

Research through design for energy transition: two case studies in Germany and The Netherlands

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Abstract

Purpose – The purpose of this paper is to enlarge the body of knowledge on research through design (RtD) methods that can be employed by landscape architects and others working on (but not limited to) sustainable energy transition.

Design/methodology/approach – A specific approach to RtD – qualitative landscape structure analysis (QLSA) – is introduced and illustrated by means of diagrams and photographs. Two case studies showcase the application of QLSA for research on solar parks in the Netherlands and research on wind turbines in the Alpine foothills in Southern Germany.

Findings – The case studies show how RtD can help to define design principles for large solar parks and arrangement of wind turbines in particular landscape types in the Netherlands and Germany, respectively. In doing so, RtD can help to expand the breadth of spatial research beyond well-established methods such as multi-criteria decision analysis and environmental impact assessment.

Originality/value – The paper provides insights into contemporary RtD in two countries and affirms the importance of such research with regard to landscape transformations while starting to define a research niche for landscape architects and other environmental designers working on the topic of sustainable energy transition.

Keywords Design research, Photovoltaics, Wind turbines, Energy landscape, Landscape architecture

Paper type Research paper

1. Introduction

After a century dominated by fossil fuels and nuclear power, renewable energy provision returns to the European cultural landscape. Central Europe is characterized by a high intensity of land use – densely populated urban and highly developed infrastructure landscapes – and highly regulated land use: farming and nature conservation are institutionalized based on standards of the European Community. This leads to situations that are completely different to those in sparsely inhabited energy landscapes that have received considerable attention over the past decade or so (for example in the San Bernardino County and the Imperial Valley in California). The great majority of European wind turbines and photovoltaic (PV) parks can be found in proximity to settlements.

The return of renewable energy to Europe results in landscape change, accompanied by acceptance issues and competitive situations in terms of economic value and environmental qualities. Landscape, in other words, is the subject of emerging discourses on the acceptance



of change and land use competition. Renewable energy technologies are no longer endemic, singular plants or facilities, but almost omnipresent landscape elements. Thousands of tall wind turbines, millions of roof-mounted solar panels and thousands of photovoltaic parks cannot be hidden; societies are challenged by new elements, new sceneries and new landscapes (Pasqualetti and Stremke, 2018).

The emergence of new energy landscapes presents particular challenges to the landscape architecture community. The very fact that landscape architects are no longer limited to the siting of particular energy technologies but instead are becoming proactive agents in the takeoff phase of what has been coined the largest landscape transformation of the twenty-first century necessitates a critical discussion of the *modi operandi* as well as the further advancement of research methods employed by landscape architects and other environmental designers.

With regard to energy transition, environmental designers can rely on several methods for conducting large-scale analyses that have been developed in the USA (see e.g. McHarg, 1969; Corner, 1999; Berger, 2002), the Netherlands (Sijmons, 2002), Switzerland (Corboz, 2001) and Germany (Mattern, 1966) over the past decennia. These methods are not limited to the planning and designing of parks or cultural landscapes, but also integrating infrastructure and land uses across scales (see e.g. Sijmons *et al.*, 2017; Kuijers *et al.*, 2018) as well as renewable energy (e.g. Stanton, 1996, 2016; MEEDDM, 2010; Regierung der Wallonie, 2013; Schöbel, 2012). The main interest of spatial researchers with regard to energy transition, however, has been on quantitative methods (see e.g. Droegge, 2008; Dobbelsesteen *et al.*, 2011; Glostra, 2013) with little attention to qualitative research methods.

Although the Netherlands and Germany are neighboring countries, the practice of environmental design differs fundamentally because of different traditions in landscape theory and conventions with respect to landscape change. The Dutch designers operate in a country with strong traditions for land reclamation and cultivation while much of Germany's landscape design discourse focuses on the century-long evolution of cultural landscape. This difference, not surprisingly, influences the challenge of re-integrating renewable energy technologies into the landscape. The two case studies presented in this paper explore research through design (RtD) methods employed for the study of future energy landscapes and demonstrate a shared set of landscape architectural research methods while reflecting on the somewhat different context in both countries.

The main question addressed in this paper is how landscape architecture RtD for sustainable energy transition can systematically employ qualitative research methods. The research of landscape architects and other environmental designers – to paraphrase Olwig (2011) – has to deal with the apparent contradiction between global concerns about climate change and local concerns for landscape. The purpose of this paper is to enlarge the body of knowledge on RtD methods that can be employed for (without being limited to) sustainable energy transition.

2. Methods

Many environmental design problems are so ill-defined that they are called wicked problems (Rittel, 1972; Bazjanac, 1974). For wicked problems, no explicit basis exists for the termination of a problem-solving activity; any time a solution is proposed, it can be developed still further (Rowe, 1987). The research presented in this paper is motivated by a set of interrelated wicked problems: resource depletion and climate change; energy transition and social acceptance; scenic preservation and landscape change.

2.1 Introduction to research through design

Whereas most environmental designers, in one way or another, engage in creative exploration during the process of designing, there is a clear difference between design that is simply design and design that qualifies as research. If designers address both a particular design and a larger set of questions, they are, according to Laurel (2003), conducting

research. To the authors, RtD is a form of “heuristic” – a means to create new perspectives (after Peirce, 1955) or envision alternative futures (after Steinitz *et al.*, 2006) and a means to reduce the number of possible solutions to wicked problems (after Newell *et al.*, 1962, p. 78).

