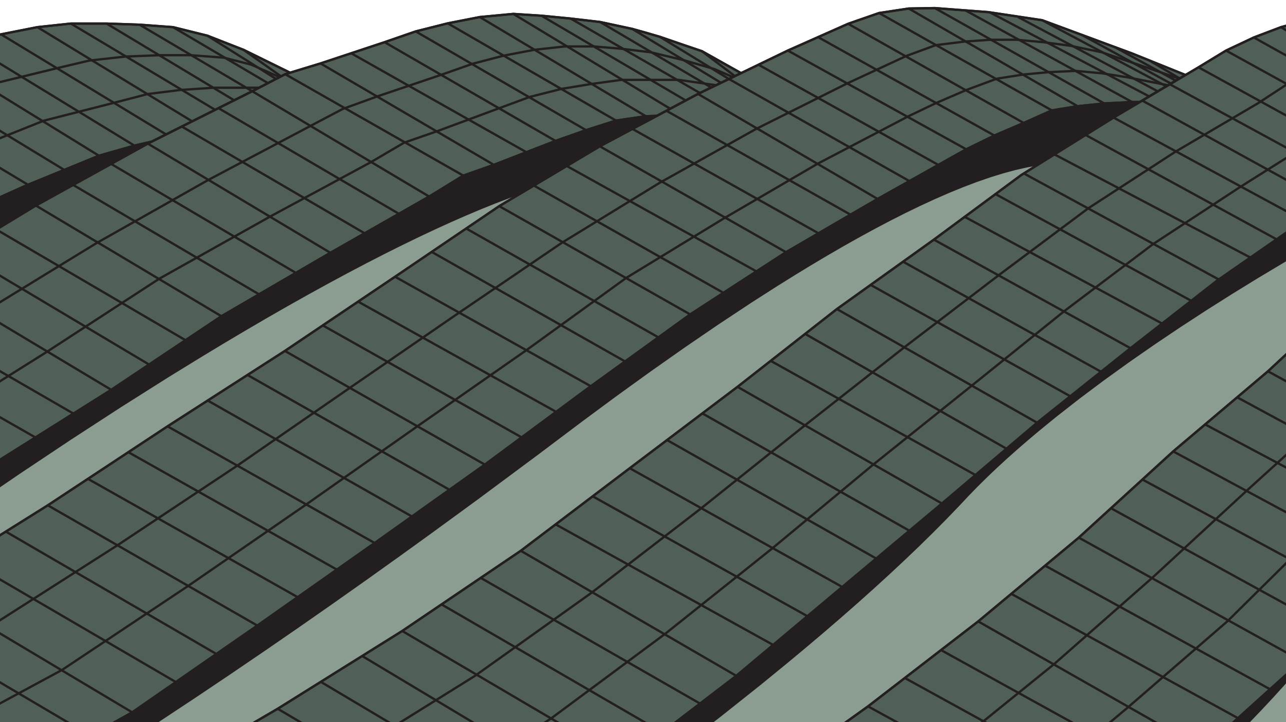
Merel Enserink

THE RISE OF SOLAR LANDSCAPES

Exploring key activities to advance practices and designing of solar power plants.



Propositions

1. The mandate of residents in solar power plant participation processes is disproportionate compared to other stakeholders (this thesis).

2. The entire energy transition is at stake if policy-makers maintain their focus and assessment on techno-economic criteria (this thesis).

3. Studies on acceptance of renewable energy have a blind spot for the effects of participatory design processes on local support and opposition.

4. Not all landscape architects are participatory designers.

5. Actionable knowledge from research requires more than publishing open access.

6. NIMBY is a very limited conception of the legitimate concerns local citizens may have about changes in their landscape.

Propositions belonging to the thesis, entitled
The rise of solar landscapes. Exploring key activities to advance practices and designing solar power plants.

Merel Enserink
Wageningen, 9 May 2025

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Merel Enserink

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photo EnergyGarden De Noordmanshoek, Wijhe (NL). Photo credit S. Stremke.

Introduction

Chapter 1

Introduction

When traveling through The Netherlands by car or train, one can see a large variety of solar power plants (SPPs) that are rapidly being installed along the larger infrastructure (Fig.1.1). From my view, most of these SPPs show resemblance to one another, even when located in very different landscape types. Most of these SPPs seem to contain as much PV panels as physically possible and are screened with the same common vegetation, such as English Ivy. To me, it seemed that the landscape design had been forgotten in the development process. However, when checking the websites of SPP developers for the project documentation, most SPPs would have a description on how the SPP was integrated in the landscape or even contributed to landscape quality. To me, most of the SPPs still looked the same. From large scale open polder landscape

Figure 1.1 Sight from the car (A15) on solar power plant 'Overbetuwe' (NL).

to small scale coulisse landscape, the SPPs did not fit into their host landscape. This difference in interpretation of landscape design and landscape quality raised all kinds of questions with me: Why are these SPPs appearing on these locations and who decides on that? Are local communities supporting or opposing these developments and are local communities included in the development process? Are Dutch policy and design practices using the right terms and tools to inform SPP development? Or is there too much focus on efficiency and on screening off the SPPs as the only considerations for the broader landscape? Should this infrastructure not be integrally designed, to become a logical part of the landscape? Honestly, at that time I was disappointed with the job of my peer landscape designers. Being perfectly aware of their qualities as designers, I was curious to the limitations in the processes that underlie the designing of SPPs.

Recently, the lack of quality of SPPs captured more attention in The Netherlands because of a political decision to place an embargo on the development of new monofunctional ground-mounted SPPs (Rijksoverheid, 2023). This embargo is a response to the persistent local opposition to the development of ground-mounted utility-scale SPPs. In The Netherlands, current SPP development is defined by techno-economic objectives (RVO, 2022). However, the opposition towards renewable energy projects is not directed at the techno-economic objectives or the technology itself, but related to environmental and socio-cultural values such as place attachment, local participation, and landscape experience (Stremke et al., 2022). Commonly, locals are not taken along in developing designs for SPPs, but confronted with semi-finalized plans that they are asked to respond to. This practice is framed as participation by some, but is often considered tokenism by others (Cuppen, 2018; Ryder et al., 2023). The plans that landscape users are confronted with, show limited consideration of the specific site, the landscape characteristics and the local values (physical and cultural). This does not align with the local socio-cultural values held by landscape users and is leading to local opposition against new SPPs (Wolsink, 2007). Altogether, the current SPP development presents shortcomings in how SPPs fit in the landscape and a possible lack of landscape design(ing). The situation calls for a more conscious approach which addresses the benefits and trade-offs of landscape transformation (Pedroli, 2022). The political decision for an embargo relates to a preference for the 'road of least resistance', by shifting the focus to another energy source, in this case nuclear energy. However, similar to the development of wind, which is still protested, moving to the next source will not make the targets of the energy transition more feasible (Planbureau voor de Leefomgeving, 2024). Moreover, it will not advance the pace of the energy transition, nor will it improve the quality of energy projects.

My research and the findings of this thesis indicate that there are possibilities to move from placing SPPs in a landscape to co-designing solar landscapes that are supported by landscape users and balance techno-economic objectives with environmental, and socio-cultural objectives. However, the findings of the research also stress that in order to advance the co-designing of solar landscapes there is a need to adapt the current practices.

1.1. Renewable energy landscapes and the Dutch energy transition

The transition to renewable energy inevitably leads to transformation of landscapes (Bridge et al., 2013; Nadaï & Van Der Horst, 2010). In this research, landscape is defined as in Article 1 of the European Landscape Convention (Council of Europe, 2000): "an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". In the current transition from fossil towards renewable energy, new types of energy landscapes are developed. Energy landscapes are cultural landscapes, often "the results from commissioning energy resources to sustain human life, […] energy landscapes are co-constructions of space and society that come into existence through a series of material and social relations" (Pasqualetti & Stremke, 2018, p.95). Renewable energy landscapes employ sources like hydropower, wind, geothermal, biomass, and solar energy (Pasqualetti, 2012; Stremke, 2015). The latter is the main focus of this thesis.

Figure 1.2 SPP Voorst B.V. along the A1 near Wilp (NL), realized in 2020 with an installed capacity of 45 megawatt. Photo credit dronewageningen, published with permission.

In the Dutch climate agreement (Rijksoverheid, 2019a), the result of a large deliberation process following the Paris Climate agreement (United Nations, 2016), The Netherlands state that in 2030 they want to generate 55 TWh from renewable sources. That is approximately 27% of the current energy usage of which in 2023 14,5% came from renewable sources (CBS, 2024). For 2050, the country plans to rely for 100% on a climate neutral energy system, mostly from renewable sources. In The Netherlands, large utility-scale SPPs are necessary to meet the set goals of the climate agreement and fulfil the Dutch energy demand both in 2030 and 2050 (Rijksoverheid, 2019a; Sijmons, et al., 2017a). Over the past years, the number of SPPs has increased significantly (Brandenburg et al., 2023), as well as the scale at which they are developed (Fig.1.2).

To guide the SPP development, many Dutch governmental authorities provide policy guidelines that describe ambitions for SPP development (e.g. Provincie Noord Holland, 2019). Besides technical and economic criteria, these ambitions mainly focus on socio-cultural, and environmental objectives. For example, several of these documents stress the importance of multifunctional land-use, as well as addressing factors such as ecological compensation and landscape quality (e.g. Gemeente Assen, 2020). Next to the governmental policies, there exist other documents with recommendations that support the implementation of environmental and socio-cultural objectives in SPPs, such as professional development codes (Holland Solar et al., 2019), and design principles (e.g. Sijmons, et al., 2017a). However, all these guidelines, codes, and principles are to some extend generic and freely interpretable. Several scholars have put the question forward whether these documents offer the right means to realize the environmental and socio-cultural objectives in SPP development (Moussa et al., 2020; Pasqualetti & Stremke, 2018; Scognamiglio, 2016; Stremke & Picchi, 2017; Stremke & Schöbel, 2019). Recent studies (De Vries et al., 2023; Oudes et al., 2022) emphasize the lack of quality found in current SPPs. They observed a lack of attention to environmental and socio-cultural objectives materializing in SPP development processes.

Moreover, in countries with high population densities, such as The Netherlands, it is challenging to allocate space for renewable energy. In such countries, renewable energy has to compete with other spatial claims such as food production, urban expansion, and climate adaptation (Sijmons, et al., 2017a). In The Netherlands, the development of SPPs is largely left to market forces: developers and landowners. They can develop a project based on the availability of land. For any project to be permitted by a municipal authority it is mandatory to organize some form of local participation (Rijksoverheid, 2019b). However, there are currently no clear guidelines on, for example, the type of participation (Uittenbroek et al., 2019) which makes organizing public participation challenging. In these processes, local engagement is often interpreted as invited stakeholder participation (Cuppen, 2018). This sort of participation represents a legislated procedure designed to inform local stakeholders and manage concerns and possible opposition (Wolsink, 2007). Current policy states that when (government) authorities consider the participation to be sufficient and the plans meet the permit criteria, the project can receive a building permit (e.g. Gemeente Assen, 2020). With this permit and a greenlight of the utility company for a net connection, the developer can apply for a national subsidy: SDE++. This national subsidy scheme stimulates large-scale developments of renewable energy. Submitted plans are evaluated on the efficiency, technical, and economic feasibility (RVO, 2023). The construction of the SPP is then still dependent on fluctuation in material prices, or technological innovation, and the connection to the energy network or a near-by energy user. That process can still take a few years, but the developer is allowed to implement the SPP on the location stated in the application for the building permit.

1.2. Distinction between solar power plants and solar landscapes

The ambition in The Netherlands is to create *sustainable* energy landscapes (Rijksoverheid, 2024). Simply implementing solar energy technologies in a landscape does not render the energy transition to be sustainable (Stremke, 2015; Stremke & Picchi, 2017). To be considered sustainable, the SPP development, and thus the landscape design, should include broader societal concerns related to environmental and socio-cultural objectives, besides technical and economic objectives (Stremke, 2015). In this thesis, the definition of Stremke & Van den Dobbelsteen (2013) is used, stating that sustainability refers to the manner how energy technologies are sited in the landscape: by acknowledging existing landscape qualities and the values of local inhabitants and other landscape users, and doing so without compromising biodiversity, food production, and other life-supporting ecosystem services. Landscape quality is defined by the functional, experiential, ecological, and temporal dimensions of a landscape (after Bakx et al., 2023). Oudes & Stremke (2020) refer to landscape quality as a key concept to help shape the design of large-scale landscape transformation for renewable energy. They base their argument on previous large-scale landscape transformations, such as the Dutch 'Room for the River' project (in Dutch: Ruimte voor de Rivier). Here, the inclusion of landscape quality as requirement for the development has helped to implement functional-technical solutions that simultaneously contribute to broader societal concerns (Klijn et al., 2013; Sijmons, et al., 2017b; Van den Brink et al., 2019).

To make the distinction between renewable and sustainable energy projects, I will distinguish in this thesis between *solar power plants* and *solar landscapes*. Here, solar power plant is defined as a ground-mounted solar energy facility at utility-scale, placed in a host landscape. To be considered a solar landscape the photovoltaic (PV) system should be designed as an element of the host landscape, using an integral design approach (Scognamiglio, 2016). The term host landscape refers to the landscape in which the SPP is or will be situated, whereas site refers to a particular location in that landscape that is defined by the project boundaries. The PV system can be combined with other functions for the SPP to become multifunctional. Oudes et al. (2022) have developed a framework in which they distinguish three types of multifunctional SPPs: mixed-production; nature inclusive; and landscape inclusive SPPs. In practice, it is less straightforward to apply any SPP typology. There is often a mix of objectives on the project level that can be related to the different types of SPPs. This leads to cases including spatial measures related to two or all three types of SPPs. Spatial measure is defined as a man-made intervention to make a physical adjustment to a landscape. These measures can relate to different functions of SPPs, such as energy generation, habitat creation, recreation, etc. (Appendix C). For example, to change an experiential quality by planting screening vegetation, or to change an ecological quality by creating a specific habitat. The focus for this thesis is on SPPs of five hectares or larger. The lower bound of five hectares was set because the spatial characteristics and effects on landscape transformation of small-scale PV installations differ significantly from utility-scale SPPs.

The actual design process of SPPs is not well documented in the literature. SPP developers and investors prefer not to share too many details on their business case to stay ahead of their competitors. Moreover, landscape architects are not always acknowledged as actors in the energy transition (e.g. Van de Grift & Cuppen, 2022). In contrast, Stremke & Schöbel (2019) assign an important role to the discipline of landscape architecture. They describe the importance of landscape architecture in designing a sustainable transition in which all objectives are integrally approached. This is in line with the potential that Sijmons & Van Dorst (2013) describe in the three main roles of the landscape architect or designer. They state that landscape architects can provide designs at the relevant scale, bridge differences between stakeholders, and communicate the narrative of the landscape transformation. Designing SPPs becomes even more important in light of the aforementioned land scarcity, and the impossibility of locating renewable energy infrastructure in places where it does not bother anybody. Scholars found that the transformation of the daily environment can be difficult for (local) stakeholders to accept (Bertsch et al., 2016), especially considering that people generally prefer their landscapes to remain unchanged (Pasqualetti & Stremke, 2018). This relates to the concept of status quo bias. "Status quo bias is a preference for the current state of affairs; that is, the status quo is taken as a reference point, and any change from that reference point is perceived as a loss" (Linnerud et al., 2019, p.3; after Samuelson & Zeckhauser, 1988). In general, people tend to be psychologically adverse to loss (Kahneman, 2011). Therefore, the design and development of SPPs is believed to benefit from an approach that acknowledges local support and opposition.

1.3. Local support, opposition, and acceptance of renewable energy

In general, renewable energy sources receive high public support. However, the local implementation of renewable energy technologies is often opposed by local stakeholders (e.g. Apostol et al., 2017; Bevk & Golobič, 2020; Sütterlin & Siegrist, 2017; Wüstenhagen et al., 2007). Many scholars affirm that local support is a key for a successful and timely transition to renewable energy (e.g. Hai, 2019; Langer et al., 2017; Schumacher et al., 2019; Sütterlin & Siegrist, 2017). In this research, acceptance refers to the passive or active response of local stakeholders in a positive or negative manner towards renewable energy developments (Gölz & Wedderhoff, 2018). This scholarly definition of acceptance deviates from the colloquial use of the term which typically denotes positive responses.

The scholarly literature describes many factors that influence the local response to renewable energy projects, the factors differ per study. Some scholars simply distinguish between positive and negative responses (e.g. Bailey et al., 2011), while others explore different dimensions or factors that influence the acceptance of a renewable energy project, such as economic benefits, environmental impact, visual impact, and procedural justice (e.g. Devine-Wright & Batel, 2013; Perlaviciute & Steg, 2014; Walker & Baxter, 2017). Several studies refer to siting and design of a renewable energy projects as determining factors for local support (e.g. Caporale et al., 2020; Kontogianni et al., 2014; Perlaviciute & Steg, 2014). Therefore, it is valuable to include local stakeholders in the development of SPPs and to address a larger set of factors in such participatory processes.

1.4. Participation of local stakeholders in renewable energy projects

Participation is commonly applied to gain local support of renewable energy projects, some scholars even argue to make local participation mandatory (Ernst, 2018). Many scholars depict local participation as a key to a socially just energy transition (e.g. Macarthur, 2016; Runhaar, 2009; Uittenbroek et al., 2019). Local participation can raise the legitimacy of decision-making (Coenen, 2009) and can contribute to procedural justice (Walker & Baxter, 2017). Both are often described as factors that influence local support and opposition (e.g. Devine-Wright, 2012; Firestone et al., 2018; Horbaty et al., 2012; Zoellner et al., 2008).

A recent study by Ryder et al. (2023) suggested that community members often perceive participation as ineffective and insufficient. They suggest that “an over-emphasis on engagement pursued according to developers’ instrumental reasoning may lead to engagement processes which stray from widely accepted best practices and are negatively perceived by communities” (Ryder et al., 2023, p.13). Hence, local engagement is often seen as tokenism, by which communities perceive that they have no real influence on final plans (Cuppen, 2018). Further, the current approach to developing renewable energy projects is believed to often increase injustice (Aitken et al., 2008; Richards et al., 2012). In terms of wind energy, this phenomenon prompted considerable interest in community-based development as an approach to incorporating procedural justice approaches (Solman et al., 2021; Warren & McFadyen, 2010). However, so far community-based development focusses mainly on a fairer distribution of economic benefits and much less on the inclusion of environmental and socio-cultural objectives in the SPP development.

De Waal et al. (2015) address the need to develop integral and bottom-up design processes to improve local support for renewable energy projects. They envision a supportive role for landscape architects and stress the necessity for a well-informed and evidence-based approach. Participation in the form of co-creation or co-designing is discussed by scholars as one approach (e.g. Stremke & Picchi, 2017). Co-designing allows for the inclusion of local knowledge and the accommodation of local objectives in development processes (d'Hont & Slinger, 2022). Co-designing and co-creation are forms of social innovation, in which actors, citizens and professionals, work together and share responsibilities and power (Itten et al., 2020; Lee et al., 2024). Co-design strategies have become standard practice in landscape architecture (Raaphorst et al., 2017; Thering & Chanse, 2011). However, it is not yet common practice in SPP development. Since participation is described as a key for local support by several scholars (e.g. Fenton et al., 2016) and is mandatory in The Netherlands (Rijksoverheid, 2019b), it is worthwhile to gain a better understanding of the possibilities, benefits, and limitations of local participation and co-designing in SPP development.

1.5. Research objective and knowledge gaps

At the moment of writing this thesis, there is a potential stand still in the development of utility-scale SPPs in The Netherlands, due to a political embargo on monofunctional ground-mounted SPPs (Rijksoverheid, 2023). As earlier explained, the embargo is the result of persistent local opposition towards SPP related landscape transformation. This response of local stakeholders was forecasted by experts and scholars (e.g. De Vries et al., 2023), following from a lack of quality in newly built SPPs and a malfunctioning of guiding policy documents and national subsidy schemes to include environmental and socio-cultural objectives. A stand still in SPP development would make it very difficult, if not impossible, to reach the stated renewable energy targets for 2030, and will make it extremely challenging to reach those for 2050. These recent events in The Netherlands show a gap between environmental and socio-cultural objectives that are held by society and (partly) addressed by policy on the one hand and the current practice of SPP development on the other hand, in which these objectives are disappearing. Moreover, it also indicates a gap between current practice of SPP development and the scholarly work on a sustainable energy transition (e.g. Loorbach, 2007; Oudes et al., 2022; Proka et al., 2018; Scognamiglio, 2016; Stremke & Schöbel, 2019; Wittmayer et al., 2017). These gaps between practice, society, and science call for a better understanding of current SPP development by exploring the shortcomings and opportunities to improve the process of SPP development. This requires a critical reflection on the current SPP practice to discover activities that can advance SPP development. In the transition management literature, four types of activities are distinguished that ought to work in an iterative manner to inform transitions: strategic, tactical, operational, and reflexive activities (Loorbach, 2007, 2010). The objective of this research is to advance the co-designing of solar landscapes, in which techno-economic objectives are balanced with environmental, and socio-cultural objectives. This objective leads to the main research question guiding the study: What are the key activities to advance the co-designing of solar landscapes in which techno-economic objectives are balanced with environmental, and socio-cultural objectives? This research question is divided in four knowledge gaps that are addressed in four research modules. In the following sections I will shortly describe these knowledge gaps and introduce the four research questions.

