential obstacles at the local level. Although challenges of this kind are nothing new in Dutch spatial planning, the energy transition makes them more urgent.

We see the sustainable energy transition both as a challenge and an opportunity for designing new cultural landscapes. We consider the quality of our living environment and the landscape to be one of the preconditions for the success of the design process. In this, it is important that we realise that not all energy options can be inconspicuously 'integrated'. Depending on the type of energy landscape, it is possible to achieve renewable energy technologies in an unobtrusive way or instead to give them pride of place within our living environment.

7. CONCEPTUAL FRAMEWORK FOR DESIGNING ENERGY LANDSCAPES

We take the view that when planning and designing sustainable energy landscapes, the following four groups of criteria should play a role: environmental, socio-cultural, economic and technological. In addition, there are specific technical requirements that always play a role, such as the accessibility to the energy installation.

One example of an environmental criterion is the reversibility of energy-related interventions. A socio-cultural criterion is the landscape experience of local residents and visitors, which is already a key component in environmental impact assessments. Access to affordable energy, as emphasised by the United Nations and the Dutch government, is an example from the economic criteria group. Technological criteria include, for example, the recycling of energy installation at the end of their lifecycle.



Conceptual framework for designing energy landscapes with sustainability criteria and specific technical requirements. The dotted line with arrows indicates that the level of sustainability may vary for different types of energy landscape.

This conceptual framework can be used as a basis for the general discussion about energy transition and help to clarify decision-making about specific interventions. Quality-based considerations of this kind can vary in degree between the international, national and local energy landscapes. This makes it possible to forge a link between the different levels of governance, policy instruments and participation processes.

There is a need for a more general discussion about which aspects should be considered by which stakeholder in the development of a specific type of energy landscape. For each type of energy landscape, it will be necessary to agree not only on a quantitative but also a qualitative ambition. This will make it possible to select criteria and make them operational in consultation with residents and users. It provides input and framing for design strategies in which a wide variety of prototypes can be used.

It is obvious that not all energy landscapes will need to develop into landmarks. This is especially the case the further we move towards a low-carbon economy in which renewable energy technology will make a significant claim on the available space. A quality-based consideration, as presented above, can help make it possible to deal more effectively with the inevitable changes to our living environment. Parts of the earlier land consolidation and the more recent Delta programme for climate-proofing the Netherlands can serve as sources of inspiration for the development of local, national and international energy landscapes that are both functional and meaningful.

8. GETTING STARTED

Outline vision, local details

The energy transition brings new urgency to ideas about landscape quality and functional combinations, which already has relevance in view of the general density of functions within the Netherlands. What does that mean in concrete terms? The planning processes need to focus more on the unique nature and quality of the landscapes. We propose that the central government continues to take the lead and formulates a vision on the relationship between energy transition and the living environment, but without imposing the choice of technology to be used. Targets, perhaps in terms of CO_2 emission reduction, can be translated at various levels to match local conditions and the preferences of those who use the landscape. The different types of energy landscapes can then be linked to the level of governance and to different approaches to participation. In this, the conceptual framework for sustainable energy landscapes presented in this paper can prove useful.

Design-based strategy

We also call for a design-based strategy that forms a bridge between technology and spatial development and involves residents at an early stage or is initiated by them. This multidimensional design attitude entails two important characteristics:

- An *integral* strategy: taking account of a variety of interests and preferences in the design process and permanently adapting to the synergies and conflicts between them in order to develop an appealing plan.
- An important role for *prototyping* and *model studies*. This is because many issues do not become clear until they have been made concrete and can actually be experienced. In addition, prototypes often provide inspiration for new solutions.

In this context, it also seems useful to identify existing examples and, where needed, realize first pilots of the various types of energy landscapes, to serve as building blocks for the larger discussion. These need to be concrete and technically accurate in order to illustrate technology-environment relationships and, on the other hand, flexible to accommodate local preferences.

Research questions

In order to adopt a design-based strategy, research is needed. For example, how will we assist the users of the landscape in expressing what is actually attractive? How can this be embedded within current and future procedures, such as those outlined in the Environment and Planning Act (*Omgevingswet*)? There exists no generally-accepted definition of environmental quality, which means that this concept will need to be investigated in the process and is likely to vary for each region. Co-creation, in which the user is central and technology follows, can also provide direction in developing technology, thereby increasing the range of technical possibilities.

Finally

The importance of energy transition and the quality of our living environment present new challenges for the Netherlands. We see it as a duty towards our own and future generations to adopt an innovative approach in tackling these issues. In this position paper, we have argued that the energy transition will bring about far-reaching changes to our landscape. Although the energy supply may have influenced our living environment in the past, we are now anticipating an unprecedented role of energy in our landscapes. It is essential to start thinking about the spatial design of new energy landscapes, both in terms of their specific content and procedurally. The significant decrease in the cost of renewable energy technology is creating opportunities to focus much more on design and quality, visual or otherwise. Through creative and concerted approaches, we can and must do everything in our power to enable our landscape evolve along with our energy supply.

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Sources for figures

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