Each of the two case studies presented in this paper employs a complex methodological framework which consists of interrelated research methods. They help to study a wide range of relationships ranging from renewable energy potentials that depend on the geographical position to the impact of renewable energy technologies by means of landscape structural concepts and computer-aided visualizations. As bound to an innovative and wicked practice, some methods belong to the category of research for design and others to research by/through design (Deming and Swaffield, 2011). The researchers employed a mixed-method approach (Creswell, 2003). This is in line with Van den Brink *et al.* (2016) who pointed out that in landscape architecture research (usually) a mix of different research activities is needed to find answers. In this paper, the authors focus on the intrinsic confluence of RtD and qualitative landscape structure analysis (QLSA).

The research in both case studies was question driven. The three main questions of the first case study were: what is the nature of large PV parks, where to site large PV parks and how to design large PV parks while maintaining spatial qualities. RtD was employed to explore the third question by means of designing. The first two questions were studied by means of more traditional research methods associated with empirical and hermeneutical studies, respectively and are therefore excluded from this paper. Please see Table I for an overview of epistemological perspectives, specific research questions and information sources for both case studies.

Epistemological perspective	Empirical study	Hermeneutical study	Design study
Topics	Phenomena: mapping of the physical substances (elements, morphologies and textures) of the landscape	Semantics: mapping of the cultural meanings (character, quality, nature and essence) of the landscape	Syntax: concept of legible elements, shape and structure of the landscape
Specific questions in energy landscape research	What are the most common technologies for solar/wind parks? What are the technical specifications for standard solar/wind parks? What are the characteristics of the selected landscape types? What are the landscape character coining natural morphologies? Under which conditions can solar/wind parks possibly be realized? What are the possible energetic outcomes? ...	How do the different worldviews influence the experience of solar/wind parks? How do the landscape characteristics affect the design considerations for solar/wind parks? ...	What sites can be considered representative for a particular landscape type? What size should the solar/wind park have in a particular landscape type? How solar/wind parks should be designed to fit the landscape type? How solar/wind parks should be designed in the selected landscapes? ...
Sources	Literature Topographic-, land-use, energy potential and planning restriction maps ...	Questionnaires, interviews, observations Literature and historical maps Mappings of immaterial landscape features ...	Sketches, overlays and cross-sections Shape analysis Modules and typologies ...

Table I.
Overview of the constituents of qualitative landscape structure analysis for both case studies presented in this paper

RtD represents a relatively novel approach to qualitative research that is of capital importance for landscape architecture in general and energy landscape research in particular. RtD, in a general sense, aims at knowledge generation based on sense, insight and experience: cognition. During RtD processes, ideas and drafts of reality and possibility spaces are discovered, surveyed and interpreted systematically. As with other research methods, researchers have to be aware of the type of knowledge that can be generated by means of RtD and the associated knowledge claim(s), each one with its own conditions, benefits and limitations (see e.g. Lenzholzer *et al.*, 2013).

Similar to other qualitative research methods, RtD is informed by data (phenomena), as well as literature and expert knowledge (theory). The main difference, however, is that empirical and theoretical knowledge is conceived, related and augmented by means of designing. Different from quantitative research methods, such as energy potential mapping (see e.g. Dobbelsteen *et al.*, 2011), that draw on deductive reasoning, RtD requires abductive reasoning (Peirce, 1955) in order to create new perspectives, categories and options (Schöbel, 2006).

For discussing RtD projects such as those presented in this paper, three epistemological aspects are of critical importance: generalizability – the external validity of applying results to other settings; reliability – the stability or consistency of findings; and validity – the accuracy of the findings from the standpoint of the researcher (Creswell, 2009, pp. 190-191). These general quality criteria need to be specified for every research project.

The epistemological and methodological specifics as well as the limitations of qualitative research such as RtD require *a fortiori* an extensive but concise, complex but transparent documentation of the whole research process. One of the main challenges of qualitative research lies in the transparency – the inter-subjective communication of the researchers' understandings in order to establish reliability not by evidence but by comprehensibility (Steinke, 2000). A systematic approach to RtD is the QLSA introduced subsequently.

2.2 Qualitative landscape structure analysis

Landscape is both physical structure and human perception, and something in-between. The physical structure is based on the natural morphologies, overlaid and modified by land use textures and infrastructures. Human perception is based on individual experiences, power of judgment and mood on the one hand, and collective schemes (cultural progress) on the other hand. These aspects concern totally different sciences and require different approaches, the humanities with their interpretative, the natural sciences with their empirical and, not finally but in-between, architecture with their conceptualizing approaches. Landscape architecture research involving aesthetics necessitates a three-dimensional approach involving hermeneutics, empirics and designs (for overview see Table I).

QLSA is an approach that allows to merge these different studies into one comprehensive analysis. The outcomes of QSLA are images, text and multi-layered maps that juxtapose the historic and thematic layers of the landscape morphology and texture with landscape characters and meanings (see Table I). Regularly, the layers include: landscape morphology; cultural landscape features (gathered by historical maps, geographical landscape units and land use types); functional criteria and preservation (e.g. nature and heritage zones); economical and social structures; structural (reading) and aesthetic (perceiving) concepts on landscape (e.g. open interviews and observations).