The first research module addresses the knowledge gap on the link between landscape design/designing and the acceptance of renewable energy projects. There is a large body of scholarly work on acceptance of renewable energy, as well as relevant scholarly work on designing renewable energy landscapes. However, both fields seem to work independently from each other and only limitedly acknowledge or refer to the other field of study. There are acceptance studies that consider landscape or related terms (e.g. landscape values, visual impact, landscape perception, landscape characteristics, landscape modification) as factors that influence acceptance of renewable energy projects (e.g. Keilty et al., 2016; Pasqualetti, 2012; Petrova, 2016; Roddis et al., 2020; Spielhofer et al., 2021). At the same time, the discipline of landscape architecture is becoming more and more involved in the design of renewable energy projects. Their involvement may relate to both the process of organizing the design with stakeholders and the actual content of spatial measures taken in the landscape design. This scholarly field - defined for this research as landscape design studies - mainly researches the spatial effect of renewable energy and how to design this transformation to make it fit to landscape (Oudes & Stremke, 2021; Scognamiglio, 2016; Stremke & Schöbel, 2019). Herein, the relation between landscape and landscape design and acceptance is underexposed in current peer-reviewed literature. The following research question guided the first research module:

1. What is the synthesis between the fields of acceptance studies on renewable energy and landscape design studies and how do these bodies of knowledge complement each other?

The research in the second research module addresses the knowledge gap on the role of designing in renewable energy projects and the potential influence of design processes on local support (Bevk & Golobič, 2020). The objective of this research is to examine the influence of a co-designed full-scale prototype on local acceptance of a SPP. Previous research has shown the importance of addressing and breaking the status quo bias (e.g. Linnerud et al., 2019; Sherren et al., 2016). Which can be done by familiarizing stakeholders with proposed landscape changes and thereby increasing their confidence in a new situation. Moreover, several scholars stress the positive effects of early participation of locals on local support of renewable energy projects (Fenton et al., 2016; Oughton, 2008; Walter, 2014), as this can lead to a more positive perception of outcomes by participants. However, co-design strategies are not yet common in the development of SPPs and the empirical evidence of the influence of these actions is very limited. One of the particular challenges in co-design processes is the complexity of technical plans and the interpretation by local stakeholders of these drawings and proposed changes (Raaphorst, 2018). To deal with this, the second research module explores the use of a full-scale prototype to communicate a range of design options in a participatory design process. The following research question guided the second research module:

2. What is the influence of a co-designed full-scale prototype on local support of a SPP?

The third research module addresses the knowledge gap on the benefits and limitations of participatory design processes of SPPs, and the balance therein between techno-economic objectives of building permits and national state aid with environmental and socio-cultural objectives described in policy guidelines and held by local stakeholders. Two tensions become apparent when studying the Dutch context. The first tension relates to the aim of participation. A tension between addressing local concerns to increase local support on the one hand, and on the other hand addressing broader societal concerns that transcend, but also sometimes run counter to concerns on the local level. The second tension relates to who can participate. A tension between predominantly choosing to include the expertise and knowledge of local inhabitants on the one hand, or on the other hand inviting expert knowledge. The objective of this study is to examine the benefits and limitations of participatory design processes in SPP development and the tensions therein as described above. This provides insight in the implications for policy and leads to recommendations for policymakers. This research addresses the lack of specifications on the manner of participation (e.g. Gemeente Assen, 2020; Gemeente Montfoort, 2022), and the lack of systematic empirical studies on how public participation is actually executed as described by Uittenbroek et al. (2019). Furthermore, the research addresses the imbalance between the criteria in SPP policy guidelines and the requirements related to the building permit and financial support or state aid (RVO, 2023). The following research question guided the third research module:

3. What are the benefits and limitations of participatory design processes in SPP development in The Netherlands, and what are the possible implications for energy policy?

The fourth research module examines the imbalance of techno-economic objectives with environmental, and socio-cultural objectives materializing in built SPPs. In this study, I research the current practice of SPP development to learn from the reoccurring discrepancies between permit documentation and built reality of SPPs in The Netherlands. Herewith, the study contributes to a better understanding on how to balance broader societal concerns, such as landscape quality, in SPP development. In this particular research module, I use landscape quality as a proxy for broader societal concerns, covering environmental and socio-cultural objectives. Landscape quality is stipulated by the European Landscape Convention as an important factor that should be accounted for in landscape transformations (Council of Europe, 2000). On several Dutch authority levels this concept is acknowledged (e.g. Gemeente Assen, 2020; Provincie Gelderland, 2019). However, the given definitions for landscape quality and requirements on landscape design are not well-defined and leave much room for interpretation. Recent studies are concerned with the materialization of measures addressing environmental and socio-cultural objectives in SPP development (Oudes et al., 2022). A first glance at the current state of Dutch SPPs emphasizes the differences between constructed SPPs and the design documentation submitted for permit approval. It is important to understand to what extent these discrepancies appear and what their causes are. The findings allow for critical reflections that can advance policy and design practices of future SPP developments. The following research question guided the fourth research module:

4. What can be learned from the discrepancies between permit documentation and built reality of SPPs in The Netherlands, to better balance techno-economic objectives with environmental, and socio-cultural objectives?

The four research modules together comprise insights in different moments and particular aspects of current SPP development in The Netherlands. To answer the main research question, I will evaluate the relative importance of the different findings of the research modules and how these can inform key activities to advance the co-designing of solar landscapes.

1.6. Research design

1.6.1. Worldview and research approach

To be able to address the above mentioned knowledge gaps and to answer the main research question, both quantitative and qualitative data and methods are employed, fitting a pragmatist worldview (Creswell, 2009). Moreover, the type of research questions that were formulated for research module 2 & 3 dictated embeddedness of the researcher in real-life practice. This type of action research too fits with a pragmatist worldview. Several scholars called for more action research on the topic of renewable energy landscapes and the relation to local acceptance (e.g. Roe, 2017; Sütterlin & Siegrist, 2017). Procedurally, action research “is composed of a circle of planning, action, and fact-finding about the result of the action” (Deming & Swaffield, 2011, p.192). The researcher learns from and through one’s practice by working through a series of reflective stages (Riel, 2019). This provides insight in the ways in which a variety of social and environmental forces interact, and leads to new knowledge on a subject as well as recommendations for co-creative design research. For the second and third research modules, I was embedded as a landscape architect in four real-life cases to perform action research. In the second research module, the action research allowed me to evaluate different design and visualization tools in a co-creation process with local stakeholders (Box 1.1). In the third research module, the action research allowed me to be part of all design discussions with stakeholders, take notes, and observe this process up close (Box 1.2). Moreover, immersing in real-world practice enables the researcher to combine theory with practice and reflect on both (Deming & Swaffield,

Box 1.1 In My Backyard Please project (IMBYP)

The In My Backyard Please (IMBYP) project was initiated in 2019 by the Dutch National Consortium 'Zon in Landschap' (PV on land). For this research, an interdisciplinary team was formed of social researchers, designers, engineers and landscape architects- a collaboration of TNO, Wageningen University, Design Innovation Group, and TS Visuals. The project aimed to operationalize and reflect on the designing of SPPs and study the related changes in local support towards a SPP. For this, a real-life case was selected. The case selection was based on the following criteria: location, relevance, design possibilities, landscape user experience, possible local resistance, stage of development, and cooperation of (local) initiator. In total six cases were considered in consultation with all project partners. One case met all criteria: Nauerna. The project consisted of several steps and interactions with the local community and other stakeholders. The project outcome remained hypothetical. A local initiative is still researching the possibility to construct a SPP on a part of this location.

Box 1.2 Energy Gardens-project (Energietuinen NL)

The EnergyGarden-project was initiated in 2019 by the Dutch Nature and Environment Federation (NMF). The project was motivated simultaneously by a pragmatist and emancipatory perspective (see Creswell, 2009). The project aimed to develop large scale energy landscapes (mainly solar energy) that are accessible for the public, multifunctional – increasing the nature and recreational values – and developed in a participatory manner, including local stakeholders in the design process and in the ownership (Natuur & Milieu Federatie, 2019). The project started with three real-life cases located within The Netherlands: Assen, Mastwijk, and Wijhe. A participatory design process was initiated in all three cases, following a RTD approach that matched the objectives to actively involve local stakeholders. Currently one of the cases is constructed, namely in Assen.

2011; Wiberg, 2019). In this research, action research resulted in new knowledge on the conditions and limitations of co-design processes for solar landscapes, next to other findings. Furthermore, the research projects employed co-creation strategies. Co-creation is often used to address social problems or innovation by involving local stakeholders (Itten et al., 2020). In the literature, co-creation is used interchangeably with co-design. Although there are small nuances between the two terms, they are both implemented in participatory processes. However, the latter more specifically refers to the role of designing and the designer (Lee et al., 2024).

1.6.2. Overview of research methods

A mix of methods was chosen to address all knowledge gaps in this thesis. This choice was necessitated by the different nature of the research questions that call for different methods. Furthermore, the belief of the researcher is that the combined strengths of different methods can improve the depths and possibly the accuracy of the findings (Kumar, 2014).

In the first research module I employed a systematic literature review (Gough et al., 2017; Grant & Booth, 2009; Petticrew & Roberts, 2008). This method was chosen because it enabled me to look at two different bodies of literature, related to two fields of research: acceptance studies on renewable energy and landscape design studies. In the review I compared both fields to better understand where these fields overlap, where they acknowledge each other, and where they can learn and benefit from each other.

The second and third research modules build on in-depth case studies. Case studies are a well-established method in landscape architecture (Flyvbjerg, 2006; Francis, 2001; Swaffield, 2016). In studying SPP development, the focus of this thesis is on densely populated countries with The Netherlands as example. Therefore, all cases are located in The Netherlands, covering several landscape types and cultural differences within the country. To answer the second research question, a projective participatory design strategy is employed (Deming & Swaffield, 2011; Francis, 2001) as part of the TKI-Urban Energy project ‘In My Backyard Please’ (Box 1.1).

> *“Participatory design is an approach that actively involves end users and neighbours in visioning, programming, and design processes in order to improve design quality, gain support and help ensure that design outcomes adequately meet their needs”* (Deming & Swaffield, 2011, p.197).

The research in this module can be depicted as a quasi-experimental design experiment (Deming & Swaffield, 2011). In which I focus upon one specific real-life case, to research the community participation and the effect of the process interventions, such as a full-scale prototype, on the local support for a SPP.

To answer the third research question, I employed participatory designing as part of a research through designing (RTD) approach (Lenzholzer et al., 2013, 2017). Lenzholzer et al. (2013) have argued that RTD is considered academic research if it complies with the academic standards on procedures, protocols and values. They use the widely acknowledged framework of Creswell (2009) to distinguish four types of RTD: (post) positivism, constructivism, advocacy/participatory, and pragmatism. In this research I employed pragmatism RTD. The research questions addressed a combination of issues (e.g. physical, social, aesthetics, etc.) which fits with this type of RTD. Moreover, RTD should result in new knowledge that can either be applied in practice and/or in further research (Lenzholzer et al., 2017). Lenzholzer et al. (2017, p.62) argue that:

> *“Since our world is changing ever faster, the ’transformative’ sciences that deal with the potential future states of our environment are likely to become increasingly important. RTD is expected to play an increasingly significant role in landscape architecture and in shaping landscape architecture as one of the ‘transformative’ sciences of the future.”*

The choice for a RTD approach was based on several studies that suggest that RTD is a fitting approach to address complex challenges like the energy transition (Cortesão & Lenzholzer, 2022; Stremke & Schöbel, 2019; Wiberg, 2019). Stremke & Schöbel (2019) go as far as to argue that RTD is necessary to shift from merely implementing PV technologies to designing solar landscapes, a shift also postulated by Scognamiglio (2016) and more recently by Lobaccaro et al. (2019). With this research I contribute to the broader academic discussion on RTD and its application in real-world practice. The third research module involved three pilot cases that were all part of the Dutch EnergyGarden-project (in Dutch: EnergietuinenNL) (Box 1.2). In all three cases there was a local initiative to develop a SPP that incorporated environmental and socio-cultural objectives. In each case, RTD was employed to research the benefits and limitations of participatory design processes in SPP developments.

For the research in module four, I performed a post-occupancy evaluation of five built SPPs in The Netherlands, followed by structured interviews with involved stakeholders. Several scholars stress the value and novelty of post-occupancy evaluation in landscape architecture (Chen et al., 2023; Deming & Swaffield, 2011). The latter is certainly true for SPP development where post-occupancy evaluations are not yet common practice. For SPPs 'post-construction' would be a more fitting term, however, for clarity in terms of research methods I will use the more commonly used term 'post-occupancy'. The post-occupancy evaluation is a valuable method to compare the designed SPP with the materialized SPP, for multiple reasons. Among others, it allowed me to study the discrepancies in the development processes and the role of landscape architects therein. Moreover, structured interviews (Fowler, 2012; Weller, 2007) were held with key stakeholders to identify causes for reoccurring discrepancies. I used the structured interviews to compare the identified causes from a broader sample of involved stakeholders. To this end, I performed a thematic content analysis (Braun & Clarke, 2006) which is an appropriate method to identify patterns in the causes by analysing quotes from different stakeholders.

1.6.3. Research quality

The quality of the research was ensured by using several strategies and techniques. Throughout the research I have been transparent about data collection, analysis methods, related findings and conclusions. At the start of this research, a data management plan was prepared. This plan was followed and updated throughout the duration of the research. The data management plan included guidelines on data collection, where and how to save files, and rules on using and coding sensitive information from the case studies. Moreover, I employed established research methods in all four research modules. Furthermore, multiple data sources were used to enable triangulation of results in all research modules (Creswell, 2009). For the post-occupancy evaluation, for example, data from project documentation, legal permit documentation, field visits, and drone images taken in a different year and season were used to ensure a comprehensive inventory of the spatial measures proposed and taken at a specific SPP. Additionally, I applied strategies in which I interacted with others to further assure the quality of the research:

- Collaboration with other researchers. All research modules were reported in scientific papers that were written in collaboration with multiple researchers. The collaboration allowed critical discussions of findings and interpretation of data, which led to an overall consensus on the conclusions of each research article. At the start of chapters 2 to 5, the publishing details are provided. Moreover, an overview of the CRediT author statement (Brand et al., 2015) specifying my contribution to each of the chapters as well as that of my co-authors is included at the end of each chapter.
- Check with partners from research consortia. In the research projects I worked in interdisciplinary teams existing of a broad range of different expertise. During the project work there was an extensive exchange on data collection and interpretation between project partners, as well as with local stakeholders. In one project, drafts of the research article were shared with project partners for review and in another project I organized additional interviews with project partners and participants to check that the researchers interpretation of the

data matched with their perspective and experience from the project.

- Checks with peers and colleagues. During my research I had many exchanges with peers and colleagues, either organized in meetings with other doctoral students and post docs, or more casual during work breaks. This exchange allowed for feedback on my research and exchanging thoughts and experiences on methods, which strengthened the argumentation to use certain methods or interpretation of findings.
- Presentations of preliminary findings at (international) conferences. On several occasions, I had the opportunity to present preliminary work and receive feedback from other researchers, as well as from professional audiences including landscape architecture practitioners and policymakers. This feedback enriched the discussion of the findings and helped me to better interpret the results of each research module. Moreover, the exercise of presenting helped me to present my findings more clearly and adapt to different audiences.
- Publication of research in international scientific journals. The rigorous peer-review processes helped me to improve the respective research chapters, by sharpening the scope, strengthening the discussion of results, and improving the scientific writing. Chapters 2 to 5 are written as original research articles for scientific journals. More specifically chapter 2 and 4 are published in a Q1 journal and chapter 3 in a Q2 journal. At the time of writing, chapter 5 was under review at another peer-reviewed journal (Q2), and is in the meantime accepted with minor revisions.

1.7. Structure of the thesis

After this introduction chapter, the thesis comprises four chapters discussing the four research modules and a final chapter concluding this thesis. Chapters 2 – 5 cover the work conducted in the four research modules. In short, chapter 2 presents the systematic literature review on the factors that influence local support and opposition of renewable energy projects, resulting in a long-list of 80+ factors described in peer-reviewed literature. Chapter 3 discusses the positive influence of a co-designed full-scale prototype on local support of a SPP. In chapter 4, lessons are drawn for policy on the requirements for local participation in relation to the inclusion of environmental and socio-cultural objectives based on three participatory design processes for SPPs. Chapter 5 contains a post-occupancy evaluation of five Dutch SPPs which discusses the reoccurring discrepancies in environmental and socio-cultural measures and their causes, as well as the role of landscape architects in SPP development. Lastly, in chapter 6, I discuss the main findings from the four research modules and articulate key activities that can advance the co-designing of solar landscapes. This final chapter comprises the main conclusions of my research.

CRediT authorship contribution statement

This chapter is solely authored by Merel Enserink.

2

photo SPP Broekstraat, Apeldoorn (NL)

To support or oppose renewable energy projects?

A systematic literature review on the factors influencing landscape design and social acceptance.

2

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Chapter 2

Abstract: The local implementation of renewable energy projects often faces opposition. The landscape transformation that comes with the transition to renewables is one of the key counter-arguments of local stakeholders. In this article, we examine the relation between research on ‘designing landscape transformations’ and ‘acceptance of renewable energy projects’; whether and how these bodies of knowledge may complement each other. The systematic literature review revealed that acceptance studies and landscape design studies describe 25 similar factors that influence acceptance. The majority of these factors are generic in nature, such as economic benefits, visual impact, and aesthetics. Additionally, we found 45 unique factors in acceptance studies and sixteen unique factors in landscape design studies. Furthermore, we found differences in distribution of factors when categorizing and comparing them by means of two conceptual frameworks. Moreover, the emphasis in peer-reviewed literature differs significantly from laypersons, challenging the current research agenda on landscape transformation and acceptance of renewable energy. The findings and the knowledge lacunas provide clear avenues for a shared research agenda. Future research needs to examine the influence of involving landscape designers on the acceptance of renewable energy projects and the effects of more inclusive design processes on factors such as trust.

Keywords: energy transition; local acceptance; inclusive design processes; energy planning; energy landscape

To support or oppose renewable energy projects?

A systematic literature review on the factors influencing landscape design and social acceptance.

2.1. Introduction

The transition to renewable energy, following from (inter-) national policies and agreements (e.g. the Paris Climate Agreement), leads to landscape transformations (Bridge et al., 2013; Nadaï & Van Der Horst, 2010). These transformations involve a change in the dominant land use and of the visual appearance of the landscape. Consequently, new types of energy landscapes are being developed that employ different types of renewable energy sources (Pasqualetti & Stremke, 2018; Stremke, 2015).

The local implementation of renewable energy projects often lacks public support (Apostol et al., 2017; Bevk & Golobič, 2020; Sütterlin & Siegrist, 2017; Wüstenhagen et al., 2007). Many scholars affirm that public support is a key for a successful and timely transition to renewable energy (Apostol et al., 2017; Gölz & Wedderhoff, 2018; Hai, 2019; Langer et al., 2017; Schumacher et al., 2019; Sütterlin & Siegrist, 2017). Public acceptance is defined in this study as the passive or active response of local stakeholders in a positive or negative manner towards landscape transformations (Gölz & Wedderhoff, 2018). It is an indicator for the level of local support or opposition towards a particular renewable energy project.

A substantial body of scholarly work exists on the acceptance of renewable energy projects (e.g. Devine-Wright & Batel, 2013; Gölz & Wedderhoff, 2018; Perlaviciute & Steg, 2014; Roddis et al., 2020). The outcomes of these studies vary, but several factors for success or failure of local implementation of renewable energy projects are recurring in the literature (e.g. economic benefits, environmental impact, process, and procedural justice). Several of these studies consider 'landscape' or related terms (e.g. landscape values, visual impact, landscape perception, landscape characteristics, landscape modification) as factors that influence support or opposition to renewable energy projects (Keilty et al., 2016; Pasqualetti, 2012; Petrova, 2016; Roddis et al., 2020; Spielhofer et al., 2021). Bertsch et al. (2016) consider transformation of the landscape as the main driving factor for the local acceptance of renewable energy projects.

More and more landscape architects contribute to the implementation of renewable energy projects. They act for example as 'facilitator' or 'boundary spanner' between policy and practice, and consult in specific renewable energy projects (De Waal et al., 2015; Picchi, 2018; Stremke & Schöbel, 2019; Van den Brink et al., 2019). The involvement of landscape architects may relate to both the process of producing the design and the actual content of measures taken in the landscape design. Whereas the influence of landscape and landscape change on the acceptance of renewable energy projects is confirmed by several scholars (e.g. Bertsch et al., 2016; Spielhofer et al., 2021), the role of design in this landscape transformation receives little attention (Bevk & Golobič, 2020). This is remarkable, because in many countries, such as the UK, The Netherlands, and Germany, landscape transformations are the outcome of a deliberate process in which various considerations are discussed, not least the consequences of renewable energy technology for the landscape and the necessary change of the landscape for its realization.