In landscape architectural research, these layers of spatial information are more than an "objective" measurement of phenomena, as pursuit for example in many landscape planning processes. In-between the two constitutive levels of landscape – the physical structure and the cultural reading and perception – these layers mediate between the phenomena and the semantics: the syntax of landscape. Among others, this implies that the preservation

and re-design of legible structures in the environment lies at the core of landscape architecture (Latz, 2018, cp; Weilacher, 2008). All layers, both with empirical and interpretative information, pass through a process of designing (see Schöbel *et al.*, 2013) and lead to a holistic image of landscape.

3. Energy landscape research in the Netherlands and Germany

In order to cover a range of contemporary energy landscape research, both in terms of energy source and geographical location, we selected one project about solar energy and one about wind energy from the Netherlands and Germany, respectively. These research projects are significantly different from design projects as they are conducted, for example, for architectural design competitions. In both cases, multi-layered analyses, textual elucidations and design principles play a significant role. The research is based on and arises from designing and leads to new knowledge. The two projects enabled us to apply and advance existing RtD methods while the empirical material helps to illustrate and discuss the effectiveness of these methods.

3.1 Research on large solar parks in the Netherlands

3.1.1 Introduction case study. At the time of writing, there are hardly any large solar parks in the Netherlands. Wind turbines dominate the contemporary energy landscape, not surprisingly for the Netherlands. Since the signing of the National Energy Agreement in 2013 and in combination with dropping prices for photovoltaic (PV) panels, more and more building permits for PV parks (also referred to as solar parks) are filed in the Netherlands and in the South of the country in particular. Energy transition is in the “takeoff phase” where it is critical to guide the implementation of new technologies in the landscape (Stremke *et al.*, 2012).

To this moment, spatial policies in the province North Brabant provide limited opportunities and little guidance for the planning and design of PV parks larger than 5 hectare. Research both on the potential landscape impact of PV parks and on the opportunities that come along with this particular kind of renewable energy technology (RET) is needed to guide implementation from a spatial policy perspective (Bergstra *et al.*, 2013).

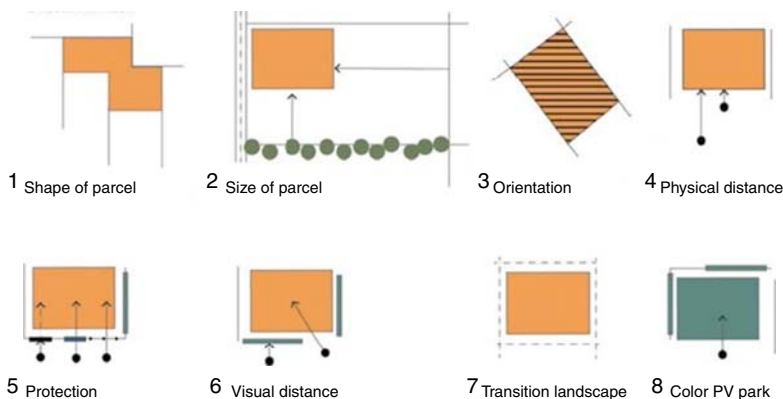
The administration of North Brabant commissioned the research on the development of large PV parks in the province. The main objective was the creation of new knowledge – knowledge that can inform policies for the development of large PV parks in the province of North Brabant. The solar parks research project (Dutch project acronym ZONB) departed from the premise that energy transition should be realized in such a manner that the landscape transformation can be considered sustainable (Stremke, 2015). Whereas other research projects at Wageningen University focus, for example, on the relations between energy technologies and the ecological dimension of sustainability (Stremke, 2015), ZONB focused on the socio-cultural dimension by means of design principles.

For this, the definition of “spatial quality” postulated by the province of North Brabant is of critical importance. Spatial quality – as agreed upon by provincial decision makers – refers to the respectful treatment of existing qualities. However, this does not mean standstill. The quality of any intervention is important, as is the development of the respective area. Spatial quality is not served if it only addresses function or program, nor can it be appreciated by itself. The development of an area is as important as the requirements for new interventions. Spatial quality consists of this balance (Provincie NoordBrabant, 2011).

In the following section, the results of the ZONB project will be presented. In doing so, we will study how PV parks can be designed in order to maintain the spatial qualities of particular landscape types in North Brabant.

3.1.2 *Findings case study.* In spite of the great importance of energy transition as one of the key drivers for landscape transformation, there are relatively few publications on landscape-sensitive design of PV parks. The following sequence of considerations is informed by Rodriguez and Rosello (2013), BRE (2013) and Modino *et al.* (2015). Eight considerations have been identified in the literature and described in Figure 1. They formed the framework by which the design of PV parks in North Brabant has been studied, and design principles have been articulated. They may also provide guidance for RtD on PV parks in other provinces of the Netherlands and beyond. The considerations and design principles are illustrated through sketches from the small-scale rural landscape of the Groene Woud:

- (1) Shape of parcel: square parcels have the most efficient form for the installation of PV panels. This is due to the internal electricity grid, generators, avoidance of shading and space needed for maintenance. In reality, of course, parcels may have any shape, which influences the number of PV panels that can be installed on the site. To reveal the relationship between parcel shape and number of PV panels, a tool was programmed to compute the net surface of PV panels for any given parcel shape and size. For the Groene Woud (Figure 2), there are hardly any square parcels. In addition, a small ditch intersects the parcel studied in this project. In order to realize a PV park, one would need to bury the ditch or, alternatively, realize drainage along the edges (yellow arrows).
- (2) Size of parcel: in the ideal case, one would look for individual parcels that are large enough to host the envisioned number of PV panels and all associated infrastructure. Of course, land can be bought/leased from several owners and parcels can be merged. Often, however, the additional costs would prevent development. In cases where the parcel is larger than that the surface needed to host the PV park, a number of additional considerations should be taken. PV panels should be placed as close as possible to existing energy infrastructure and roads, as far as possible from objects that create shading and in a corner of the parcel to facilitate the agricultural use of the remaining land. For the Groene Woud, the parcel is larger than 10 ha, which leaves room to site the PV park according to the design consideration explicated below. The site, however, is not archetypical as most parcels in this landscape are smaller than 10 ha, a fact that complicates implementation. Also, many parcels contain elements such as hedgerows that affect the siting and design of PV parks (e.g. due to shading).



Source: Based on Bergstra *et al.* (2013)

Figure 1.
Representation of
the eight design
considerations
identified through
literature study

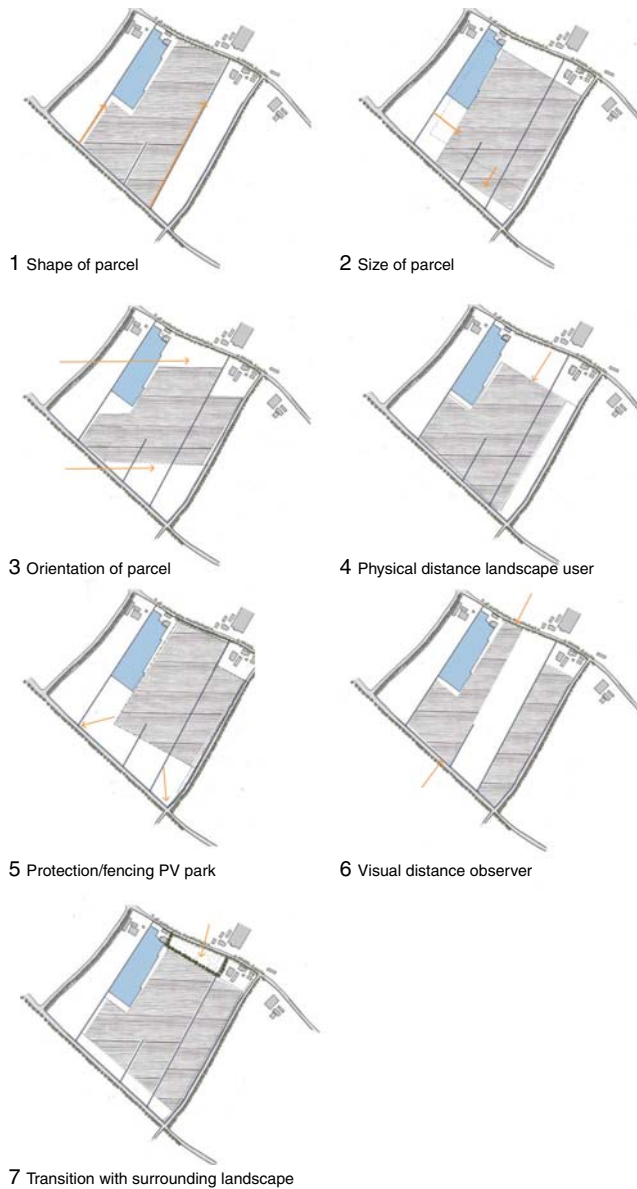


Figure 2.
Selection of sketches
for design
considerations 1
through 7 for the
Groene Woud
landscape

Source: Based on Bergstra *et al.* (2013)

- (3) Orientation of parcel: PV panels work the most efficient (in the Northern Hemisphere) if they are oriented south, toward the sun. Most parcels, however, have a different orientation, which again influences the number of PV panels that can be installed. The orientation of the parcel is therefore another critical aspect that should be considered in the initial phase of the design process, along with the aforementioned two aspects. The parcel in the embedded case has a

North-East to South-West orientation which prevents optimal distribution of panels parallel to the edges of the parcel. For this, the rows of panels have different lengths except for the north and the south side where new edges are created (see Figure 2).

- (4) Physical distance landscape user: the physical distance between landscape user and PV park has great implications upon the experience and therefore for the visual impact of the park (Haurant *et al.*, 2011). How this aspect is addressed in the design process depends, to a great deal, on the perspective that is taken with regard to new technology in the landscape. Hiding PV parks in the landscape, for example, can be fostered by large physical distance between observer and subject. In the Groene Woud, the proposal is to locate the PV park away from the main road that runs along the Northern edge of the parcel (Figure 2). However, for many other parcels in this landscape there are fewer possibilities to do so and (if desired) other means to hide PV parks have to be employed.
- (5) Protection/fencing of PV park: the fence (or similar protective structure) along the perimeter of the park should fit the landscape. This can be done, for example, by making use of local materials and by placing the fence along existing parcel edges rather than right around the park. Also, vegetation can be used to camouflage fences. To further substantiate design principles with regard to fencing, a small study of edges and demarcations was done for each of the landscape types. For the Groene Woud case, one can make use of the existing ditches around the parcel along with a relatively low fence to protect the PV park (Figure 2).
- (6) Visual distance observer: visual distance and visibility between observer and PV park have great implication on the experience of the parks. Pending on the design perspective and user preferences, the park can be hidden or even accentuated, for example, by vegetation. A good understanding of the present landscape characteristics and typical vegetation is of importance. For the embedded case, vertical vegetation such as hedges are typical in the landscape and can also be used to hide the PV park from view (Plate 1).
- (7) Transition surrounding landscape: the transition between the PV park and its surrounding landscape is not limited to protection/fencing. Around the park and in its proximity, landscape structures can be recovered or strengthened to better embed the PV park in the landscape (e.g. planting trees to strengthen the experience of traditional linear landscape elements). For the embedded case, a setback from the main road is proposed (shown in Step 4). Along with the suggested vegetation (shown in Step 6), a new “landscape room” is created which is consistent with the small-scale structure of this landscape (see Plate 1).
- (8) Color PV park: finally, the color of technical elements (e.g. panels, supporting structure) has great influence on the experience of a PV park. Decisions depend, as with several earlier considerations, on the chosen design perspective and user preferences. The impact of color is dynamic and the same color can have different effects throughout the day/season/year. It is largely determined by hue, saturation, light and atmosphere. Photorealistic renderings can reveal the varying effects of colored technical elements in the landscape. The effects of the color of technical elements can be ignored for the site in the Groene Woud because the PV park is hidden from view.

Photorealistic visualizations are a key element of the RtD process and help a great deal to illustrate the outcomes of different sets of considerations and design principles.

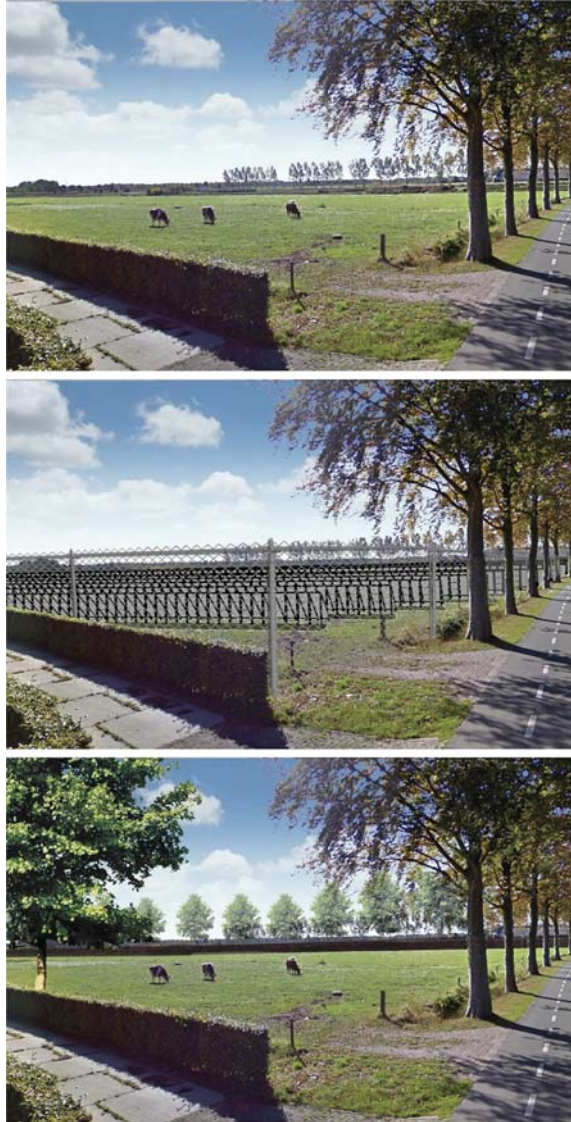


Plate 1.
Photograph of existing conditions in the small-scale rural landscape of the Groene Woud (above), visualizations of the technical scenario (middle) and landscape-sensitive design scenario (below)

Source: Based on Bergstra *et al.* (2013)

For ZONB, it was decided to prepare a set of visualizations for a baseline scenario where PV parks are realized on the basis of technical considerations exclusively and a landscape-sensitive design scenario making use of the considerations presented above. For each landscape type, the two visualizations were accompanied by a photograph of the current situation at the site. Generally speaking, the character of the small-scale rural landscape in the Groene Woud allows PV parks to be well-integrated and hidden from view (Plate 1). This is mainly due to the large number and variety of landscape elements and rather short vistas.

3.2 Citizen wind parks and world heritage site in the German Alpine foothills

3.2.1 *Introduction case study.* In the Alpine foothills, 100 km south-west of Munich, an association of 62 private land owners, supported by five municipalities, planned to build two wind parks of three and nine wind turbines respectively in the 2.5-MW class with a total height of 200 m in the historical and touristic landscape of the Pfaffenwinkel. The Pfaffenwinkel is a hilly landscape with a considerable number of monasteries and pilgrim churches, among the most famous ones is the UNESCO World Heritage *Wieskirche* (in English: Pilgrimage Church of Wies). The description of the *Wieskirche* in the World Heritage registration says: “Miraculously preserved in the beautiful setting of an Alpine valley, the Church of Wies (1745–1754), [...] is a masterpiece of Bavarian Rococo – exuberant, colorful and joyful.” “A unique feature is the harmony between art and the countryside. In this sparsely settled area, in complete solitude, it was possible for a religious and architectural idea to be realized unhindered” (WHC, 2006).