To address this knowledge gap of designing renewable energy landscapes in relation to acceptance, we explore the relation between landscape design and acceptance of renewable energy projects. The study presents a novel theoretical synthesis (Sovacool et al., 2018) between the fields of 'acceptance studies on renewable energy' and 'landscape design studies'. We study how these fields currently acknowledge each other, what overlaps in terminology and considered topics exist between the fields, and where the fields could strengthen each other in the future. For this, we performed a systematic literature review, to analyse both fields on the factors they describe to influence local acceptance of renewable energy projects. We compare the fields to reflect on differences and similarities in terms of factors. Furthermore, the study has empirical novelty, while it contributes to a better understanding of acceptance of renewable energy as used and studied in these two domains. Additionally, the study provides an opportunity to relate our findings to daily practice of policymakers, practitioners and other stakeholders in both fields.

In the next section we introduce the concepts of 'landscape design' and 'acceptance' in connection to renewable energy and conceptualize how these fields are interrelated. The third section describes our methods and materials. Section four elaborates on the factors that influence the opposition and support for renewable energy projects from the fields of 'acceptance' and 'landscape design'. In section five, we discuss the results and present our main conclusions.

2.2. Conceptual framework

Our literature review is based upon a thorough understanding of two key concepts and their interrelation. Firstly, we describe the concept of 'landscape design' and its connection with acceptance of renewable energy projects. Secondly, we describe the concept of 'acceptance' of renewable energy and its connection with landscape design.

2.2.1. Landscape design and renewable energy

The term landscape varies in status, meaning and usage (DeLue & Elkins, 2008; Palka, 1995). Landscape can be referred to as (a) an indication of a place or terrain (e.g. Palka, 1995), (b) the visual perception, scenic value or experience of a place (e.g. Spielhofer et al., 2021), or (c) both the physical characteristics and the perception of a landscape. The latter interpretation is in line with Article 1 of the European Landscape Convention (ELC) (Council of Europe, 2000), which describes landscape as "an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". In the research presented in this paper, we embrace this comprehensive definition of ELC because it includes both the experience of a current situation as well as the possibility of changing this situation either by natural development or human intervention. Perception of landscape change is considered by several landscape design studies as a factor for social acceptance (e.g. Bosch et al., 2020; Picchi et al., 2019; Selman, 2010).

Scognamiglio (2016) draws a direct connection between local acceptance of renewable energy projects and designing solar energy landscapes. She argues that the importance of landscape design for local support is highly underestimated. Landscape architects design landscapes to accommodate (new) uses while taking into account the functional, experiential and temporal dimensions of landscapes (Oudes & Stremke, 2020). In a recent study, Oudes & Stremke (2020) studied three cases of large-scale landscape transformation, and concluded that designing large-scale transformations can benefit from a more encompassing approach and attention to these three dimensions of landscape. Moreover, Sijmons & Van Dorst (2013) stress that the role of landscape design is threefold. Firstly that landscape designers should make good designs at every relevant scale, secondly that design might also play a role in the process in terms of mediation, by giving spatial expression to the existing socio-cultural values in the landscape transformation. Finally, design in their opinion can provide a consistent connective narrative for the landscape transformation which can play a role in communication between policymakers and the public.

Stremke (2015) introduced a conceptual framework for the design and designing of sustainable energy landscapes that comprises sustainable technical, economic, environmental, and social aspects. How these aspects are addressed in the design and the design process itself determine whether a renewable energy landscape can be considered sustainable or not. While current renewable energy developments mainly focus on the technical and economic dimensions, Stremke (2015) addresses the importance of considering all four dimensions in an integral manner. Moreover, by emphasizing the involvement of local stakeholders in the landscape design processes, he draws attention to the critical importance of local acceptance. The sustainable energy landscape framework (Stremke, 2015) is used as a basis in several landscape design studies on renewable energy landscapes (e.g. Oudes & Stremke, 2018; Stremke & Schöbel, 2019).

2.2.2. Acceptance of renewable energy

In the literature on 'acceptance of renewable energy' the definition of the term 'acceptance' is discussed extensively. Some scholars define acceptance as a static, positive judgement or aim. Cohen et al. (2014) for example, state that social acceptance is a balance that can be attained by considering positive outcomes, such as economic benefits and greenhouse gas reduction, as a counterweight to overcome negative outcomes, such as diminished view sheds and landscape intrusion. Other scholars understand acceptance as an indication of the passive or active support and opposition (e.g. Bailey et al., 2011; Gölz & Wedderhoff, 2018) that changes over time (e.g. Keilty et al., 2016; Wolsink, 2007) and varies according to different geographical scales (e.g. Devine-Wright et al., 2017). Bertsch et al. (2016) align with this interpretation and define acceptance as "a subjective measure of the readiness of people to accept a certain facility in their neighbourhood – regardless of rational judgement". In this research we follow this more dynamic interpretation of acceptance, it being both the local support and opposition towards a landscape change (Bailey et al., 2011; Gölz & Wedderhoff, 2018), which can differ on geographical scales (Devine-Wright et al., 2017), that can be influenced (Bevk & Golobič, 2020), and can change over time (Keilty et al., 2016; Wolsink, 2007).

Acceptance studies on renewable energy differ in the factors they consider important for acceptance. The most general approach for studying acceptance is to simply differentiate between two groups of factors: those of support and those of opposition to renewable energy projects (Bailey et al., 2011). However, many studies distinguish more specific factors for defining and measuring acceptance of renewable energy projects. Perlaviciute & Steg (2014) studied contextual and psychological factors for determining 'public acceptability' of renewable energy, taking into account both collective and individual level costs and benefits as well as perceived fairness. Devine-Wright (2012) presents a framework of project-related factors that influence local acceptance of renewable energy projects, namely place attachment, impact, trust, and procedural justice. Gölz & Wedderhoff (2018) examined the perception of fairness, trust, and regional added value to measure the 'regional acceptance' of the German energy transition. Another scholarly discussion focuses on the different layers of social acceptance. Sovacool & Ratan (2012) advanced the framework by Wüstenhagen et al. (2007) adding several conditions to the three layers that together shape 'social acceptance' of renewable energy: socio-political, market and community acceptance. Recently, Roddis et al. (2020) specifically examined 'community acceptance' arguing this to be the most important level for implementation and support of renewable energy projects, especially when considering the deployment stage. Their research, a literature study and case study on a solar power plant, reveals a large number of determinants which they cluster into eight main factors: aesthetic, environmental, economic, project details, temporal, social, construction and process (Fig.2.1). The strength of their study is that they test their framework, which is based on peer-reviewed literature, in a case study. This enables them to distinguish which factors are found most important by laypersons and how this relates to the emphasis of such factors in peer-reviewed literature. Interestingly, the factor environmental

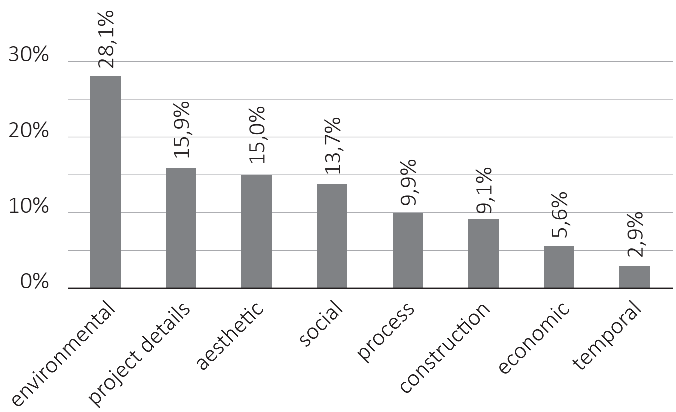


Figure 2.1 Percentages of factors (i.e. determinants of community acceptance), from the public on a case study of a solar power plant (Roddis et al., 2020)

scored highest (28,1%) in their case study, while temporal and economic factors are least considered by the community in this case study.

Landscape is often mentioned in acceptance studies on renewable energy. Landscape, however, is seldom defined and- if so- definitions vary greatly. Some scholars refer to landscape as the place where a transformation is happening which can be impacted negatively. However, they do not provide a definition of what they consider landscape to be (e.g. Cordoves-Sánchez & Vallejos-Romero, 2019). Some authors refer to the ELC or similar definitions, acknowledging the interplay of human and natural influences and the temporal dimension of landscape (e.g. De Boer et al., 2018; Zoellner et al., 2008). Several acceptance studies refer to the human perception of landscape and, more specifically, the visual impact caused by a renewable energy project often relating to existing landscape values (Bevk & Golobič, 2020; Firestone et al., 2018; Keilty et al., 2016; Lothian, 2020). Bevk & Golobič (2020) stress that landscape design should receive more attention when solar power plants are developed. Devine-Wright (2008) argues that a better understanding is urgently needed of how processes of engagement in renewable energy siting are influencing public perceptions.

Although the acceptance of renewable energy projects is related to the landscape and the design of those landscapes, and landscape design includes social factors, no papers explore the terminological and thus theoretical links between the two fields. In this study we are looking for the theoretical meeting points between the fields of landscape design and acceptance of renewable energy projects, by identifying factors that influence acceptance. We hypothesize that social science may have a blind spot for what interactive and creative opportunities landscape design can offer and that landscape architects may have a blind spot for some of the social factors that are known to be of influence for the acceptance of landscape transformations. In the following section we describe the methods we employed in our research.

2.3. Methods

This paper is based on a systematic literature review (Gough et al., 2017; Grant & Booth, 2009; Mengist et al., 2020; Petticrew & Roberts, 2008), employed to identify factors for the support or opposition to renewable energy projects from two distinct bodies of literature, namely the field of 'acceptance studies' and the field of 'landscape design' involved with large-scale landscape transformations such as renewable energy landscapes. To ensure transparent and reproducible results, we hereafter describe the following three research steps (Petticrew & Roberts, 2008): 1) search strategy development & implementation; 2) relevance & quality assessment; and 3) data extraction & synthesis.

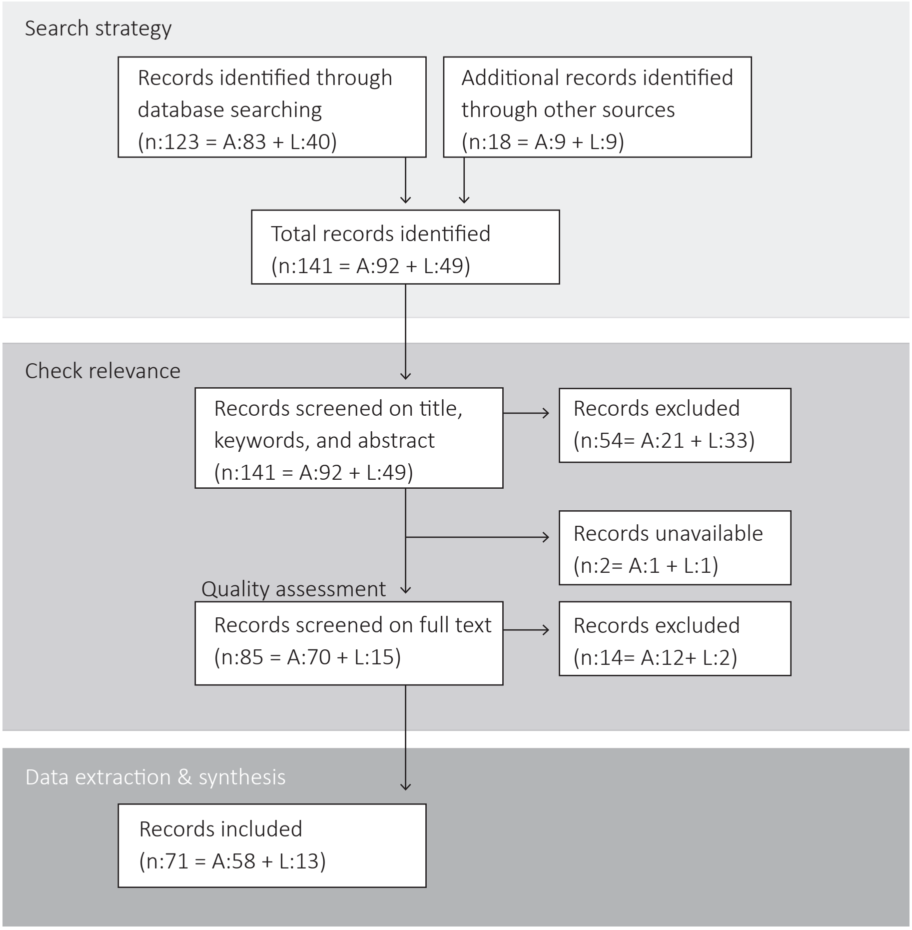
2.3.1. Search strategy development & implementation

We performed two separate searches in the online database *Web of Science*. We used this database because it is considered to be the most sophisticated scientific search engine within The Netherlands, our university, and research domain. Moreover, Web of Science only includes journals with a high impact factor, which we see as a validation of a thorough scientific screening through academic peer-review. Each search focused on one field: acceptance studies and landscape design studies. We defined keywords based on the scope of the research objective. For the acceptance studies we were interested in a broad list of factors that influence support or opposition towards renewable energy projects, therefore we employed the keywords: "acceptance" AND "renewable energy" AND "landscape". The reference to landscape in title, keywords or abstract limited the amount of papers that we retrieved. For the literature search on landscape design studies we defined the keywords: "landscape architecture" OR "landscape design" OR "landscape planning" AND "renewable energy". We limited the literature searches to original research articles. To further refine the search results we limited our searches to consider the subject areas 'environmental science', 'social science', or 'energy'. We did not apply a filter on year of publication in either of the searches.

In the field of acceptance studies, we identified 83 records. We then added nine relevant publications that were suggested to us by other scholars or mentioned in the initial 83 records. The total sample on acceptance of renewable energy included 92 records. In the field of landscape design, we identified 40 records (Fig.2.2). Because the literature search did not retrieve all records known by the authors we used a snow-ball technique to find additional relevant literature (Kumar, 2014) and supplemented the sample with peer-reviewed literature known by the authors or suggested to us by other scholars. One explanation for these missing records is that landscape design papers do not always mention the discipline in title, abstract or keywords. Another explanation for the limited amount of records is that the landscape design studies are limited to the field of landscape architecture, -design, and spatial planning; Whereas the acceptance papers draw from multiple fields, such as engineering, psychology, geography and political science. Together, we identified nine additional records, which resulted in a total sample of 49 records in the field of landscape design. We identified a total of 141 records in both fields.

2.3.2. Relevance & quality assessment

In the second step of the review process we performed a critical relevance and quality assessment by screening the retrieved publications to decide which ones to examine in detail (Grant & Booth, 2009; Petticrew & Roberts, 2008). First, the first author examined the usage of our search terms in the title, keywords and abstract to ensure the relevance of the publications for this literature review. The abstracts were examined in more detail to ensure the suitability of the records to answer our research questions. A very large share of the landscape design studies did not make any reference in the abstract to possible influences for support or opposition of landscape transformation, making them irrelevant for this study. Those were therefore excluded from the sample. The outcomes of this assessment were reviewed by the other authors. Additionally, if the relevance of the study was doubted by the first author the record was discussed by all authors, after which they decided to include or exclude the record for quality assessment. After this first check we included 70



A = field acceptance studies on renewable energy
L = field landscape design

Figure 2.2 Process overview literature search, relevance & quality assessment, and data extraction & synthesis

records from acceptance studies and 15 records from landscape design studies for the quality assessment. We used the following inclusion criteria: For acceptance studies the main criterion for selection was the reference to landscape or environmental factors relating to acceptance. For landscape design studies we established the following criteria 1) the study should focus on the contextual setting or design of larger landscape transformations, preferably related to renewable energy; and 2) the study then should refer to acceptance or social factors that are considered. All case studies were evaluated on reliability and scale. After the quality assessment, the final sample included a total of 71 papers: 58 publications on acceptance and 13 publications on landscape design. The records in the acceptance field were published between 2007 and 2021; the records from the landscape design field between 2010 and 2021. The geographical distribution of papers differed between both fields, the landscape design papers were mostly related to the European context, while the acceptance field addressed a wider context. Besides many European studies, the sample included several studies from Australia, Canada, Japan, and the USA. We excluded none of renewable energy technologies in our sample.

2.3.3. Data extraction & synthesis

The last step in the review process was to compare the content of the papers that were selected through data extraction and synthesis. We extracted data on references to factors for acceptance (or similar) from both fields. The indication of factors differs per article, some state clearly which factors they address in relation to acceptance, others only acknowledge that a certain influence played a part in effecting support or opposition. All data were recorded in a Microsoft Excel spreadsheet, as a tool for identifying patterns across studies (Popay et al., 2006). Many studies defined their own factors or made adjustments to existing frameworks by adding additional factors or specifying factors. This led to an overview of factors, which we used to identify similarities and differences between both fields by comparing the data in two steps (Fig.2.3). First, we compared both fields on their factors to identify similarities and differences in terms and in number of references to each factor. Secondly, we examined the similarities and differences between the fields in the emphasis placed on factors in acceptance studies and landscape design studies. We did this by categorizing the factors from both fields according to two existing conceptual frameworks. First according to the sustainable energy landscape framework (Stremke, 2015), to examine how the factors relate to a theory from landscape design. And, secondly, categorizing the factors according to the community acceptance framework by Roddis et al. (2020), to perform a similar comparison with a framework from acceptance studies. In the comparison, we worked with percentages to deal with the

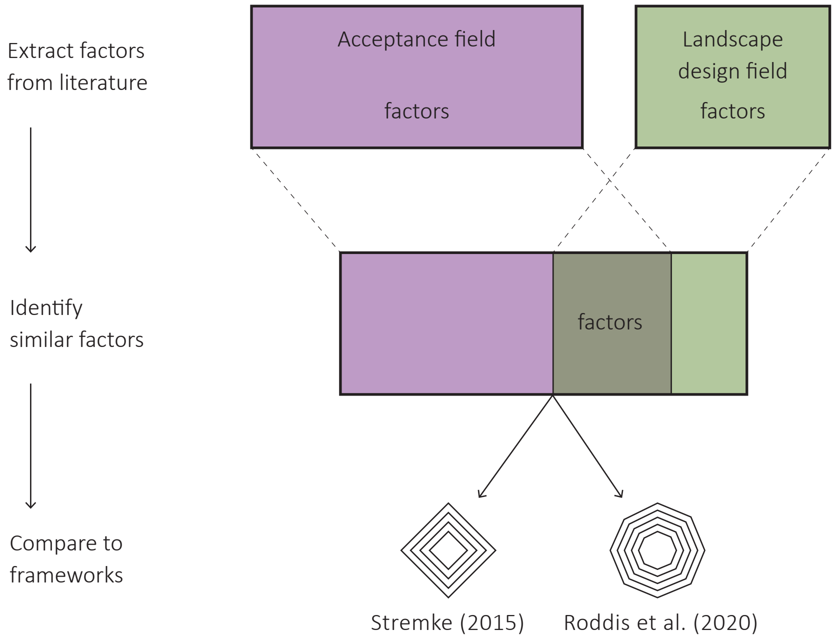


Figure 2.3 Overview of steps performed during data extraction & synthesis.

large difference in found records between the fields. This enabled us to compare the relative frequency of occurrence of factors in peer-reviewed literature within and between the two research fields. This frequency does not represent any weight or importance of a certain factor.

2.4. Results

2.4.1. Overview of factors

The analysis of papers from both fields results in a set of 86 factors that influence support or opposition towards renewable energy projects. We extract 70 factors from acceptance studies and 41 factors from landscape design studies. By comparing the 86 factors from both fields we identify a number of similarities and related factors. All factors are sorted per field according to the frequency of appearance in the literature (Table 2.1).

Table 2.1 The 70 factors from acceptance studies and 41 factors from landscape design studies, sorted on four levels according to the frequency of appearance in peer-reviewed literature. Factors with the same term in both fields are shown in italic.

Frequency of appearance	Factors mentioned in the acceptance field (n: 70/86)	Factors mentioned in the landscape design field (n: 41/86)
very often (> 60%)		*Community involvement & participation;*
often (40-60%)	Economic benefits; environmental impact; visual impact;	*Aesthetics & scenic quality; community values; environmental concerns; perception of landscape change;*
sometimes (20-40%)	*Aesthetics & scenic quality; nuisance; community involvement &participation; community values; decision making; landscape values; procedural justice; economic impact; perception of landscape change; place attachment; communication; environmental concerns; jobs;* health & well-being; process; site selection; temporal dimension; transparency; moral & ethical values; design; landscape characteristics; trust; visibility;	*Economic benefits; visual impact; environmental impact; landscape quality; place attachment; attitudes (towards RE); economic impact; jobs; nuisance; project size; recreation and community activities;* designing renewable energy landscapes; close collaboration with local authorities; involving farmers; landscape architect as facilitator; multifunctional land-use;
seldom (< 20%)	*Attitudes (towards RE); landscape quality; wildlife habitats & -creation; CO2 emissions; knowledge & understanding of RET; price; perception of risk; project size; recreation & community activities;* cultural heritage; demographic characteristics; fairness; information; regional added value; technology; trust in developer; impact on agricultural land use; (cost) efficient; geographical locations; property values; social values; safety of plant; tourism; air pollution; construction; end-of-life; landscape modification; noise pollution; physical characteristics of energy alternatives; project details; trust in politics & institutions; alternative options; business model; cumulative impacts; flooding; functional efficiency; legacy; light pollution; mitigation measures; NIMBY; quality of energy provision; stable energy provision; traffic; visual preference.	*Knowledge & understanding of RET; communication; CO2 emissions; decision making; landscape values; perception of risks; price; procedural justice; wildlife habitats & -creation;* ecological compensation; ecosystem services; environmental (in)justice; inclusive bottom-up processes; economic sustainability; energy security; forced expansion; key role of cultural and public associations; landscape narrative; local initiative & energy cooperation; multi-stakeholder process.

2

2.4.2. Factors mentioned in acceptance studies

Overall the acceptance studies on renewable energy range from considering a few general factors (e.g. Calvert et al., 2019; Gölz & Wedderhoff, 2018) all the way to 28 specific determinants (Roddis et al., 2020). Most acceptance studies on renewable energy select which factors are necessary to be examined to answer their research question. This often leads to a selection of factors or specifications of factors. An example is the factor *trust*, which is referred to by some scholars in general as *trust* (e.g. Ketzer et al., 2020; Perlaviciute & Steg, 2014; Wolsink, 2007) and by others defined more specifically as *trust in the developer* (e.g. Devine-Wright, 2012; Firestone et al., 2018; Zoellner et al., 2008), or as *trust in politics & institutions* (e.g. Caporale et al., 2020; Keilty et al., 2016). The most frequently mentioned factor in the field of acceptance studies is *economic benefits*. *Environmental impact* and *visual impact* are often mentioned in acceptance studies as factors to influence support or resistance towards renewable energy projects.

2.4.3. Factors mentioned in landscape design studies

Examining acceptance of renewable energy landscapes is, as we found in this literature review, seldom the aim of the landscape design studies. Therefore the number of peer-reviewed landscape design studies addressing the relation between landscape and acceptance is limited. Nevertheless, we found thirteen studies that refer to acceptance and describe several factors that influence acceptance (e.g. Lobaccaro et al., 2019; Picchi et al., 2019; Stremke & Schöbel, 2019). On average, studies from the field of landscape design refer to nine factors. Similar to the acceptance studies, the factors differ both in scale and definition. Moreover, some of the factors are only addressed in one study, such as *communication* which is only mentioned by De Waal & Stremke (2014). Scognamiglio (2016) mentions seventeen factors for acceptance of ‘photovoltaic landscapes’ (designed large-scale solar power plants). Landscape design studies very often mention *community involvement & participation*. Other often mentioned factors are: *aesthetics & scenic quality*, *community values*, *environmental concerns*, and *perception of landscape change*.

2.4.4. Similarities and differences between fields

When comparing both fields, 25 factors are literally similar or can be interpreted similarly (Table 2.1). Several factors are mentioned using the exact same term, such as *visual impact*, *place attachment*, and *nuisance*. Some factors seem to be similar but use a different term, such as *energy security* and *stable energy provision*. Most mentioned factors in both fields are *community involvement &* participation, *economic benefits*, *visual impact*, *aesthetics & scenic quality*, and *environmental impact*.

We found a total of 45 factors that are only mentioned in the field of acceptance studies, such as *health & well-being*, *site selection, temporal dimension, transparency*, *fairness*, and *trust*. When the factors *trust* and related factors *trust in developer, trust in politics & institutions* are added together these are often mentioned in the acceptance studies. Moreover, these studies often argue that trust (and related terms) is a determining factor for local support or resistance towards renewable energy projects (Stremke, 2015). The absence of this factor in the landscape design studies is interesting, because *trust* influences local attitudes which, in turn, relates to the possibilities for *community involvement & participation*. The latter is very often mentioned as a factor in the landscape design studies (Table 2.2). While *community involvement & participation* is the most mentioned factor in landscape design studies it is only sometimes mentioned in the acceptance studies. The landscape design studies list sixteen factors that are not mentioned in the acceptance studies, such as *designing renewable energy landscapes, close collaboration with local authorities*, and *ecosystem services*. Furthermore, landscape design studies have a stronger focus on factors, such as *environmental concerns* and *perception of landscape change*. Acceptance studies on renewable energy, on the other hand, focus more on factors such as *health & well-being*, *process*, and *site selection*.

2.4.5. Comparison of categorized factors

Lastly, we categorized the factors according to the four dimensions of the sustainable energy landscape framework (Stremke, 2015) (Table 2.3), and to the conceptual framework for community acceptance (Roddis et al., 2020) (Table 2.4). When we

Table 2.2 Comparison between the fields of acceptance studies and landscape design studies on the frequency of appearance of references to factors (purple = only mentioned in acceptance field; green = only mentioned in landscape design field). Table shows factors with largest difference, full overview in Appendix A.

Factor	Acceptance field	Landscape design field
Health & well-being	sometimes	never
Process	sometimes	never
Site selection	sometimes	never
Temporal dimension	sometimes	never
Transparency	sometimes	never
Moral & ethical values	sometimes	never
Design	sometimes	never
Landscape characteristics	sometimes	never
Trust	sometimes	never
Visibility	sometimes	never
Landscape values	sometimes	seldom
Decision making	sometimes	seldom
Procedural justice	sometimes	seldom
Perception of landscape change	sometimes	often
Environmental concerns	sometimes	often
Close collaboration with local authorities	never	sometimes
Involving farmers	never	sometimes
Landscape architect as facilitator	never	sometimes
Multifunctional land-use	never	sometimes
Designing renewable energy landscapes	never	sometimes
Community involvement & participation	sometimes	very often

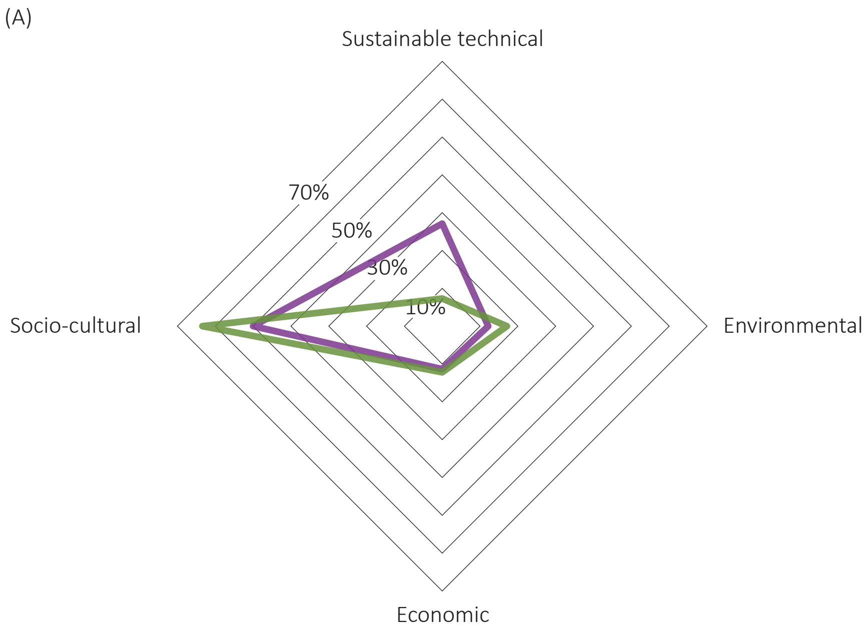
compare these categorizations some differences in focus on certain aspects between both fields become visible (Fig.2.4). Analysing the results with the framework on sustainable energy landscapes (Stremke, 2015) we find a similar focus in amount of factors related to economic aspects. However, acceptance studies tend to give more attention to sustainable technical aspects (20% difference), while landscape design studies tend to give more attention to social aspects (13% difference) and environmental aspects (6% difference). Interestingly the category of social aspects is in both fields much larger than the other three aspects, demonstrating a strong focus in peer-reviewed literature on social and/or process related factors. When sorting the factors to the main factors of community acceptance (Roddis et al., 2020) we find some alignments in the focus on the main factors aesthetic, economic, social, and temporal. However, acceptance studies have a stronger emphasis on the main factors

Table 2.3 Factors sorted according to dimensions of the sustainable energy landscapes framework (Stremke, 2015).

Aspect	Factors	% of factors mentioned in acceptance field	% of factors mentioned in landscape design field	Same factors (%)
Sustainable technical	Air pollution; business model; construction; cumulative impacts; design; economic sustainability; (cost) efficient; end-of-life; energy security; functional efficiency; light pollution; noise pollution; physical characteristics of energy alternative; project details; project size; quality of energy provision; safety of plant; stable energy provision; technology; temporal dimension; traffic;	27%	7%	5%
Environmental	CO2 emissions; ecological compensation; ecosystem services; environmental concerns; environmental impact; geographical location; landscape characteristics; landscape modification; wildlife habitats &-creation;	11%	17%	36%
Economic	Economic benefits; economic impact; impact on agricultural land use; jobs; multifunctional land-use; price; property values; regional added value; tourism	11%	12%	44%
Socio-cultural	Aesthetics & scenic value; alternative options; attitudes; close collaboration with local authorities; communication; community involvement & participation; community values; cultural heritage; decision making; demographic characteristics; designing RE landscapes; fairness; forced expansion; health & well-being; inclusive bottom-up processes; information; involving farmers; key role of cultural and public associations; knowledge & understanding of RET; landscape architect as facilitator; landscape narrative; landscape quality; landscape values; legacy; local initiative & energy cooperation; mitigation measures; moral & ethical values; multi-stakeholder processes; NIMBY; nuisance; perception of landscape change; perception of risk; place attachment; procedural justice; process; social values; recreation & community activities; site selection; transparency; trust; trust in developer; trust in politics & institutions;; visibility (distance); visual impact; visual preference.	50%	63%	36%

Table 2.4 Factors sorted according to main factors of the community acceptance framework (Roddis et al., 2020).

Main factor	Factors	% of factors mentioned in acceptance field	% of factors mentioned in landscape design field	Same factors (%)
Project details	Business model; design; economic sustainability; (cost) efficient; end-of-life; energy security; functional efficiency; geographical location; physical characteristics of energy alternative; project details; project size; quality of energy provision; safety of plant; stable energy provision; technology;	19%	7%	7%
Construction	Air pollution; construction; cumulative impacts; light pollution; noise pollution; traffic;	9%	0%	0%
Environmental	CO2 emissions; ecological compensation; ecosystem services; environmental concerns; environmental impact; environmental justice; flooding; landscape modification; wildlife habitats &-creation;	9%	17%	44%
Temporal	Cultural heritage; landscape narrative; landscape quality; landscape values; legacy; perception of landscape change; temporal dimension;	9%	10%	43%
Economic	Economic benefits; economic impact; impact on agricultural land use jobs; multifunctional land-use; price; property values; regional added value; tourism;	11%	12%	44%
Process	alternative options; close collaboration with local authorities; communication; community involvement & participation; decision making; designing RE landscapes; fairness; forced expansion; inclusive bottom-up processes; information; involving farmers; key role of cultural and public associations; landscape architect as facilitator; local initiative & energy cooperation; mitigation measures; multi-stakeholder process; procedural justice; process; site selection; transparency; trust; trust in developer; trust in politics & institutions;	20%	32%	17%
Social	Attitudes (towards RE); community values; demographic characteristics; health & well-being; knowledge & understanding of RET; moral & ethical values; NIMBY; perception of risk; place attachment; social values; recreation & community activities;	16%	15%	55%
Aesthetic	Aesthetics & scenic value; landscape characteristics; nuisance; visibility (distance); visual impact; visual preference.	9%	7%	50%



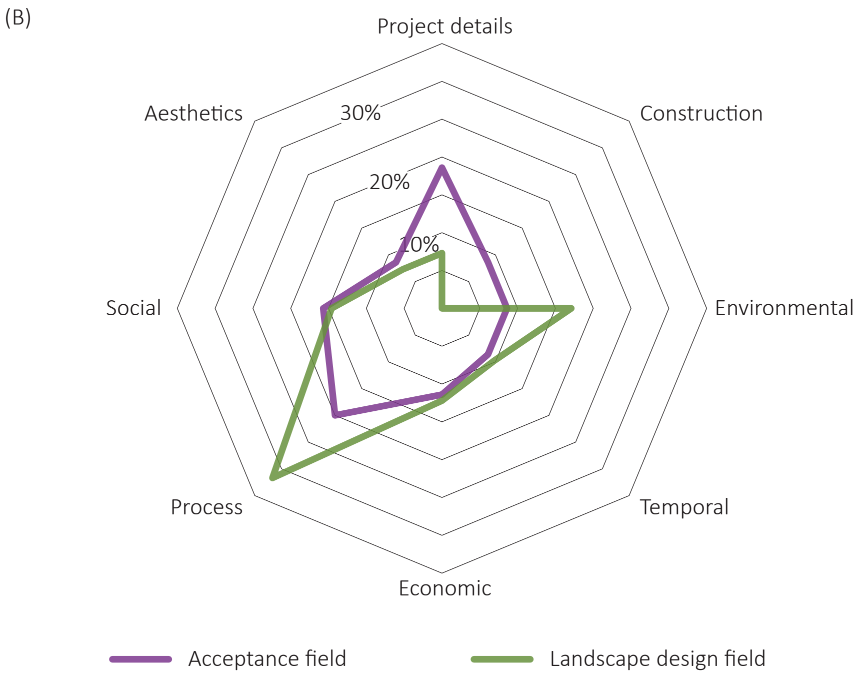


Figure 2.4 Factors categorized according to the conceptual frameworks of (A) sustainable energy landscape (Stremke, 2015) and (B) community acceptance (Roddis et al., 2020).

construction (9% difference), and project details (12% difference). Landscape design studies have a stronger emphasis on environmental (9% difference), and process (12% difference) factors. In this framework the process factors have the largest representation of related factors. This presents an alignment between both fields on the attention for involvement of local stakeholders and the effect of process on support or opposition of renewable energy projects.

2.5. Discussion & conclusion

In this systematic literature review we studied two fields of research - acceptance studies and landscape design studies- on the factors that influence the local acceptance of renewable energy projects. We study how these fields currently acknowledge each other, what overlaps in terminology and considered topics exist between the fields, and where the fields could strengthen each other in the future. This study contributes to the theoretical synthesis between two fields of research and to the empirical knowledge on the acceptance of renewable energy.

In our literature review we found 86 different terms that describe a factor for the acceptance of renewable energy projects (Table 2.1). The literature clearly shows that the discussion on these factors is still ongoing. Across both fields but also within individual studies, different factors are used to examine local support or opposition towards renewable energy projects. Nevertheless, we identified 25 factors mentioned both in acceptance and landscape design studies. This indicates that there is some alignment between both fields with regards to somewhat general factors, such as *economic benefits*, *visual impact*, and *aesthetics & scenic quality* (Table 2.1; Appendix A). We also illustrated that the attention to the factors differs for the two fields (Table 2.2) and that there is no consensus yet on which factors to include when examining the acceptance of renewable energy projects. These similarities and differences become visible as well when comparing the results from the peer-reviewed literature with two conceptual frameworks. We found that both fields focus strongly on the socio-cultural dimension of the sustainable energy landscape framework (Stremke, 2015). Moreover, both fields seem to place a similar emphasis on temporal, economic, social, and aesthetic factors when comparing the factors to the community acceptance framework (Roddis et al., 2020). This indicates some alignment between the acceptance studies and studies on landscape design (Table 2.4; Fig. 2.4). However, the fields differ significantly as following.

The absence of certain factors in one field or the other is interesting. Especially when referring to factors that are frequently addressed in one field, such as *trust* (and related terms) as a factor in acceptance studies and *community involvement & participation* in landscape design studies. A stronger consideration of these factors in both fields, one could argue, is beneficial for the local acceptance of renewable energy projects. On the one hand, landscape architects that are conscious about the factor *trust* will gain a better understanding of the local situation and relations among the stakeholders. On the other hand, social scientists could study the factor *process* more thoroughly, examining if more inclusive design processes indeed influence the local acceptance of renewable energy projects (Bevk & Golobič, 2020). That is not to say that public engagement will secure public support for renewable energy developments (Devine-Wright, 2008).

Moreover, when we compare the scholarly research foci to the findings of the case study by Roddis et al. (2020) (section 2.2.2) we detect large differences in emphasis placed on factors by scholars and laypersons. It seems that laypersons place a stronger emphasis on the factor environmental (18% difference), while peer-reviewed literature places more emphasis on the factor process (17% difference). One explanation for this could be that local stakeholders are imbedded in some process but do not adjust or improve this process themselves, making them pay less attention to this factor. Researchers, on the contrary, more frequently study processes or approaches for the implementation of renewable energy projects. Nevertheless, these differences in emphasis between laypersons and scholars raises the question if the current research agenda on landscape transformation and acceptance of renewable energy is addressing the most relevant challenges and if not more attention should be given to environmental factors. At the same time, Olson-Hazboun et al. (2016) argue that future research on acceptance of renewable energy should not predominantly focus on environmental concerns and beliefs, because this would further increase the polarizing views in society on renewable energy development as response to environmental and/or climate change concerns. However, if public support is indeed a key for the transition to renewable energy sources, as suggested by e.g. Schumacher et al. (2019), it will be necessary to critically reflect on the present day attention of many scholars to a selected group of factors.

In our study, we encountered some difficulties in dealing with the differences in focus and variety in terms used for factors. The difference in terms used is partly explained by the specificity of some factors with respect to the different (spatial) scale levels, as well as by differences in scope and geographic context. Because of this variety in terms, one cannot claim to have a complete overview of all possible factors for the acceptance of renewable energy projects. In this context, it must be stressed that we analysed the identified literature until we did not find additional factors anymore. Another limitation of the study is that it was not possible to compare studies on the weight or importance they assign to a certain factor, because not all studies include the same factors and not all studies assign clear weight/importance to the factors they consider. Lastly, some terms can be interpreted differently or it could be argued that they can be categorized differently. However, the most frequently returning factors were clearly defined and could be found in both fields; they are represented in the lists and comparison of factors.

When we study the references to the process of designing renewable energy landscapes, we find that this is not frequently mentioned in peer-reviewed literature. Design is seldom referred to in the acceptance studies on renewable energy. Moreover, these studies do not necessarily relate to the process or refer to the possibilities of designing renewable energy landscapes. For acceptance studies this could be explained by the temporal setting of most papers. Although it is acknowledged that acceptance of renewable energy can change over time (Wolsink, 2007), most studies tend to focus on a certain moment in time. We found that most acceptance studies do not focus on the design phase, but either study the moment before a change will take place (e.g. Ferrario & Castiglioni, 2017; Liebe & Dobers, 2019; Sütterlin & Siegrist, 2017) or the moment when a landscape transformation has happened (e.g. Lothian, 2020). This differs from the practice of landscape design, which interprets landscape as an ever-changing phenomenon, recognizing a past, present and future, of which the latter can be influenced and designed. Design professionals are engaged in the moment of transition and therefore experience the influence the process has on the designed artefact. Designing for energy transition is mentioned in the landscape design studies only a few times. However, several studies do refer to factors that can be related to the design process such as *community involvement & participation*, *multi-stakeholder process*, *inclusive bottom-up process*, and *landscape architect as facilitator.* Scognamiglio (2016) stresses the importance of landscape design and the potential effect of design on the local support of in her case solar power plants. Additionally, Stremke & Picchi (2017) address the possibilities of co-designing renewable energy landscapes and stress the importance of including all local stakeholders during this process. The limited literature and empirical research on the connection between landscape design and acceptance of renewable energy demonstrates a clear knowledge gap. Future research should, among others, examine the influence of involving landscape designers on the acceptance of renewable energy projects and examine the effect of more inclusive design processes.

In addition, our study presents relevant findings for current renewable energy infrastructure planning and development. When we examine the factors we find several factors that highlight opportunities to be addressed in current practice. For example, the factor *health & well-being*, which is often mentioned in the acceptance studies, but not mentioned in landscape design studies (Table 2.2). A stronger consideration of *health & well-being* in the design could have spatial implications for the landscape design. Moreover, *health & well-being* should be considered by landscape architects as an influence on local acceptance of renewable energy projects. Another factor that stands out is *site selection.* For an optimal landscape design of renewable energy projects, the *site selection* and related *decision making* should be part of the landscape design process (Apostol et al., 2017). Moreover, the *process* itself could get more attention. Many factors in the landscape design studies refer to the processes (Caporale et al., 2020; De Waal et al., 2015; Ketzer et al., 2020; Lobaccaro et al., 2019; Picchi, 2018), including factors such as *close collaboration with local authorities*, *inclusive bottom-up process*, and *key role of cultural and public associations*. The attention to these factors in both fields varies, but the literature suggest that a better implementation of these factors would positively influence local support of renewable energy projects giving these initiatives a higher probability to be implemented.