UNESCO requires to protect the “visual integrity” of the larger environment of designated heritage sites, especially for large-scale infrastructure projects such as wind parks (Ringbeck, 2008). This condition of the UNESCO has been accepted by the signatory countries but has not been implemented into German planning procedures. The UNESCO, for example, is not considered an “agent of public concern” during the standard environmental impact assessment for wind parks.

Over the past years, a series of different approaches have been developed in order to evaluate wind projects in prominent landscapes with UNESCO world heritage sites (e.g. Hartz *et al.*, 2013; Grontmij, 2013). Since there is no scientific tradition of multi-criteria analysis in Germany (such as in Britain landscape character assessments, see Stanton, 1996, 2016 or in France see MEEDDM, 2010), these approaches are limited to steering the development or, in other words, limiting and excluding wind turbines from these landscapes.

To examine the perspective wind park situated in the same landscape as the protected monument, the land-owner association commissioned the second author of this paper with a landscape research project. The commissioners asked to evaluate an existing proposal for the wind park that suggested to use the space in the so-called concentration zone of the adopted land use plan (Peiting Municipality, 2012, cp. Figure 4 (left)) and, if necessary, devise alternative siting options for the wind turbines.

To protect the “beautiful setting” (WHC, 2006) of the Church, the developers of wind turbines were asked to avoid any visible connections between the monument and the new landscape elements. A condition was met due to a combination of landscape relief and vertical vegetation (tall trees). The situation has been analyzed by landscape sections and – because of doubts casted by the representative from the International Council on Monuments and Sites (ICOMOS) – demonstrated during an on-site helicopter flight.

The RtD process became necessary because of an additional demand: the surrounding of the monument should be preserved in its beauty as well. Alternative locations for the wind turbines should express exceptional respect of the landscape, which is, compared to the detailed assessment of the architectural and artistic quality of the *Wieskirche* in the official documents, described quite vaguely as “beautiful,” “harmonious,” “remote” and “open.” A substantial description for the landscape was not provided by UNESCO. During the RtD process, the landscape was examined in by means of empirical, hermeneutical and design studies which together constitute the QLSA.

The empirical analysis of the natural landscape morphologies and cultural landscapes gathered the major natural units and the geomorphologic structures. The hermeneutical analysis discusses the landscape character focused on the perspective of the monument as its “environment”: the outstanding universal value of the World Heritage monument is

created not only by the historical substance of the building, but also by a particular situation at a historic site or landscape. “Therefore the environment is the specific situation that refers to the historical site of the monument” (Walgern, 2013, p. 29, translated by the second author). Often, World Heritage Sites are equipped with a buffer zone that goes well beyond the actual object. They are mapped and fixed as far as possible. “The buffer zone should include the immediate environment of the nominated property, important views and other areas or features that play an important practical role to support the estate and its protection” (UNESCO World Heritage Centre, 2009, p. 36). To assess the historical context of the World Heritage Site, one has to understand the religious meanings of the neighboring monastery, the pilgrim paths, the architecture and the remote siting of the pilgrimage church. The hermeneutical analysis also conceptualizes the present semantics, perceptions and discourses. Besides interviews, local newspapers with public comments sections are important sources of information.

Running parallel to the empirical and hermeneutical analysis, the design study analyzed both the material proportions, such as architectonic proportions between the church, the wind turbines and the landscape, as well as the immaterial relationships or coherences, such as visual scenes (from the viewer involuntarily focused landscape area) and landscape characters as typology and individuals. Simultaneously, alternative designs for the siting of the wind turbines were developed. Rather than a “copy-paste approach,” the Church of Wies served as a model of interpretation of a “landscape appropriate” design (referred to as “landscape sensitive” design in the first case study).

3.2.2 Findings case study. In the Alpine foothills, the morphological analysis exposes both the phenotype of the natural and the cultural landscape. The relief intensity, the erosion forms of mountains and hills coined the agricultural land use and challenged the modern industrial systems. For many years, Pfaffenwinkel has been characterized by permanent grasslands, infrastructure and energy generation such as the large hydroelectricity dams of the river Lech along with power lines and other infrastructures such as radio towers that are visible from scenic viewpoints.

The special landscape quality as the desideratum of the church of Wies appears in four very different “Wieskirchen-landscapes.” In all four views, the relations of *Wieskirche* as an object or “figure” in the landscape environment as its “ground,” are fundamentally different, so it generates at least four different, “figure-ground relationships.” *Wieskirche* and its landscape are both dominant and other-worldly, the panoramas are sublime and picturesque, narrow and wide, and the silhouettes always consist of several layers, with hard-edged lines as well as roundish soft ones. To describe the landscape of *Wieskirche* as a beautiful Alpine panorama, that description is by far too short. The specific nature of the architectural production of that building and its location is precisely that these contrasts appear to be harmonious, but always somewhat surrealistic and strange.

The alternative designs of the two wind parks pursue a “landscape appropriate design.” Two models are developed from the frameworks that were described heretofore. In the smaller wind park, the new design ensures that the wind turbines are spread loosely on the grounds of the peaks of the young moraine hills. It should be avoided that the three turbines form an exact geometric line. This would be possible by the formation of a slight bow, which generates a relationship. The alternative design follows a peculiarity of the *Bergwiesen*. They would be on the steep edges remains of the folded molasse, while the gently inclined slopes are young moraines. With this line of molasse locations the open space in the *Bergwiesen* would be preserved and edged, following the prevailing wind direction and the south-facing large sceneries (see Figures 3 and 4).

The research concludes that the four landscape characters – not “atemporal” but still harmonic – would be maintained with the wind parks. Likewise the pilgrim paths.

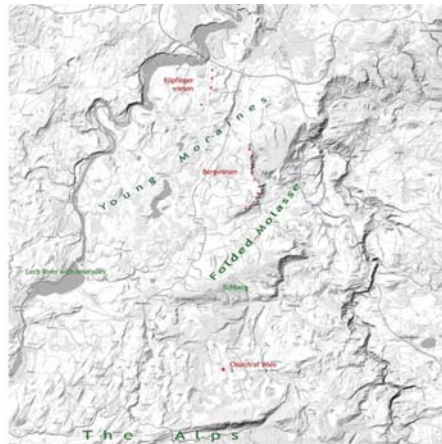
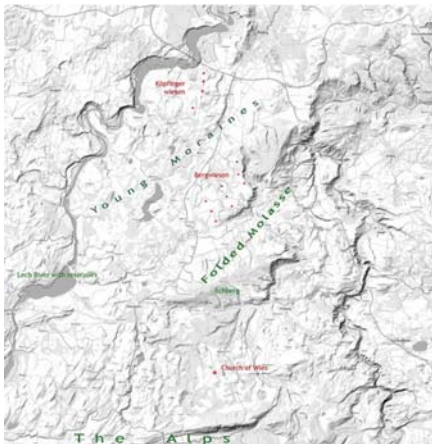
The historical and religious meaning of pilgrimage comes into being by the contrast of a – profane – initial point and a – spiritual – remote destination. Under these circumstances, it is well acceptable that modern landscape elements are visible from both, the starting point of pilgrim paths as well as from regional scenic viewpoints, outpacing them along the way to the World Heritage Site. This desideratum is secured in the present planning situation.

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Notes: Old moraine landscapes with large forests and large wind parks. Young moraine landscape with broad, pastoral scenic views and few smaller groups of wind turbines. Chains of foothills of folded molasse and flysch zone: crests of wind turbines following the lines of the Alps
Source: Based on Schöbel (2013)

Figure 3. Landscape characters and appropriate wind turbine formations in the Alpine foothills



Source: Based on Schöbel (2013)

Figure 4. Original planning with a field of turbines (left) and design solution (right) with the Bergwiesen turbines (red dots) following the folded molasse landscape morphology

In the end, similar to other cases in Europe, the UNESCO World Heritage committee did not follow the detailed and integrated landscape research. In its final statement, more than one year after submitting the research results, the committee proclaimed that wind turbines should not be built in the wider environment of the heritage site. Instead, the committee followed the argumentation of the local office of the ICOMOS (unpublished document) after which the landscape of the Pfaffenwinkel as a “completely untouched setting” should be protected.

In spite of this decision against wind energy development in Upper Bavaria, the RtD on the Pfaffenwinkel landscape is being more and more accepted as a profound approach to landscape and heritage. In the last two years, it served as a basis for a number of assessments on landscape and heritage. More recently, several wind turbine proposals in the region have been approved.

4. Discussion

For discussing RtD as systematic approach to qualitative research, three aspects of critical importance have to be taken into consideration – generalizability, reliability and validity – along with the fact that RtD studies require *a fortiori* an extensive and transparent documentation of the whole research process.

The RtD processes and the associated research activities illustrated in this paper present innovative approaches to the question posed by the stakeholders; they have been enabled to develop policies/arguments for the siting and design of large PV parks and wind parks, respectively. The two projects served the authors to apply and advance methodological knowledge.

The generalizability of the RtD findings is somewhat limited and no claims can be made that the findings of the RtD processes are valid for landscape types other than the ones studied. Yet, careful selection of the sites within each landscape type was one way to be able and generalize at least within the respective landscape type. This is critical because not all possible locations for PV or wind parks can be examined at such a high level of detail.

The actual steps of the RtD process originated from the literature. This way, the process is (by nature) evidence-based provided that the literature can be considered factual with empirical support, but at the same time design-driven. This is similar to other research methods, for example modeling, where advanced models rely on the correctness of their predecessors. The reliability of findings cannot be expressed in absolute terms but is considered reasonable for the research as a whole: the very fact that different landscape types have been studied enabled us to derive recommendations with respect to landscape character but also highlight differences between landscape types. In addition, new insights from research on one landscape type, informed the RtD process in other landscape types.

Validity has been addressed by a systematic checking of intermediate and final results by other experienced researchers in the solar team and practitioners in the wind project, respectively. Critical reviews of intermediate and final results were conducted by the commissioners and (in addition) by government representative with much experience regarding renewable energy in North Brabant as well as in the Alpine foothills.