In conclusion, the literature review illustrates that there is no consensus yet on which factors influence the acceptance of renewable energy projects, and to what extent they influence acceptance. Both fields, acceptance studies and landscape design studies, would benefit from a clearer definition of factors and further case studies that illustrate the weight or importance of factors for the acceptance of specific renewable energy projects. Moreover, future research should, among others, examine the influence of involving landscape designers on the acceptance of renewable energy projects; to explore for example the effect of more inclusive design processes on factors such as *trust*. More knowledge on a wide range of factors influencing the acceptance of renewable energy projects and intensified collaboration between social scientists and landscape architects is paramount to succeed in the quest for energy projects that are embraced by landscape users and, on a more general level, to succeed in a procedurally-just transition towards a post carbon future.

2

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CRediT authorship contribution statement

Merel Enserink: Conceptualization; Data curation; Methodology; Investigation; Project administration; Visualization; Writing- original draft; Writing- review & editing. Rudi van Etteger: Conceptualization; Writing - review & editing; Supervision. Adri van den Brink: Conceptualization; Writing - review & editing; Supervision. Sven Stremke: Conceptualization; Funding acquisition; Investigation; Writing - review & editing; Supervision.

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3

photo Full-scale prototype built on site, Nauerna (NL)

Seeing is believing, experiencing is knowing.

The influence of a co-designed prototype solar power plant on local acceptance.

3

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Chapter 3

Abstract: The current approach to developing renewable energy projects often faces local opposition and has been said to increase injustice. One way of addressing procedural justice is to include local stakeholders in the design process. However, it can be difficult for lay audiences to understand the technical complexities of solar power plants. We built a full-scale prototype to support a participatory design process with local stakeholders and used engaged action research to examine the influence of this prototype on local acceptance in one real-life case in The Netherlands. The prototype helped to break the status quo bias. Furthermore, the study shows that well-designed participatory processes can aid understanding and help provide local stakeholders with possibilities to affect outcomes. Such processes can contribute to the legitimacy of the development of solar power plants and, in this case, increase local support for the development.

Keywords: renewable energy; participatory design, procedural justice; landscape design, transdisciplinary

Seeing is believing, experiencing is knowing.

The influence of a co-designed prototype solar power plant on local acceptance.

3.1. Introduction

Many countries are undergoing a transition toward renewable energy technologies. The Netherlands has set ambitious targets for renewable energy of 27% minimum by 2030 and nearly 100% by 2050 (Rijksoverheid, 2019a). However, as of 2021, only 12% of Dutch total energy use came from renewable energy sources, 1.5% of which was from solar energy (CBS, 2021). Thus, a timely implementation of renewable energy is necessary to reach these targets.

Moreover, to reach these targets, landscapes need to be transformed. However, contrary to so-called fossil energy landscapes that are often located away from everyday environments, renewable energy landscapes will often be located closer to people's daily environments (Sijmons et al., 2017a), particularly in densely populated countries such as The Netherlands. As a result, the transformation of these daily environments might be difficult for local stakeholders to accept (Bertsch et al., 2016), especially considering that people generally prefer their landscapes to remain unchanged (Pasqualetti & Stremke, 2018). Linnerud et al. (2019) found that energy transitions are no longer primarily obstructed by a lack of scientific or technical knowledge, but that human resistance to change might now be the main barrier to rapid energy transition. This calls for a refocus from technical to social modes of thinking.

Further, theories on status quo bias and place attachment describe an experienced sense of place and place identity that often makes people hesitant to embrace landscape change (Halevy, 2007; Linnerud et al., 2019). Several scholars have addressed the importance of local acceptance as key to a timely transition to renewable energy systems (Apostol et al., 2017; Schumacher et al., 2019). In this research, local acceptance is understood as the active or passive support and opposition toward landscape change (Bailey et al., 2011; Gölz & Wedderhoff, 2018) that can change over time (Keilty et al., 2016; Wolsink, 2007), can vary across geographical scale (Batel, 2020; Devine-Wright et al., 2017), and can be influenced (Bevk & Golobič, 2020).

In the Netherlands, the development of solar power plants (SPPs) is largely left to market forces and to the main actors—developers and landowners—that are responsible for local engagement in these projects (Holland Solar et al., 2019). Here, local engagement is often termed *invited stakeholder participation* (Cuppen, 2018), or legislated procedures designed to inform local stakeholders and manage concerns and possible opposition (Wolsink, 2007). A recent study by Ryder et al. (2023) suggested that community members often perceive participation as insufficient and ineffective. Hence, local engagement is often seen as tokenism, by which communities perceive that they have no real influence on final plans.

Further, the current approach to developing renewable energy projects is believed to increase injustice (Aitken et al., 2008; Richards et al., 2012). In terms of wind energy, this phenomenon has prompted considerable interest in community-based development as an approach to incorporating procedural justice approaches (Warren & McFadyen, 2010). Procedural justice has been found to be influenced by four elements: information sharing, possibilities to participate, ability to affect outcomes, and dealing with developers (Walker & Baxter, 2017). At the same time, other scholars have begun to argue for improved design of SPPs (e.g. Oudes & Stremke, 2021; Scognamiglio, 2016; Stremke, 2015; Stremke & Schöbel, 2019). These researchers have proposed a shift from a 'economic-technical efficient model' to an integral design process that considers socio-cultural and environmental values of affected landscape users as well as economic and sustainable technical values.

In addition, the development of SPPs may benefit from an approach that acknowledges the effects of NIMBY (i.e., not in my backyard) and status quo bias and that actively addresses the phenomenon of place attachment in the design process. Enserink et al. (2022) suggested that landscape designers should pay more attention to factors such as trust that can influence local acceptance during design processes. They argued that incorporating these factors into participatory design processes can increase local support for SPP development. Moreover, the manner of how an initiative is developed often matters in the sustainability of its development (Stremke, 2015), which suggests the value in embracing local stakeholders as participants in the design process (Stremke & Picchi, 2017). Previous research has shown that early participation can positively influence local acceptance of renewable energy projects (Fenton et al., 2016; Oughton, 2008; Walter, 2014), as this can lead to a more positive perception of outcomes by participants. Additionally, through their involvement, inhabitants can better realize a measure of agency and control over changes to their environment (Attwood, 1997; Macarthur, 2016). Hence, scholars refer to local participation as key to strengthening both procedural justice approaches and design quality (e.g. Breukers & Wolsink, 2007; De Waal & Stremke, 2014; Hoddinott et al., 2019; Scognamiglio, 2016).

For many other types of developments, co-creative design strategies have become standard practice (Raaphorst et al., 2017; Thering & Chanse, 2011). However, these approaches are not yet common in the development of SPPs. One of the challenges in participatory design is the visualisation of technically complex design plans and the interpretation by local stakeholders of these drawings and proposed changes (Raaphorst, 2018).

In this paper, we present the findings of a different, and rarely used, intervention in a participatory design process for SPP development: the use of a full-scale prototype that shows a range of design options. The objective of this research is to examine the influence of a co-designed prototype on local acceptance of a SPP. First, we summarize relevant theories from the social science literature on attitudes toward renewable energy and illustrate how these relate to participatory design. Second, we explain the methods and materials applied in this study. We then present and discuss the results of the research. Last, we present main conclusions and recommendations for future research.

3.2. Theoretical framework

3.2.1. Place attachment

Many scholars refer to *place attachment* as an overarching theory that describes a local sense of place and place identity (e.g. Devine-Wright, 2012). “Place attachment is a collective orientation and describes the process of becoming attached to an environmental setting” (Carlisle et al., 2014, p.125; after Vorkinn & Riese, 2001). This phenomenon can explain opposition to landscape change, even for generally accepted issues such as the development of renewable energy plants. Reese et al. (2019) discussed the plausibility of place attachment becoming more dynamic for large-scale landscape changes. The authors suggested that stakeholder level of place attachment can change, and that residents can become less protective of a place they are attached to after it has begun to change. Furthermore, the social aspects of place attachment are often stronger than the physical aspects (Reese et al., 2019). This contrasted with the findings of Bertsch et al. (2016), who argued that the physical transformation of a landscape is the main driver of a lack of local support of renewable energy projects. This finding aligns with those of other scholars who found that *visual impact*, *aesthetics*, and *landscape modification* are important factors that influence local acceptance (e.g. Bevk & Golobič, 2020; Petrova, 2013; Roddis et al., 2020; Spielhofer et al., 2021; Wolsink, 2007). In this research, we analysed place attachment prior to the development of a site by investigating local values in three dimensions: person, process, and place (Scannell & Gifford, 2010).

3.2.2. NIMBY

The NIMBY concept suggests that while people may, in principle, support development changes (e.g. renewable energy), many begin to oppose these same changes when they become reality in the vicinity of their living environment (Wolsink, 2007). Local opposition, which is often characterised by this concept, is common in current renewable energy policy and planning practices (Jones & Richard Eiser, 2010; Wolsink, 2007). However, many scholars dispute this concept as too simple to explain the intricacies of local opposition (e.g. Batel, 2020; Jones & Richard Eiser, 2010; Petrova, 2013; Wolsink, 2007). For example, studies on the siting of energy-related infrastructure projects have repeatedly found that the reasons and mechanisms driving resistance to such projects are more complex and move beyond NIMBY reactions (Devine-Wright, 2012; Stadelmann-Steffen & Dermont, 2021; Wolsink, 2007). For example, the NIMBY concept does not adequately explain local concerns on *visual impact* and *landscape modification* (Petrova, 2013). Many critics of the concept call for a more nuanced understanding of public perception of renewable energy developments. In this research, we investigated this concept by asking stakeholders about their motives behind their support or opposition toward a SPP.

3.2.3. Status quo bias

Status quo bias is another concept concerned with local response to landscape change. “Status quo bias is a preference for the current state of affairs; that is, the status quo is taken as a reference point, and any change from that reference point is perceived as a loss”(Linnerud et al., 2019, p.3; after (Samuelson & Zeckhauser, 1988). In general, people tend to be psychologically adverse to loss (Kahneman, 2011). To address this bias, it can be helpful to familiarize stakeholders with proposed landscape changes, thereby increasing their confidence in new situations. Opportunities to address status quo bias suggest what stakeholders can gain by proposed changes, or by ‘breaking the frame’ and allowing participants to see their landscape from a different perspective (Sherren et al., 2016). For example, this can be achieved through 2D or 3D visualizations that make it easier for stakeholders to process information (Delgado & Shealy, 2018). Another option is to bring people to demonstration setups or pilot projects (Linnerud et al., 2019). ‘Breaking the frame’ can also be applied directly on renewable energy plant sites through the use of scale models or prototypes. This approach was applied in this research in order to invesigate the influence of full-scale prototypes on the acceptance of a SPP.

3.3. Methods and materials

3.3.1. Engaged action research

This paper presents the results of what is commonly referred to as *engaged action research* (Deming & Swaffield, 2011; Wiberg, 2019). Procedurally, this approach "is composed of a circle of planning, action, and fact-finding about the results of the action"(Deming & Swaffield, 2011, p.192). Here, the researcher learns from and through practice by working through a series of reflective stages (Bereiter & Scardamalia, 1993; Riel, 2019). This approach was chosen because it provides insight into the ways in which a variety of social and environmental forces interact, and can lead to a better understanding of the influence of a full-scale prototype as part of a participatory design process. This study builds on the results of a research project called *In My BackYard Please*. For this case study, the researchers were involved in a participatory design process as members of a project team in direct contact with local stakeholders. To record of the developments of the project, personal logs were kept, and each phase was documented. In this research, 'ex post facto' heuristics were used to critically reflect on the results (Thering & Chanse, 2011).

3.3.2. Case study and case selection

Case study research is a commonly-used approach in landscape science (Francis, 2001). Case studies can provide insight in specific situations and offer the opportunity to learn general lessons (Flyvbjerg, 2006; Hoddinott et al., 2019). This approach typically involves four steps: selecting a case, conducting a study, analysing the results, and disseminating the findings (Francis, 2001). For our study, the case selection process was based on the following criteria: a Dutch location, relevance, design opportunities, landscape user experience, possible local resistance, stage of development, and willingness of local stakeholders to cooperate. Six potential cases were considered, and the final selection decision was made in consultation with all project partners.

One case met all criteria: Nauerna (see Fig.3.1). This location showed potential due to the presence of an invested community that, on one side, wanted to work on a SPP,

Figure 3.1 Case study location in The Netherlands: Nauerna.

but on the other, showed some signs of resistance to landscape transformation. For example, earlier plans to further extend a local landfill had been met with fierce legal resistance by local stakeholders. Prior to the *In My Backyard Please* project, a local action group investigated the potential of solar energy on a site near the village, in particular the possibilities for an initiative on the nearby landfill. However, no concrete plans were made at that time.

Participatory process

This project used an inclusive participatory design process implemented at an early stage of SPP development. Figure 3.2 presents an overview of the activities that contributed to this process. First, interviews (A1) were conducted to gauge the level of place attachment of local inhabitants and entrepreneurs (Carlisle et al., 2014; Scannell & Gifford, 2010). Then, a landscape analysis (P1) was conducted, including mapping the energy potential for the area (Van den Dobbelsteen et al., 2012). In March 2020, the project team organized two parallel co-design sessions for the community (A2) to assess the potential size, location, and design theme for a SPP. In these sessions, the

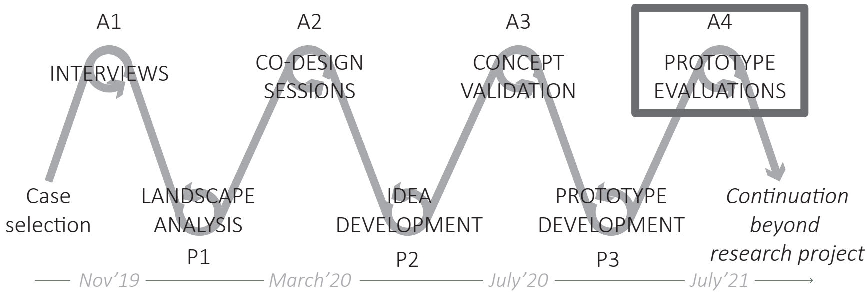

Figure 3.2 Overview of the participatory design process. The prototype evaluations (A4) are the focus of this study. (A: action with local community; P: preparation/development by project team).

participants were asked to think unconventionally and to formulate creative ideas for the design of a solar energy installation. The results of these sessions formed the basis for developing the idea (P2), which was then translated into design principles and developed into three distinct design concepts ranging in size, location, and theme. In July 2020, these concepts were validated with the local community in an online session (A3), which was necessitated due to Covid-19 regulations. Based on this input, a full-scale prototype was designed as a test model that showed different options for composition (P3), including a wave-shaped construction and the application of a range of graphics on the PV panels (Fig.3.3). The community then evaluated the design alternatives presented with the prototype. These evaluations (A4) are the focus of this study. In these sessions, participants were also specifically questioned about their support of SPP development and the potential of using a full-scale prototype to visualize design ideas in the context of a participatory design process.

Prototype evaluation & data collection

All residents were invited to join the prototype evaluation sessions (A4). These sessions were conducted over two days (Friday & Saturday) with 1.5-hour timeslots that could be attended by up to five participants. The number of participants per session was limited by Covid-19 regulations. The sessions began with a general introduction in a nearby restaurant to consider possible differences in background information, to clarify the process, and to explain the role of the prototype evaluations in the process. The participants then evaluated the prototype from a 100m distance (Fig.3.4a), and a survey was conducted to record feedback and capture the data. These responses were informally discussed while approaching the prototype during a 15-minute walk. Once on site, the participants were then asked to again study the prototype at close range and to complete a second part of the survey (Fig.3.4b). After this process was complete, a small group discussion was conducted to exchange thoughts and feedback. A total of 21 inhabitants from the 92 resident households participated in these prototype evaluations. The sample exhibited a good distribution in terms of socio-economic background, age, gender, education, and place of residence with respect to the potential SPP site. All data were processed using Microsoft Excel for analysis.

Figure 3.3 The full-scale prototype constructed on site showing the wave-construction and range of design options for PV-panel graphics (July 2021).

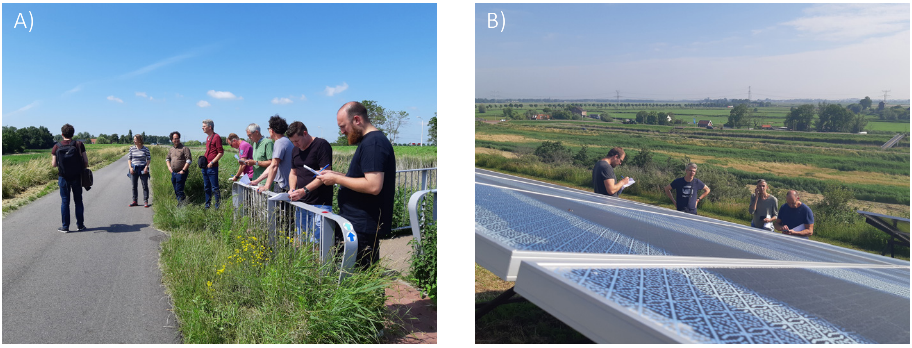

Figure 3.4 Impression of the prototype evaluation: evaluating the full-scale prototype from a distance and at close range (July 2021).

3.3.3. Data analysis and synthesis

In this study we examined the influence of a full-scale prototype on local acceptance of a SPP in a Dutch community. First, the findings were evaluated using a 'situational responsiveness' approach, which means that the concepts and methods involved were selected because they were deemed the most appropriate for evaluating the effect of a design intervention in this location (Rogers, 2009). Below we present an overview of participant responses to the use of the full-scale prototype in particular and to acceptance of the SPP development in general. Second, *ex post facto* heuristics were used to analyse the level of procedural justice of this session (Thering & Chanse, 2011). The following elements of procedural justice were evaluated: information sharing, possibility to participate, ability to affect outcomes, and dealing with the developer (Walker & Baxter, 2017). The last element was later changed to 'dealing with the landfill owner' to fit the characteristics of the specific case. We used this framework to evaluate the fairness of the selected approach and to reflect on the effect of the sessions. Third, we analysed how a selection of factors may have influenced local acceptance, including aesthetics, community involvement, community values, trust, and visual impact (Enserink et al., 2022). Finally, using a five-point Likert scale (i.e. very positive – positive – neutral – negative – very negative), we determined if these factors had a positive or negative influence on participant acceptance. We validated the results with two key stakeholders: a community representative and an external designer who was present during the prototype evaluation process.

3.4. Results

3.4.1. Survey results (A4)[1]

The majority of participants (85.7%) reported that the full-scale prototype provided them with more insight into the impact and design possibilities of a SPP at the selected location (Fig.3.5a). One participant stated that even though the prototype provided

[1] All data from the survey are available as supplementary data (see Appendix B).

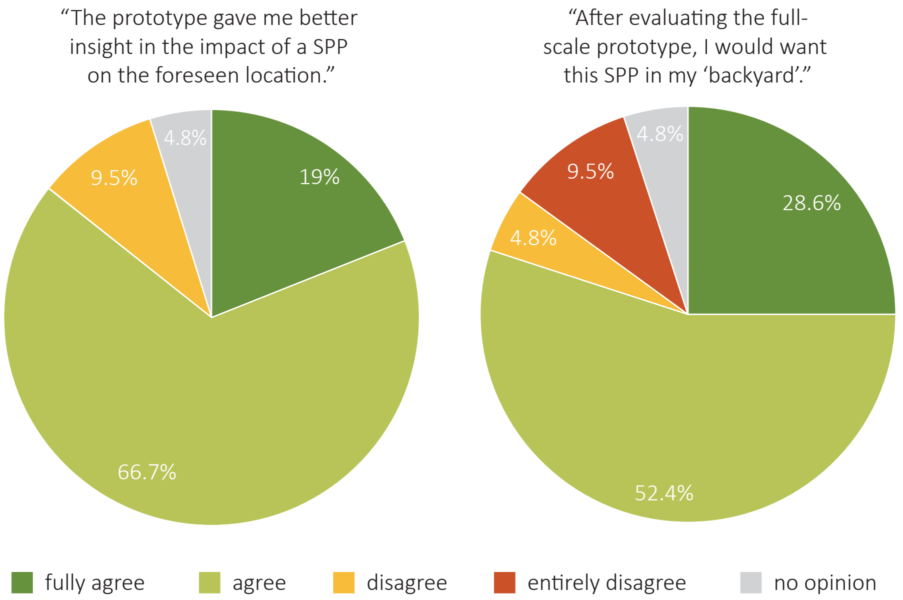

Figure 3.5a Most respondents (85.7%) found the prototype insightful, especially in terms of visual impact.

Figure 3.5b Most respondents (81%) stated that they would like to have the SPP in their 'backyard'.

valuable insight, a 3D image of the complete solar project would have given an even better representation. Most participants answered that the prototype positively influenced their opinions (81%), one participant commented that:

> *"Seeing it, together with the given explanations, made it possible for me to confidently judge the design possibilities."* (Participant #16)

Further, 81% of the participants responded positively to a question about the realisation of this SPP in their 'backyard' (Fig.3.5b). After viewing the full-scale prototype, inhabitants reported that they could better familiarize themselves with the possibilities and effects of this project, thereby increasing their trust in the SPP. However, the 14.3% of participants that responded negatively to this question were those that would have a direct view of the project. Some of those responses came from residents that had recently moved to the area and felt excluded from the design process. According to the survey results, 61.9% of the participants stated that the

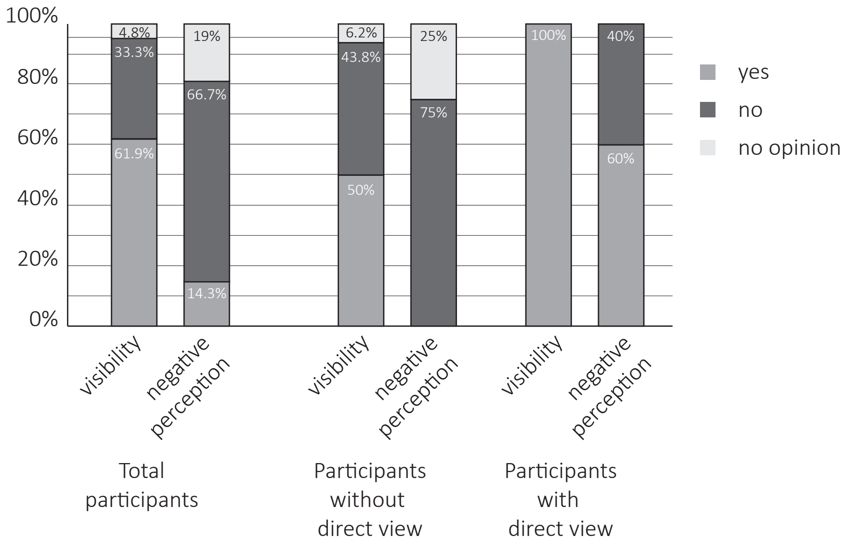

Figure 3.6 Responses on visibility and visual impact, sorted by participants with and without a direct view from their residence on the proposed SPP site.

prototype was visible from a distance of 100m, and 66.7% reported that they did not perceive this as negative (Fig.3.6). However, when sorting the results by view from participant residences, we found that people with a direct view of the proposed site from their living rooms responded more negatively. All five participants with a direct view answered that they thought the prototype was very visible, and 60% of them perceived this as negative (Fig.3.6). These respondents were also those who responded negatively to a question if they would want the SPP to be built in their 'backyard' (Fig.3.5b).

3.4.2. Procedural justice analysis

Table 3.1 describes how the elements of procedural justice were present in the prototype evaluations (A4)[2]. The largest influences on acceptance related to the elements 'information sharing' and 'ability to affect outcomes', both in terms of *visual impact* (i.e., "can I see it?") and *aesthetics* (i.e., "what do I see when I see it?"). By placing the prototype on a site in direct view of the community it was ensured that the

2 Appendix B includes the analysis of the elements of procedural justice in the other research project phases.

Table 3.1 Analysis of the procedural justice elements in the prototype evaluations (A4).

Elements procedural justice	Description
Information sharing	The full-scale prototype was placed near the development site and provided an impression of what a SPP might look like. It showed a range of design options and technical possibilities. At the start of each session, a summary update was given about the progress of the process.
Possibilities to participate	All households were invited to join a prototype session. The sessions were spread over two days to provide more opportunities to join a session. There were 21 total participants, a reasonable representation of the community (i.e. 92 households).
Ability to affect outcomes	Participants were asked to fill out individual surveys on their experience, preference, and if/how the SPP should be developed. Some participants voiced doubts about their influence on the outcome. They were reassured that local commitment is necessary in the development of the SPP.
Dealing with landfill owner	The landfill owner was not an active stakeholder in the sessions. However, a representative for the landfill was present to accompany the participants on site. While the sessions focused solely on community input, the walks with the representative did make some exchange possible between both parties.

local community could develop a well-informed opinion on the potential development. Together with the prototype, the project team shared other relevant information on the possibilities of a SPP on this site. Moreover, during these evaluations, there were opportunities for face-to-face conversations and group discussions. Further, the prototype evaluation process provided plenty of opportunity to participate, as all households were invited and were given several options to join. Moreover, the prototype evaluation provided each participant with the same opportunity to convey their opinions. During this phase, ‘I do not want a SPP’ was considered a legitimate answer.

Some participants did state that they doubted if their participation was going to ‘affect the outcomes’. They were reassured that their input would indeed be considered and that the development would depend on this input. Lastly, the prototype evaluation was tailored to the community and ‘dealing with the landfill owner’ was limited, as

Table 3.2 Analysis of factors influencing local acceptance (A4).

Factors	Description	Evaluation of influence session on local acceptance				
		++	+	+/-	-	- -
Community involvement	The sessions provided plenty of opportunity to exchange ideas between community members and the project team.		+			
Visual impact	The prototype provided valuable insight into the visual impact of a possible SPP. Most respondents (81%) answered that it had a positive influence on their opinions.	++				
Aesthetics	The full-scale prototype presented several options for the design of a SPP. The twofold evaluation (i.e. from a distance and nearby) made it possible for participants to evaluate the design ideas.	++				
Community values	The design options represented a range of ideas and preferences from the community. The prototype allowed the community to discuss the possibilities of the SPP design.		+			
Trust	The sessions restored trust in the research project through transparent communication about the project and the acknowledgment of variation in the preferences held by community members. Some participants voiced concerns about the influence of their opinion. These concerns were directly addressed in the session. Subsequently, recent events between the local stakeholders decreased their level of trust.			+/-		

at this point the relationship between the community and the owner was somewhat challenging due to other factors. Therefore, the landfill owner was not invited to join the sessions as an active stakeholder. However, for security reasons a representative for the landfill was required to accompany the groups on site. As there were many friendly exchanges during the site visit, we are confident that the presence of this representative did not influence participant responses.

3.4.3. Influence of prototype on local acceptance

Overall, the prototype evaluations (A4) reported a positive influence on local acceptance, resulting in less opposition and more support for the SPP development (see Table 3.2). Regarding the evaluation of factors that influenced local acceptance, we identified that the possibilities for *community involvement* were regarded as positive. Furthermore, the factor *trust* was evaluated as neutral. As a result of the sessions (A4), the level of *trust* in the research project was increased, even though autonomous developments outside the scope of the project have had a negative effect on this factor.

Status quo bias was addressed by demonstrating the possibilities and impact of a SPP on site with a full-scale prototype. The prototype responded to the potential of status quo bias, as was encountered during A3 (see Appendix B), by demonstrating a range of design possibilities. This provided the opportunity for participants to express their thoughts about the designs and how they perceived the impact of a development on this location. This related to the factors *visual impact* and *aesthetics*, which were addressed in the prototype evaluations and were assessed as a very positive contribution to local acceptance (Table 3.2). For example, participants acknowledged that this process helped them in several ways:

> *"The prototype really helps the imagination."* (Participant #5)
>
> *"The prototype gives better insight into the scale and how it would look on site. The waving construction is quite special."* (Participant #17)

Some of the responses collected during the A4 sessions could relate to the NIMBY concept, as a few participants seemed only to argue from their own perspective and therefore opposed the SPP. However, we do not associate these responses with this concept, as there were more intricate explanations for these statements. For example, some autonomous developments and recent decisions from the municipality have decreased the level of *trust* of local inhabitants in the other stakeholders and strengthened their negativity and opposition toward any development on this site. One such response from an inhabitant with a direct view follows:

> *"We just heard that the municipality will allow the industry to increase the height of their new buildings up to 30m—again, a broken promise. If this [SPP] becomes reality, we will be enclosed on all sites by industrial developments. This is simply the last straw—we want to keep some green to look at."* (Participant #13)

This response articulates the loss of *trust* in local authorities due to changes that were made in the building regulations of a nearby industrial site. And while the development of this site and the SPP development are to be planned separately, they did influence the same group of stakeholders within the same timeframe. In addition, the processes related to these developments influenced each other and therefore local acceptance of the SPP.

3.5. Discussion

In this study, we employed engaged action research as part of a participatory design process to examine the influence of a full-scale prototype on the local acceptance of a SPP. A full-scale prototype was constructed on a site to allow a community to evaluate design possibilities and to investigate the effect of this prototype on local acceptance of a SPP development.

First, we examined the validity of the selected case in order to generalize the study results (Flyvbjerg, 2006). We concluded that the Nauerna case, although quite specific, is still representative of the possible local response to this type of development. These types of place—i.e. landfills—have a high probability of future transformation into renewable energy landscapes, as they often already exhibit large-scale developments that tend to have negative impacts on their surroundings. Therefore, from a socio-political perspective, the process of transforming these sites can be easier compared with other non-industrially developed sites, as local inhabitants are typically less concerned about these changes (Walker et al., 2010). This finding is in line with those of Reese et al. (2019). However, in Nauerna, this strategy may have fuelled distrust in government action and strengthened the status quo bias. Here, this approach increased social cohesion in which the community banded together against this threat to their environment. We found a very strong level of place attachment (A1) even though the landscape has been altered significantly over the previous decades. This specific finding questions the common strategy for the siting of SPPs in many countries.

In addition, the current dominant development strategy of SPPs often causes local opposition. However, Bragolusi & Righettini (2022) found that an inclusive participatory approach can positively contribute to the legitimacy and democracy of such developments. Moreover, Macarthur (2016, pp.634-635) argued that “given the urgency of renewable energy transitions to climate change mitigation, participatory designs may, in fact, prove the most ethically defensible but not necessarily the most effective instrument.” Oughton (2008) stated that the critical evaluation of the legitimacy of a process can often be outweighed by issues of efficiency, which remain noticeable in the current approach. Again, the results of this study emphasize the importance of legitimacy in participatory processes in building local support for a SPP. Moreover, our results suggest that local commitment to the development and support of a SPP can be strengthened by ‘possibilities to participate’, the opportunity ‘to affect outcomes’, and to co-design a SPP that considers the wishes of local communities. Here, most participants (81%) responded positively to a question on realizing this SPP in their ‘backyard’ (see Fig.3.5b).

Moreover, the prototype used in this study helped to reduce status quo bias by positively changing community perspectives (Table 3.1). Prior to this project, the residents had been largely negative toward this and other developments. The prototype provided a tangible and realistic experience of a proposed SPP which allowed participants to evaluate the potential impact of this landscape change (Fig.3.5a). This positive response represents a significant change from an earlier assessment (see Appendix B). For A3, most participants were sceptical of this development and uncertain about the *visual impact* of the proposed SPP. The study results strengthen the observation that *visual impact* and a direct view shed from participant residences are possible precursors of negative responses to SPP development (see Fig.3.6). Given the common negativity of local stakeholders concerning other developments, this positive turn is significant and can be attributed to the use of the prototype.

In addition, the use of 2D visualisations in design processes and the difficulty of interpreting such graphics by laypersons is discussed in the literature (e.g. Kullmann, 2014; Raaphorst et al., 2019). These difficulties were evident in A3 (see Appendix B). Here, the visuals of the design concepts did not convince the participants of the design ideas. In line with Raaphorst et al. (2019), we argue that planners and designers should be aware of the drawbacks of the use of visual representations and that they should be employed carefully and in a considered manner. Designers and planners involved in participatory design processes for SPP development should be aware of the role 3D visualisations can play and the possibilities of using full-scale prototypes to test design ideas in later project stages. In this case, the prototype proved to be an important element in the discussions with participants, as it helped them to better visualize the impact of the design ideas in their context (Fig.3.5a). However, while prototypes can offer a full immersive and multisensory experience, 3D interactive virtual or augmented reality methods can also offer these advantages at a lower cost. Future studies could extend this line of inquiry by testing different types of visual representations and their effect on participatory design approaches, as well as the possibilities of intermediate interactive digital visualisation technologies and their effect on local acceptance.

Furthermore, our findings suggest that the procedural justice element ‘ability to affect outcomes’ is an important condition for local support (Table 3.1). This aligns with similar findings on local approval of wind turbines (Walker & Baxter, 2017). Part of the support that we found for the development of the SPP can be attributed to factors such as the possibility of *early involvement* of local inhabitants (Fenton et al., 2016; Oughton, 2008) and the *transparency* and inclusion of local opinions in the *decision making* for this SPP (Ryder et al., 2023). Additionally, the factor *trust in the developer* and former experience can shape and influence these processes and interactions (see Table 3.1). In this study, new conflicts arose between the stakeholders during the research project which led to a decline in *trust* between these stakeholders.

While we elicited some negative responses, we did not associate these with the NIMBY concept, largely because there were more intricate arguments and autonomous developments that influenced local response. Ioannidis & Koutsoyiannis (2020) addressed the necessity of analysing the imminence of landscape impacts caused by SPP developments instead of framing this as the NIMBY concept. In this study, the situation of the prototype evaluations on site helped to facilitate constructive conversations with residents about possible landscape changes and their impacts. Moreover, the use of a prototype made it possible to discuss alternatives that might be acceptable for residents. Of course, the use of a full-scale prototype does not ensure that a SPP will be built, nor does it necessarily increase the pace of implementation. Finally, this study required additional time, effort and resources due to complications as a result of the Covid-19 pandemic. Nevertheless, the use of a prototype did increase *trust* of the local inhabitants in the research project and the design of the SPP. Therefore, the full-scale prototype stands as a valuable intervention for this type of location.

Lastly, designers and planners should recognize status quo bias and address this bias during co-design processes. They should be aware that participants can become more resistant if they feel uncomfortable with proposed changes, possibly due to the difficulties in understanding the uncertainties of these changes. If designers and planners acknowledge the challenges for laypersons to understand the physical implications of large-scale landscape transformations in their living environment, they can provide visual aids to assist them (Raaphorst et al., 2019). This can increase levels of interaction between participants and designers and planners, which can have a positive influence on local acceptance. However, as the intricacies of participatory design processes make them very complex, future research could provide more detailed guidance for participatory design approaches that address complex spatial challenges, and in particular the development of SPPs.

3.6. Conclusion

To conclude, the study results illustrate the positive influence that a full-scale prototype can have on local acceptance of a SPP (Fig.3.5b). The study emphasizes the relevance of providing tangible multi-sensory information in creating local support for SPP developments. The prototype helped stakeholders to hold constructive discussion and positively influenced their opinions about the possibility of a SPP on the selected site (see Fig.3.5a). Of course, the use of a full-scale prototype does not assure project development. However, even if the decision was to cancel the SPP development, that decision would be made on the basis of experiencing a SPP analogue and not on the basis of visual communication methods that can be misinterpreted. Future research could compare the effects of full-scale prototypes with those of other representation types. For example, research could explore if the added value of a prototype in a participatory design process outweighs the additional investment of resources, compared with interactive 3D extended or virtual reality models.

Even though the efficiency of participatory approaches might still be found lacking in comparison to conventional methods, a participatory design approach can remain preferable as the most ethical approach to addressing large-scale developments (Macarthur, 2016). A well-designed participatory process can contribute to the legitimacy of a project development (Uittenbroek et al., 2019). Even in the face of initial local opposition, this type of process can provide possibilities to address opposing views at early stages and to investigate alternatives. Finally, this study illustrates that the active involvement of local stakeholders, and in particular inhabitants, in the siting, design and development of SPPs can affect the outcomes and presents a key factor in creating community support.

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CRediT authorship contribution statement

Merel Enserink: Conceptualization; Methodology; Investigation; Project administration; Visualization; Data curation; Writing - original draft; Writing - review & editing. Rudi van Etteger: Conceptualization; Investigation; Writing - review & editing; Supervision. Sven Stremke: Conceptualization; Funding acquisition; Investigation; Writing - review & editing; Supervision.

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photo EnergyGarden Assen-Zuid under construction, Assen (NL).

The life and death of good intentions?

Unravelling participatory design processes of three Dutch solar power plants.

4

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Chapter 4

Abstract: Public participation in renewable energy projects is required in The Netherlands, as it is key to a socially just energy transition which embraces local and societal concerns. Participatory design processes can address the call for public participation and achieve qualitative aims stated in policy guidelines. However, todays permit procedures of local authorities focus on technical and economic factors, while other societal concerns seem to disappear in the development process of solar power plants (SPPs). In this study, we unravel the participatory design processes of three Dutch cases to explore their benefits and limitations, and implications for future policies. We find that local inhabitants have a strong position in these processes. Moreover, we find an imbalance of proposed measures materializing in the final design. Although there is attention for societal concerns beyond those of the local inhabitants, measures that address societal concerns are more frequently altered or removed. This is mainly due to economic factors and a conventional approach to SPP development as monofunctional land-use. Based on our research, we argue for redressing the balance between the concerns of local inhabitants, such as nuisance, and broader societal concerns, such as biodiversity and landscape quality. We recommend improving policy, or directly changing subsidy requirements, to ensure a better balance of involved stakeholder groups and their possibilities to participate and affect the decision-making in SPP design processes. This would foster trajectories towards more environmental sustainable and socially just deployment of renewable energy technologies for the energy transition.

Keywords: co-design; case study; action research; utility-scale solar; procedural justice; social acceptance

The life and death of good intentions?

Unravelling participatory design processes of three Dutch solar power plants.

4.1. Introduction

In the development of renewable energy initiatives, public participation is depicted as a key to a socially just energy transition (e.g. André et al., 2006; Macarthur, 2016; Runhaar, 2009; Uittenbroek et al., 2019; Verduzco Chávez & Bernal, 2008). Moreover, public participation is said to raise the legitimacy of decision-making (Coenen, 2009), and to contribute to procedural justice (Walker & Baxter, 2017). Participation in the form of co-creation or co-designing is discussed by scholars (e.g. Stremke & Picchi, 2017) and policy makers (e.g. Gemeente Assen, 2020; Provincie Noord Holland, 2019) as an important ingredient for the development of renewable energy projects. Participatory design allows for the inclusion of local knowledge and the accommodation of local concerns in development processes (d'Hont & Slinger, 2022).

In the Netherlands, public participation is a requirement for developers of solar power plants (SPPs) to receive a building permit (Gemeente Assen, 2020; Gemeente Montfoort, 2022). Co-designing, one specific form of participation, is a well-known method in landscape architecture (Kothuis & Kok, 2017). However, it is not yet common practice in SPP development. Moreover, there is a lack of systematic empirical studies on how public participation is actually executed (Uittenbroek et al., 2019). Furthermore, the manner of participation is not often specified and the policy requirements for SPPs are in need of improvement. On many governmental levels there are policy guidelines that describe ambitions for SPP development (e.g. Provincie Noord Holland, 2019). Besides technical and economic criteria, these ambitions include socio-cultural and environmental values. For example, several of these documents pay attention to the necessity of multifunctional land-use as well as addressing factors such as ecological compensation and landscape quality (e.g. Gemeente Assen, 2020; Provincie Overijssel, 2020). However, there seems to be an imbalance between the different criteria and values when it comes to the building permit for SPPs, as well as in the requirements for financial support or state aid. Two tensions become apparent when studying the Dutch context. The first tension relates to the aim of participation. A tension between addressing local concerns to increase local acceptance on the one hand and addressing broader societal concerns that transcend, but also sometimes run counter to concerns on the local level on the other hand. The second tension relates to who can participate. A tension between predominantly choosing to include the expertise and knowledge of local inhabitants on the one hand, or inviting expert knowledge on the other hand. Furthermore, literature on the design and (co-)designing of solar power plants (SPPs) is still limited, and the role of experts, such as (landscape) designers, is overlooked as renewable energy actor in much of the literature (e.g. Van de Grift & Cuppen, 2022). Contrary to this, scholars argue that landscape architects have an important role to play in the energy transition (Scognamiglio, 2016; Stremke & Schöbel, 2019). Landscape architects can play a role in terms of mediation by giving spatial expression to alterations and or adaptation of plans, and creating a narrative with their designs which can support the communication between stakeholders, while delivering good designs at every relevant scale (Sijmons & Van Dorst, 2013).

The objective of this study is to examine the benefits and limitations of participatory design processes of SPPs and the tensions between concerns of local inhabitants and broader societal concerns. This provides insight in the implications for policy and leads to recommendations for policymakers. In this research, we performed action research to examine three Dutch cases of SPP development that employed co-designing processes. We analysed how socio-cultural and environmental values are considered during the participation processes and if additional policy instruments are necessary to ensure these values materializing in the final design of SPPs. The study provides empirical novelty (Sovacool et al., 2018), because the researchers, as embedded action researchers, had exclusive access to the data and stakeholders involved in these participatory design processes. The next section presents the policy context relevant for SPP development in The Netherlands. In section 3 the materials and methods are described and in section 4 the results are presented. Section 5 contains the discussion of the results and implications for policy, section 6 presents the conclusions.