The potential impact of wind turbines nearby a “landscape coining and coined monument” in Bavaria as well as the development of large PV parks in the province of North Brabant with strong land use competition are in the true sense of the word “wicked problems.” An approach like QSLA, that relates landscape morphological, cultural and mental structures, seems to be the only adequate basis of an RtD process. The wind energy project addressed insights of both the heritage council as well as the investors of the wind

park; the solar energy project combined renewable energy potentials with qualitative landscape considerations. The developed categories and levels of argumentation of the research projects built an intersubjective and transparent basis for discussing the reintroduction of renewable energy technologies in the cultural landscape – a wicked problem – which, in the case of the wind energy project, resulted in a negative decision of the ICOMOS agency.

For the commissioners of the wind energy project, the landscape “issue” was a new experience, as farmers and administrators were more accustomed to ecological, economical and touristic functional perspectives. In the process of the research project, however, they opened their mind to what we call a contextual and aesthetical responsibility for the landscape. This experience verifies that the differences in landscape planning and design standards between Germany and those nations that have signed the European Landscape Convention and consistently use design oriented approaches (Denmark: Løgstør Municipality, 1996; Scotland: Stanton, 1996, 2016; France: MEEDDM, 2010; Belgium: Regierung der Wallonie, 2013) are not merely outcomes of cultural differences but instead professional antagonisms that deserve much more attention in the future.

In the wind energy project, however, the positive experience with the commissioners cannot be expanded to the other experts involved: the monument conservators and ICOMOS. A distinction between “monuments with landscape” and “landscape with monuments” can be made and for the first category a claim for exclusiveness of preservation has been stressed by those experts. In landscape architecture, quite differently, it is common sense that landscape changes require an inclusive modus of planning, in line with the European Landscape Convention. Accordingly, the larger landscape structure defines the limitation of a site-specific assessment and not the single monument. For ICOMOS, however, it is the other way around.

On the side of the researchers, all subjective statements have been marked, explained and reflected. All efforts have been made to substantiate statements on empirical data – primarily historical and morphological maps and citations of expert publications – and generally accepted guidelines. The described conjoining of methods by means of QLSA, however, has not yet been standardized neither in Germany nor in the Netherlands. While the conjoining process culminated in a proof of concept – designs and design principles for wind parks and solar parks where economic (wind speed and solar irradiation), aesthetical and structural demands come together – the coherence of the approach becomes evident. The practical effect of the research can be illustrated by the fact that almost one dozen studies using the same approach have been conducted in the meanwhile.

5. Conclusions

This paper reported on landscape RtD for sustainable energy transition. The two cases provide insights into the current state of application of selected research methods in Landscape Architecture both in Germany and the Netherlands. The illustrated RtD methods may be of value to landscape researchers working on different spatial questions and can be complemented with other means of inquiry.

Both cases presented here were commissioned projects with specific questions to be answered by the landscape researchers. RtD has been operationalized by means of QLSA. As illustrated by the two case studies, RtD and QLSA are related but the two terms should not be used synonymously. In spite of the applied nature of the research, the projects helped to advance conceptual thinking (e.g. spatial quality), substantive knowledge (e.g. design principles) as well as procedural knowledge (e.g. how to plan and design solar and wind parks).

Although the research presented in this paper arose from practical demands, the challenge requires fundamental research focus. As demonstrated, contemporary research on

energy landscapes needs freedom in the definition of the spatial focus – not limited by single functions or objects, administrative boundaries or given planning scales. The definition of landscape, the spatial extent of the study, as well as the forms and functions that have to be considered are intrinsic part of the research.

The two cases on the possible implications of RET implementation on the landscape are not comparable with traditional landscape architects assignments by commissioner x to design space y. Landscapes are at stake and, more importantly, there is no blueprint to implement energy transition. RtD studies, for example, may conclude that the current policies and planning procedures are ill suited to realize energy transition in a timely and sustainable manner (see Oudes and Stremke, 2018; Schöbel, 2012).

Scientific validity is not solely attested by reliability, but also by comprehensibility, reproducibility and practicability. Generalizability is achieved not by transferring the specific results to another case, but by interpreting the findings. Either way, because of the wicked nature of the commissioners questions, mixed-method approaches have been applied which somewhat blurs the clear historical distinction between qualitative and quantitative research (also see Van den Brink *et al.*, 2016).

The starting point for both RtD projects was the historically developed – economically, but often also aesthetically influenced – cultural landscape. Landscape analyses therefore not only capture multiple levels, the morphological structures and elements of the physical landscape, the textures and elements of the cultural landscape, but also the landscape characteristics and meanings. The “wicked problem” of integrating large solar parks and wind turbines into that “palimpsest” (Corboz, 1983), however, requires to go beyond descriptive action and start designing “intelligent interventions” (Corboz, 1983). The rich portfolio of means to disentangle and comprehend landscapes might be one of the reasons why more and more decision makers, stakeholders and researchers from other disciplines approach landscape architects for collaboration (see e.g. Sijmons *et al.*, 2017; Kuijers *et al.*, 2018).

Beyond any delusions of grandeur, landscape architecture research can play a significant role with respect to energy transition – but it never stands alone (also see Stremke and Dobbelsteen, 2013). It is crucial to be familiar with a wide range of research methods. This familiarity also implicates that the challenge is not to try and substitute, moderate or chair all the experts, but to conflate expertise in holistic and multi-variant proposals. In addition, landscape architects can contribute to and advise during multi-stakeholder discussions on the nature of “landscape” which often arise when confronted with potential landscape transformations due to energy transition and other drivers of change.

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