4.2. Policy and theoretical background

4.2.1. Dutch renewable energy policy and financial instruments

Following the Paris Climate Agreement (European Union, 2019), The Netherlands have set targets to reduce greenhouse gas (GHG) emissions with at least 55% in 2030 in comparison to 1990. The target for renewable energy supply is set on a minimum of 27% in 2030 and nearly 100% by 2050 (Rijksoverheid, 2019a). In The Netherlands, energy supply is left to the market. However, to bridge the competitive gap between renewable energy and conventional energy the Dutch national government initially adopted a renewable energy support scheme (Kozlova et al., 2023). In 2008, the first financial instrument was implemented to subsidize companies and non-profit organization in the development of large-scale renewable energy initiatives that aim to reduce CO_2 emissions, the so called 'SDE subsidy'. The SDE subsidy scheme has undergone two large revisions, leading to the current SDE++ subsidy. As of 2023, subsidy requests are assessed on practicality, and technical and financial feasibility (RVO, 2023).

The Dutch national energy targets – 55 TWh in 2030 (Rijksoverheid, 2024) – are translated to lower authority levels. The second level exists of thirty energy regions that strategize to implement renewable energy in their territory (Nationaal Programma RES, 2024a). The regions are responsible for the energy planning, which includes both spatial and process components to ensure progress on the implementation of renewable energy. Some regions have the same composition as Dutch provinces, other regions consist of a combination of municipalities. The energy regions work together with other regional stakeholders, such as the water boards, environmental organisations, and grid operators. The third authority level in The Netherlands consists of the municipalities, who define their own renewable energy targets. These targets are interpretations of the national and regional targets but influenced by the local political preferences represented in the municipal boards (e.g. Gemeente Olst-Wijhe, 2019).

Furthermore, most of the Dutch provincial authorities have articulated spatial guidelines for SPP development (e.g. Provincie Noord Holland, 2019; Provincie Overijssel, 2020). These documents sketch conditions for SPPs and comprise general statements on environmental compensation, often employing existing landscape classifications. Moreover, these guidelines often refer to qualitative objectives such as 'landscape quality' or 'multifunctional land use' (e.g. Provincie Overijssel, 2020). To be considered multifunctional, a SPP should fulfil several needs at the same time, such as combining energy generation with ecological restoration or recreational functions (Oudes & Stremke, 2021). Some municipalities have specified provincial guidelines by articulating their own guidelines for SPP development based on the local landscape characteristics (e.g. Gemeente Apeldoorn, 2020; Gemeente Assen, 2020).

4.2.2. SPP permit process and participatory requirements

SPPs need building permits that are authorized by municipalities. Municipalities follow their own policy requirements in these permit processes (e.g. Gemeente Montfoort, 2022). All policy documents prescribe some form of public participation in the planning and design of SPPs. However, the manner of participation is often not specified in these policies. For example, one municipality requires that permit applicants provide documentation that proves that there was fitting communication and participation. Based on those reports the municipality will judge if this is sufficient (Gemeente Apeldoorn, 2020, p.12). This example is representative for the type of formulation that can be found on participation requirements by many municipalities in The Netherlands (e.g. Gemeente Assen, 2020; Gemeente Olst-Wijhe, 2019). Moreover, the initiation and development of SPPs is left to market forces, therefore the developing party (e.g. commercial developer or energy cooperation) is responsible for organizing the participation in these projects. The type of local engagement that they commonly apply can be best described as 'invited stakeholder participation' (Cuppen, 2018). This type of engagement is a legislated procedure designed to inform local stakeholders and manage concerns and possible opposition (Wolsink, 2007). It meets the basic requirements for a building permit of a SPP. However, this type of participation is often perceived as insufficient and ineffective by stakeholders (Ryder et al., 2023) and does not safeguard procedural justice (Klok et al., 2023). Scholars, such as Macarthur (2016), argue for local participation as the most ethically defensible way to ensure that local stakes are included in large-scale landscape transformation, even if it is not the most efficient approach. Moreover, Oughton (2008) emphasizes that besides the effectiveness of participatory processes the legitimacy of the approach should be evaluated carefully. This includes a stronger argumentation for who should be involved and when. A call that is echoed in the work of Uittenbroek et al. (2019), who argue for more research on participatory processes and a sharper definitions of the objectives of these processes. With this study we add to a more holistic understanding of participatory design processes and their contribution to more sustainable landscape development (Roe, 2018).

4.3. Methods and materials

4.3.1. Case introduction

With this multiple-case study (Swaffield, 2016) we examine three SPPs that were developed through participatory design, to explore the benefits and limitations of participatory design in SPP development. By studying multiple cases, we add reliability to our results by filtering out local idiosyncrasies (Yin, 2014). All three cases are located in the Netherlands (Fig.4.1) with similar national policy settings. All cases are part of an innovation project by the nature NGO *Natuur en Milieu Federatie* (Nature and Environment Federation). The project is called ‘EnergyGardens’ (In Dutch: *Energietuinen*) and draws attention to the participatory design process and the landscape design (Di Nucci et al., 2023). All three SPPs were designed within the same time period (2019-2023) and are comparable from that perspective (Flyvbjerg, 2006).

Figure 4.1 Locations of the three cases in The Netherlands, part of the EnergyGarden-project (www.energietuinen.nl).

The cases are located in different types of landscapes, each with their own specific history, context (Fig.4.1), and stakeholders (Table 4.1).

4.3.2. Key stakeholders

The EnergyGardens-project prescribed an inclusive participation process in which local stakeholders were involved and empowered by designers, providing them with opportunities to share their ideas and concerns about the SPP development. All involved stakeholders could make proposals to formulate and add a spatial measure, alter an existing measure, or remove a measure. Some stakeholders could also take decisions on these proposals. In the three cases, different stakeholders were involved in the design and development (Table 4.1). Hereunder we present a short stakeholder analysis to sketch an overview of involved key stakeholders, their interest and main

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* "Community" or local community is a group of local inhabitants that is actively involved in stakeholder meetings.

** "Think tank" is a selection of local inhabitants and stakeholders that functions as 'soundboard' for suggestions of the project team and provides feedback on proposals.

*** "Neighbours" are local inhabitants that live adjacent to the proposed SPP site.

Table 4.1 Overview of involved stakeholder groups per case.

		Interest					Main motivation						
case	stakeholders	Economic	Environmental	Process	Socio-cultural	Technical	Economic	Environmental	Process	Socio-cultural	Technical	Making proposals	Making decisions
Assen	Commercial developer	x				x	x					x	x
	Nature NGO		x		x			x				x	x
	Landscape architect		x	x	x					x		x	x
	Municipality				x	x					x	x	
	Province		x		x	x					x	x	
	Energy cooperation	x					x					x	x
	Community[*]		x	x					x			x	
	Ecologist		x					x				x	
	Total	2	5	2	2	1	2	2	1	1	0	8	4
Mastwijk	Commercial developer	x				x	x					x	x
	Nature NGO		x		x			x				x	x
	Landscape architect		x	x	x					x		x	x
	Municipality	x		x					x			x	
	Community		x	x					x			x	
	Think tank[**]		x	x	x	x			x			x	
	Neighbours[***]			x					x			x	
	Ecologist		x					x				x	
	Total	2	5	5	3	2	1	2	5	1	0	8	3
Wijhe	Commercial developer	x				x	x					x	x
	Local initiator (NGO)		x	x	x						x	x	x
	Nature NGO		x		x			x				x	x
	Landscape architect		x	x	x					x		x	x
	Municipality	x				x					x	x	x
	Province		x		x	x					x	x	
	Community		x	x	x				x			x	
	Think tank		x	x	x					x		x	
	Neighbours			x					x			x	
	Food forest expert	x	x				x					x	x
	Architect	x			x	x					x	x	x
	Total	4	7	5	7	4	2	1	2	2	4	11	7

motivation (Table 4.1). The motivations of stakeholders for proposing or deciding on spatial measures were gathered during the design sessions. The motivations are based on the input given by the specific stakeholder; e.g. “I want measure X, because of reason Y.” These motivations were linked to acceptance factors of renewable energy, after Enserink et al. (2022). Below, we provide more details on key stakeholders to further explain their particular position in the cases.

The commercial developer represents the main initiator of the SPPs and took most decisions. Their key interests relate to the financial and technical feasibility of the plan. Moreover, they rely on the local acceptance of the plans for the SPP, which is a prerequisite to receive a building permit by the municipality.

The nature NGO initiated the EnergyGardens-project and included themselves as active stakeholder in the design processes. The nature NGO had some power in decision-making by signing a ‘declaration of intent’ with the commercial developer and other project partners. The declaration included a financial commitment to support and facilitate the design participation and to contribute financially to additional measures, such as seating furniture, information signs, and planting material.

The role of the municipality in the participatory design processes differed per case; From providing input on spatial measures in Wijhe; To being involved behind the scenes to check safety requirements and conditions in Mastwijk; To only being informed on the process in Assen. In all cases the municipality was responsible for approving the building permit for the SPP.

The role and number of involved local inhabitants differed significantly between the cases. In Assen, the inhabitants were mainly represented by the two involved energy cooperation’s, that existed of organized local inhabitants. In Mastwijk, there were several active local inhabitants that attended multiple sessions. Moreover, the neighbours living adjacent to the prospected site were very resourceful and had a longer history with the commercial developer & land-owner; A situation that placed additional pressure on the future development of the site. In Wijhe, a small group of local inhabitants had initiated a SPP-project and were organized as local initiator (NGO). As initiator of the SPP, they organized their own consultation with the local community. Additionally, the local initiator (NGO) had several private meetings with the neighbours.

The role and involvement of experts differed between the cases, except for the landscape architects who were included in all three cases. The role and responsibility of the landscape architect was threefold: 1) facilitating the stakeholder sessions, 2) safeguarding the importance of integral design including additional measures for nature, recreation and education, and 3) documenting the design process and drawing the landscape design. Other experts joined the participation process based on the required expertise and knowledge per case. In Assen and Mastwijk, an ecologist joined the process. In Wijhe, several experts joined the process, including a food forest expert and an architect.

4.3.3. Action research

In all three cases the researchers were embedded as landscape architects in the participatory design process, a position often referred to as action research. Action research was chosen because it provides the opportunity to address real-life issues, while at same time advance ongoing research and answer the research question (Chevalier & Buckles, 2019; MacDonald, 2012; Reason & Bradbury, 2008). In the three cases a cyclical participatory design process was initiated (Fig.4.2) that allowed the researchers to learn from each design iteration (Deming & Swaffield, 2011; Kindon et al., 2007). As landscape architects, the researchers facilitated the design sessions and provided the design materials. In this process they collaborated and discussed with all involved stakeholders about adding, altering, or removing spatial measures. The researchers made notes of each session, noting the design phase (Fig.4.2), purpose of the session, type of participation (Arnstein, 1969), set-up of the session, location, involved stakeholders, number of attendees, results of the session (e.g. making proposals and decisions on spatial measures, per stakeholder, including notes on motivation for measures (Enserink et al., 2022), action points, and process decisions.

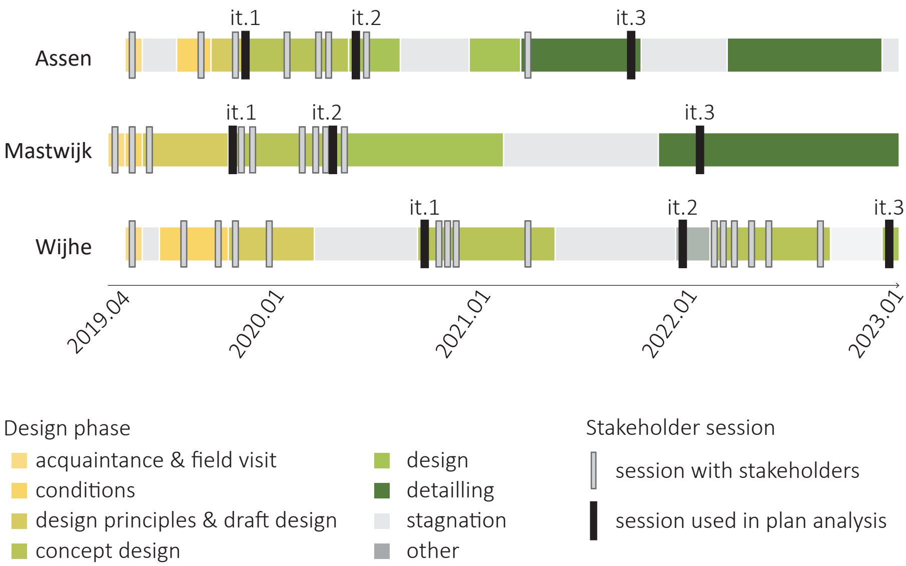

Figure 4.2 Schematic overview of design processes in the studied cases. All cases are coded to similar design phases. Stakeholder sessions are presented by vertical lines, the number of sessions differed per case in response to the local context.

4.3.4. Data analysis & synthesis

For the multiple-case study, we performed a plan analysis (Nijhuis et al., 2011) on three design iterations of each case (Yin, 2014) (Fig.4.2). We studied 1) the plan drawing of the first iteration of the concept design, 2) the plan drawing of the last iteration of the concept design, and 3) the final design drawing. We described the specificities from each design iteration to record, evaluate, and compare the findings (Flyvbjerg, 2006; Francis, 2001). We gathered all available documentation on the three design plans, including notes of the researchers and plan drawings. All data was collected in a Microsoft Excel file.

As part of the plan analysis, we made an inventory of all discussed spatial measures in each studied design iteration. To structure the data from all cases, we coded the measures in six categories:

- Solar infrastructure (n:9), e.g. 'increasing hectares of PV'(S1), 'changing the orientation of PV'(S4) , and 'changing row distances of PV'(S5);
- Infrastructure (n:9), e.g. 'changing the maintenance road (car access)'(I1), and 'adding/changing pedestrian routes (in PV patch)'(I4);

- Landscape & ecological functions (n:9), e.g. 'strengthening landscape elements (wooden banks, forest patches)'(E2), 'strengthening ecological features'(E3), and 'increasing biodiversity by planting solitary trees'(E6);
- Recreation (n:10), e.g. 'adding/changing recreational features (benches, information panels)'(R2); 'adding/altering viewpoint'(R7), and 'shielding PV from sight by trees and hedges'(R9)
- Food production (n:6), e.g. 'increasing hectares food forest (elements)'(F1), and 'increasing hectares crop land'(F3);
- Other (n:2), e.g. 'selling land (part of the site)'(O2).

In total we established 45 codes for spatial measures (Appendix C). Subsequently, we obtained an overview of the stakeholders as to whether they were making proposals and/or taking decisions on these measures and explored the motivation they gave for them, based on the notes from each session. The motivations for proposals and decisions were coded by the researchers and simplified to factors for acceptance of renewable energy (Enserink et al., 2022). This provided us with a full overview of who proposed a measure, who made the decision on including it in the design, and if the measure was added, altered, or removed from the design plan and why. Subsequently, we analysed the data in three steps. 1) We analysed the number of spatial measures discussed in three design iterations (added, altered, removed) and the provided motivations sorted to factors for acceptance of renewable energy (Enserink et al., 2022), to better understand what (additional) measures materialize in the final design. 2) We analysed the proportion of measures proposed and decided by the different stakeholders, what categories they address most, and what motivations they provide for these proposals and/or decisions, to better understand the role of stakeholders and their influence on spatial measures materializing in the final design; And 3) we analysed which spatial measures are covered by current policy regulations and which spatial measures are contributed by participants that have a strong mandate in these processes, based on the findings in step 2, to examine if such participatory design processes and current policy instruments are sufficient to ensure environmental and socio-cultural measures to materialize in the final design.

4.4. Results

4.4.1. Spatial measures identified in the cases

In total, 84 types of spatial measures were discussed in the three studied design iterations in the three cases (Table 4.2), of which 66 measures are included in the final designs. Categories that received most attention in the participatory design processes are landscape & ecological functions (n:20), infrastructure (n:18), and recreation (n:18). The number of measures per category differ per case because of the involved stakeholders, local context, and the different landscape types. Of the 84 spatial measures, that were proposed in the first design iteration, 54 measures were altered or removed in a later design iteration: Forty spatial measures were altered and fourteen were removed from the plans (Table 4.2). Alteration of spatial measures

Table 4.2 Overview of spatial measures (n) sorted to categories. The column 'spatial measures' summarizes the first proposal for spatial measures to be either included (added) or excluded (removed) from the design. The column 'Revision of spatial measures' summarizes alterations during the 2nd and 3rd design iteration. The last column presents the final number of spatial measures included in the designs after the three design iterations.

	Spatial measures			Revision of spatial measures in 2nd and/or 3rd iteration			Spatial measures included in final design
Category	added	removed	total	altered	removed	total	total
Landscape & ecological functions	18	2	20	9	3	12	16
Recreation	17	1	18	7	1	8	16
Infrastructure	17	1	18	12	5	17	13
Solar infrastructure	14	2	16	5	2	7	12
Food production	10	0	10	5	3	8	7
Other	2	0	2	2	0	2	2
total	78	6	84	40	14	54	66

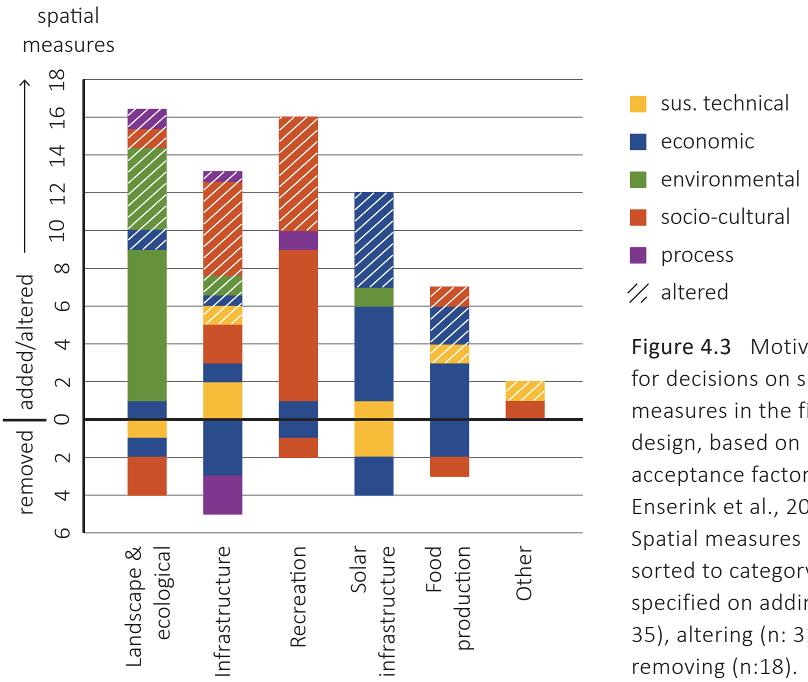

Figure 4.3 Motivation for decisions on spatial measures in the final design, based on acceptance factors (after Enserink et al., 2022). Spatial measures are sorted to category and specified on adding (n: 35), altering (n: 31), and removing (n:18).

occurred in all categories with most measures related to infrastructure (n:12) and landscape & ecological functions (n:9). From the fourteen spatial measures that were removed five belong to infrastructure, three to food production, and three to landscape & ecological functions.

The motives for adding spatial measures are quite evenly spread over the dimensions economic, environmental and socio-cultural (Fig.4.3). When examining the motivation for revisions, we find that in general most decisions on alterations were motivated by economic factors, such as *cost efficiency*. Seven alterations are motivated by economic factors, eight removals of spatial measures are motivated by economic factors. In the category infrastructure, four spatial measures are altered because of socio-cultural factors, such as *recreation*, *education*, and *community values*. This can be an addition on or relocating of an earlier proposed spatial measure. However, it can also translate to downsizing a measure to ensure that it remains in the plan as an additional feature. In the category landscape & ecological functions, four spatial measures are altered because of environmental factors. These revisions can be a result of new insights as well as experts joining in a later design phase, who made suggestions to alter spatial measures. Moreover, when spatial measures are removed from the plan, three of the removed measures are motivated by technical factors, such as *safety of the plant.* These were restrictions that were overlooked in an earlier design phase or only became known after discussion with the local authorities. Furthermore, two of the removed measures are motivated by process factors, which is expressed in factors such as expected *nuisance* and *trust in the developer*.

4.4.2. Critical participants and their motivations

When analysing the role of the participants, we find that some participants have a stronger position for their proposals to materialize in the final design. We observe that the landscape architect and nature NGO propose most additions and alterations of spatial measures (Table 4.3). However, their proposals (n:47) are most often altered (n:21) or removed (n:8) when compared to other participants. Other participants were responsible for 50% of these alterations and for all removals of the spatial measures (Appendix D). In the design drawing, five of these alterations are revisions to spatially downsize an intervention, reducing the size of a measure for example to reduce costs. At the same time, participants such as the neighbours, add much fewer spatial measures (n:4), but do see all of their proposals, including revisions of other participants proposals, materialized in the final design (n:5). Interestingly, we find that local inhabitants motivate these measures often with factors such as expected *nuisance* of the SPP development (Fig.4.4). In these cases, the inhabitants living adjacent or close to the prospected plot seem to argue for spatial measures from a more personal perspective, for example only considering the *visibility* of the SPP from their own home or garden, or possible *nuisance* from visitors of the SPP. In one case the neighbours argued to replace the existing maintenance road, located adjacent to their property to the other side of the plot (I1). Their argument was to create more distance between them and future visitors of the SPP. In the participatory design process the proposed measures by local inhabitants manifested themselves without discussion or consideration of the existing larger landscape or-design, or even the additional costs of such a measure. Furthermore, a large group of participants was

Table 4.3 Overview of involvement per stakeholder in three design iterations of the participatory design processes. Indicating the proportion of proposals (adding, altering, and removing spatial measures) and decisions on spatial measures, and emphasizing the proportion of measures that materialized in the final designs.

	Making proposals						Making decisions	
Stakeholders	To add a spatial measure	To alter a spatial measure	... of which proposals by others	To remove a spatial measure	... of which proposals by others	Final proposal	Total decisions	Final decisions
Commercial developer	9	6	5	14	7	21	42	31
Nature NGO	16	7	5	1	1	17	31	20
Landscape architect	31	14	4	3	1	25	35	16
Local initiator	7	2	1	0	0	3	16	7
Food forest expert	5	3	1	0	0	3	7	5
Architect	0	1	1	2	2	3	5	4
Municipality	1	2	2	1	1	2	2	1
Neighbours	4	2	1	1	1	5	0	0
Ecologist	3	2	2	0	0	4	0	0
Community	1	0	0	1	0	1	0	0
Energy cooperation	1	0	0	0	0	0	1	0
Think tank	0	1	1	0	0	0	0	0
Total	78	40	23	23	14	84	139	84

concerned with a few selected measures (Fig.4.4). This can be related to a specific expertise that they brought to the design process or a limited interest in the landscape design of the SPP. The commercial developer has the largest share in removing spatial measures from the plan (n:14). Most of which were motivated by economic factors (n:6), such as *business case* and *cost efficiency* (Fig.4.4).

The decisions on spatial measures are not always made by the same participant that proposed the measure. Several participants were only allowed to propose

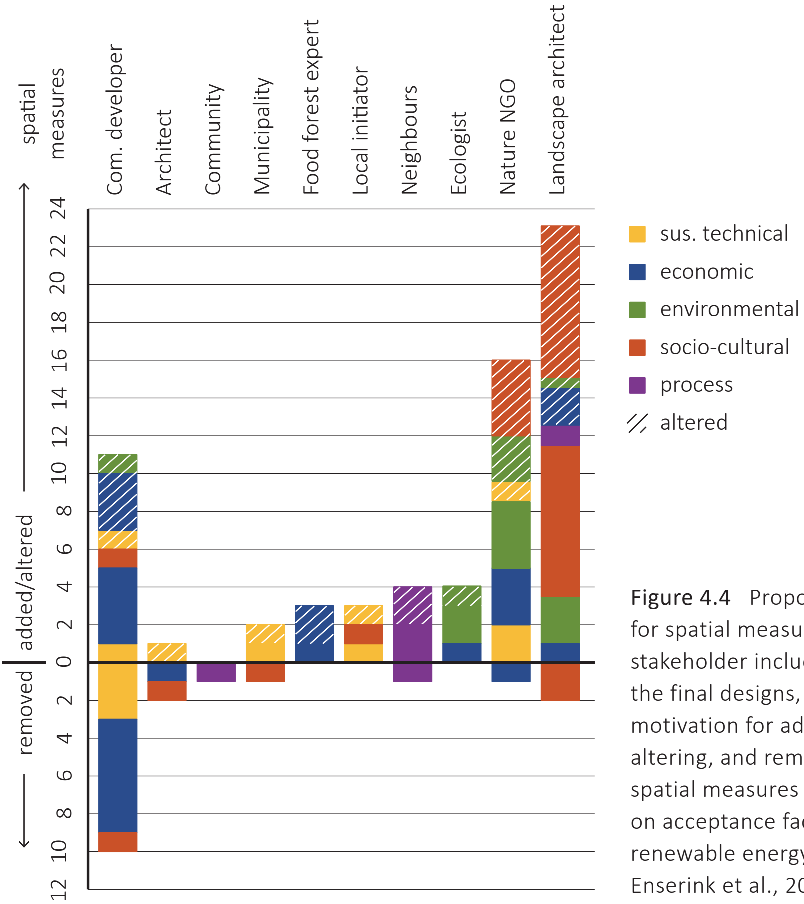

Figure 4.4 Proposals for spatial measures per stakeholder included in the final designs, and motivation for adding, altering, and removing of spatial measures based on acceptance factors of renewable energy (after Enserink et al., 2022).

spatial measures, such as the ecologists. Other stakeholders were responsible for the decisions on their proposals, such as the commercial developer or nature NGO. We find that most of these measures are included in the final design, either because their input was requested based on their particular expertise (e.g. proposals by an ecologist) or considered important for local acceptance (e.g. proposals by local inhabitants). The decisions on their proposals are most often made by the commercial developer. The positive decisions on proposals by local inhabitants are motivated by the commercial developer to increase *trust in the developer* and to ensure the cooperation of local inhabitants. In general, the commercial developer has the largest share in final decisions (n:31) (Table 4.3). The nature NGO has the second largest share in final decisions (n:20) (Table 4.3). Most of these decisions by the nature NGO are motivated by environmental factors (n:9), such as improving *wildlife habitats* and increasing *biodiversity*.

4.4.3. Societal concerns in participatory design of SPP

We find that societal concerns are mentioned by involved stakeholders in all three cases. However, these concerns are not always a priority for inclusion in the final design. Figure 4.5 presents a comparison of the spatial measures materializing in the final designs of the three cases and if they are stated as requirement for a building permit in local policy instruments. In quadrant I, we mainly find landscape & ecological measures (n:9). These measures are included in the final design and required by current policy instruments (Table 4.4). Most of these measures are proposed by the ecologist (n:3) and the nature NGO (n:5), and decided upon by the nature NGO (n:8) (Fig.4.5). In quadrant I, six spatial measures are altered in the design process, of which 31% is spatially downsized. This indicates that although these measures are required by current policy they were outweighed by other stakeholders with arguments often relating to economic factors.

We found that of the total 66 spatial measures that were included in the final plans, 50 are not required by current policy (76%) (Table 4.4). This indicates that these measures were mandated by the involved stakeholders. In this quadrant (II), large categories are infrastructure (n:14), recreation (n:12), and solar infrastructure (n:9). The landscape architect (30%) and the nature NGO (24%) took much of the decisions on spatial measures in this quadrant (Fig.4.5). Their measures materializing in the final design can be partly explained by their role in the three cases as part of the EnergyGarden-program. The influence of the nature NGO was supported by their financial involvement. Moreover, the work of the landscape architect was supported by the commonly agreed program ambition to push for landscape quality in the SPP design. It should be noted that these are not regular circumstances or common practice yet in SPP development in The Netherlands. Furthermore, in quadrant II we find 24 spatial measures that were altered, of which 46% were spatially downsized to

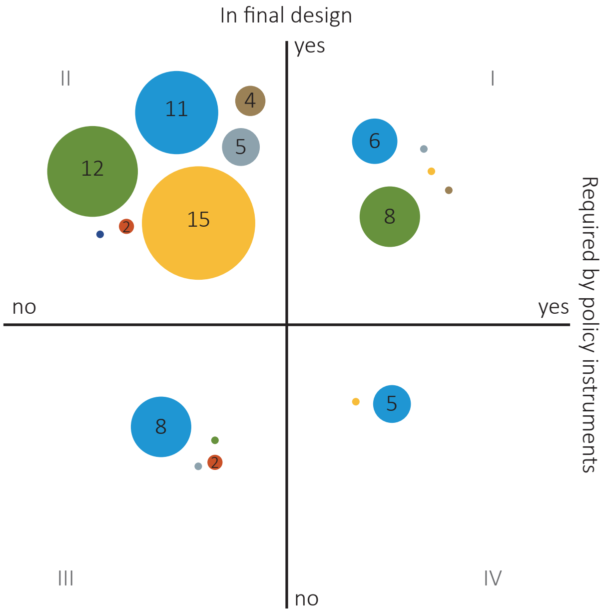

Figure 4.5 Comparison of inclusion of spatial measures in the final design and if they are required by current policy instruments, sorted to stakeholders final decisions on spatial measures. Size of circles refers to number of measures decided upon per stakeholder.

Table 4.4 Overview of all spatial measures sorted per category, comparing inclusion of spatial measures in final designs to indicated requirement of measures by current policy..

Category / Final design vs. policy requirement	Solar infrastructure	Infrastructure	landscape & Ecological functions	Food production	Recreation	Other
I. In final design & required by policy (n: 16)	S1; S7; S9;		E2; E3 (3x); E4; E5(2x); E6(2x);	F3;	R9(2x); R10;	
II. In final design, not required by policy (n: 50)	S3; S4(2x); S5(2x); S6(3x); S8;	I1(2x); I2(2x); I3(2x); I4(2x); I5(2x); I6(2x); I8; I9;	E1(3x); E7(2x); E8; E9;	F1(2x); F2; F4; F5; F6;	R1; R2(2x); R3; R4; R5; R6; R7(2x); R8(3x)	O1; O2;
III. Not in final design & not required by policy (n:12)	S8;	I4; I5; I7(2x); I8	E128(2x);	F2; F4;	R6(2x)	
IV. Not in final design & required by policy (n:6)	S2; S7; S9		E2(2x)	F3;		

reduce costs. This indicates that measures addressing societal concerns are covered by involved stakeholders, but that the input of these stakeholders can be outweighed by others in the final decision-making.

Quadrant III presents the spatial measures (n:12) that are not required by current policy and are either 1) not well-mandated by stakeholders and thereby overruled by motivations such as *cost efficiency*, or 2) well-mandated by stakeholders to not be included in the final design. For example, the local community and neighbours opted to remove certain spatial measures because they had concerns about possible *nuisance* related to the SPP development. In quadrant III, six of the spatial measures (50%) are removed because of economic factors. Interestingly, two spatial measures are removed because of socio-cultural factors, such as an intervention not fitting with the *landscape narrative*. When it comes to the decisions in quadrant III, we find that the commercial developer has the largest share (67%) of final decisions (Fig.4.5).

Six spatial measures did not materialize in the final design even though they are required by current policy instruments (Table 4). The commercial developer has a large role in decision-making in quadrant IV (83%) (Fig.4.5). Two of the spatial measures in quadrant IV addressed strengthening existing landscape elements. They did not materialize in the final design, because a) the measure was suggested outside the project area or b) the measure did not fit with the long-term landscape development. Of the solar infrastructure, two spatial measures were removed because of technical restrictions, such as *safety of the plant*. The remaining spatial measures were removed because of economic motives, such as *cost efficiency* and *business case*.

4.5. Discussion

This paper explored three Dutch SPPs, to examine the benefits and limitations of participatory design of SPPs with regards to the tensions between participants concerns and broader societal concerns, as well as to explore policy implications. First, we examine the set-up of this research and limitations that should be considered when discussing the results. The advantage of performing action research is that the researchers are in direct contact with all stakeholders and that they have access to all data (Chevalier & Buckles, 2019; Flyvbjerg, 2006; Francis, 2001; MacDonald, 2012; Reason & Bradbury, 2008). Being at the table makes it possible to experience the process first hand and it provides the researchers with the genuine opportunity to take notes during formal and informal meetings. The pitfall of this inclusion is that the researchers bias can affect the process, the final design, the documentation, and interpretation. We tried to minimize personal biases by involving multiple researchers in the participatory design sessions and cross-checking observations. Moreover, all process documentation and designs, as well as preliminary results of the study were checked by the commercial developers and nature NGO, to ensure that notes by the researchers on motivations for spatial measures were in accordance with their interpretation. This triangulation ensures validity of the collected data (Creswell, 2009; Kumar, 2014).

4.5.1. The benefits of participatory design in SPP development

We found that the proposals by local inhabitants are well-represented in the final design of all three cases. All of their proposals are included and only one of them is altered by another stakeholder (Table 4.3). We assessed that in one case this can be framed as a way to recover past distributive injustice (Lacey-Barnacle, 2020). Here, the experienced nuisance of the past land-use, a land-fill, had a strong effect on the possibilities for future development and the process and participation of local stakeholders. In the participation process, this expressed itself in the developing party accommodating all wishes and demands of local inhabitants, mainly to improve their relationship, to increase *trust in the developer*, and to ensure local cooperation. In all three cases, the involvement of local inhabitants contributed positively to the procedural justice, because they could truly affect the final design of the SPP (Enserink et al., 2023; Walker & Baxter, 2017).

Moreover, the chosen participatory design approach allowed experts to contribute to the design of the SPPs. In all three cases there were expert stakeholders that specifically argued for environmental and socio-cultural values, such as the nature NGO and the food forest expert. Their involvement ensured more attention for the sustainable design of the SPP and resulted in the inclusion of many landscape & ecological measures (n:16) as well as recreational measures (n:16) in the final designs (Table 4.2). Furthermore, the involvement of experts resulted in a highly interactive process during which no less than 64% of the analysed spatial measures (n:54) were altered or removed from the plans. Furthermore, the involvement of a diverse group of stakeholders ensured attention to all categories of spatial measures. Good intentions were formulated and considered, signifying a positive development in the attention to qualitative ambitions, such as landscape quality, in the design of SPPs. A shift articulated by several scholars as a necessary development (Scognamiglio, 2016; Stremke & Schöbel, 2019).

4.5.2. The limitations of participatory design in SPP development

The case study also daylighted several limitations of participatory design in SPP development. We found that although the final plans include several additional spatial measures besides solar infrastructure, the SPPs cannot be considered truly multifunctional (Oudes et al., 2022). The SPPs are essentially monofunctional with selected additional features. In addition, most of the above-mentioned good intentions had a short life and died before finalisation of the plans (Table 3). Moreover, several spatial measures were added, altered, or removed without consideration of the existing landscape or -design (Oudes et al., 2022). We found that the majority of spatial measures addressing socio-cultural or environmental concerns – two key dimensions of the sustainability framework (Stremke, 2015) – are altered or removed. The latter most often with economic motivations (n:17) or related to technical factors (n:6). This is in stark contrast with for example Stremke (2015) calling for a balance between all four dimensions to ensure a truly *sustainable* energy transition. Moreover, we found that much alteration and removal of spatial measures happened on the infrastructural (n:17), and landscape & ecological measures (n:12)(Table 4.2). The decisions to remove spatial measures were most often taken by the commercial developer (Fig.4.4) and not by the stakeholder who originally proposed the measure (Table 4.3). This interaction emphasizes the good intentions on including additional measures in the SPP, however, many of these intentions dissolve during the design process. The strong focus on economic and technical factors illustrates a conventional approach to SPP development as monofunctional land use. This situation is fostered by the current national subsidy schemes in The Netherlands that assesses only practicality, and technical and financial feasibility (RVO, 2023). Furthermore, the large number of spatial measures being altered or removed during the process towards the final design makes it even more uncertain if and how these additional features will be realized and maintained in the future. Given the ease with which environmental and social measures were altered and removed during the design process, further research should examine the materialization of these additional measures. While they were promised at some point in the design process, they may not materialize during the actual construction process.

Secondly, we like to return to the role of the local inhabitants and their influence on spatial measures in the final design. Although the involvement of local inhabitants in itself is a benefit, because it contributes to both a socially just energy transition (Lacey-Barnacle, 2020; Macarthur, 2016; Solman et al., 2021; Uittenbroek et al., 2019) and to a local feeling of responsibility (Groh & Möllendorff, 2020), it also represents a limitation. In all three cases, we found that local priorities did not necessarily align with broader societal concerns (Fig.4.4). The motivations given by local inhabitants for these measures did not address the functional, experiential, or future value of the landscape (Oudes & Stremke, 2020). On the contrary, we found that motivations focus very strongly on the individual needs of the local inhabitants and do often go against broader societal concerns, such as larger recreational and ecological networks. This is in stark contrast to other publications (e.g. Ryder & Devine-Wright, 2022), that emphasize the awareness of local residents of broader societal concerns. Furthermore, the role of the designer was limited to drawing the given input, instead of mediating or integrating measures in the design narrative (Sijmons & Van Dorst, 2013). Moreover, the emphasis of commercial developers on the concerns of the local inhabitants outweighs the input from other (expert) stakeholders that might argue for broader societal concerns. It is therefore questionable if the approach can be considered truly just. Alternatively, we argue that the transition to renewable energy would become more procedurally just when there is a better balance between different types of stakeholders and their abilities to influence the decision-making towards the final design. This becomes especially evident when we consider landscape users that are not local residents and who are often disappointed with the design of SPPs, because they did not get a voice in the participation and/or their influence on the decision-making was too limited (Knudsen et al., 2015; Smith & McDonough, 2001).

4.5.3. The implications for policy

We like to discuss two implications of our research for policymakers. First, current policy instruments in The Netherlands are strongly focussed on technical and economic factors, which is reflected in both the national subsidy scheme (RVO, 2023) and in the requirements of municipal building permits for SPPs (e.g. Gemeente Montfoort, 2022). This focus assures efficient spending of government subsidies. However, it seems superfluous when there are always stakeholders involved that mandate these concerns, namely the commercial developers (Table 4.1). At the same time, the directive power of the national subsidy scheme is not fully valorised. This is problematic because of the eminent gap between the qualitative objectives in (national) policy (e.g. Provincie Noord Holland, 2019; Rijksoverheid, 2019a) and the (lack of) attention to the quality of SPPs in the permit procedures of local municipalities. Broader societal concerns, such as multifunctional land-use and landscape quality, are not clearly defined and hardly assessed in the permit procedures of municipalities. We like to argue that improving the assessment criteria for these and other societal concerns can pave the way for a larger share of additional measures being included in the SPP. This evolution of policy away from merely quantitative financial targets towards more qualitative societal goals seems justified, given the already realized substantial achievements in realization of targets for solar energy and other renewable energy generation in The Netherlands (Brandenburg et al., 2023). Next to incentivizing SPP developers to include qualitative spatial measures, such policy would allow to hold developers accountable for both the quantity of energy generation and the quality of SPPs. A first step in this direction has been taken in the 2023 evaluation of the present-day SDE++ subsidy scheme, in which qualitative targets for nature-inclusiveness are suggested to be included in future subsidy requirements in The Netherlands (Van Gastel, 2023).

Secondly, while participation is mandatory for SPP development in The Netherlands, the manner in which stakeholders are involved in this process and their role in decision-making is not clearly defined (e.g. Gemeente Olst-Wijhe, 2019; Uittenbroek et al., 2019). We observed in our case study that the local inhabitants had a strong position in the participatory design processes (Table 4.3). In itself this is positive (Solman et al., 2021), however, looking at the bigger picture we find that these stakeholders have a somewhat limited perspective on the SPP development and largely argue for individual benefits. The measures they proposed and their motivations do not align with those of the wider community or broader societal concerns. Simultaneously, we find that stakeholders that mandate broader societal concerns are often overruled by other stakeholders, such as the commercial developer (Fig.4.4). Especially when there are doubts about technical or financial feasibility that could interfere with the municipal permit process or subsidy request. Policy needs to play a vital role in ensuring a better balance between stakeholder's abilities to affect outcomes (Walker & Baxter, 2017). For example by installing a regionally operating quality team, that reviews plans before submission for subsidy. Earlier experiences in the Dutch Room for the River program, with such committees, suggest that this is an effective approach (Klijn et al., 2013). Moreover, it would contribute positively to the procedural justice of the energy transition (Lacey-Barnacle, 2020), by ensuring that broader societal concerns are covered during (local) participatory design processes, besides the more individual concerns of local inhabitants.

4.6. Conclusion

Based on our multiple-case study, we conclude that participatory design processes currently benefit local inhabitants and experts (where they partake) to mandate their concerns about SPP development. The latter group safeguards more attention for the landscape design of SPPs in the three cases, which is a relevant advancement regarding the sustainable development of solar energy (Scognamiglio, 2016; Stremke & Schöbel, 2019). However, we also identified several limitations of participatory design processes. First, not all involved stakeholders have the same ability to affect the outcomes. We find that local inhabitants mainly suggest spatial measures related to their personal experience and individual concerns related to the landscape transformation such as vegetation to hide PV panels from their residences. These measures, more than others, get implemented by commercial developers to manage local concerns and avoid possible opposition. Expert stakeholders, such as landscape architects and the nature NGO that mandate broader societal concerns are not fully acknowledged as actors in these cases. Many of their proposals are altered or removed entirely by other stakeholders. In other words, good intentions live or die not according to their intrinsic quality but according to *who* proposes them. Furthermore, many of the qualitative ambitions rendered in present-day policy are not well-defined as binding requirements for a building permit and renewable energy subsidy in The Netherlands. This decreases the chance of qualitative measures to materialize in the final design. Further research into the build reality of SPPs seems opportune, to better understand the potential and realized quality of additional measures through time and the apparent dissolving of good intentions in the process.

Based on our research, we argue for redressing the balance between the concerns of local inhabitants, such as nuisance, and broader societal concerns, such as biodiversity and landscape quality. We recommend improving policy, or directly changing subsidy requirements, to ensure a better balance of involved stakeholder groups and their possibilities to participate and affect the decision-making in SPP design processes (Knudsen et al., 2015; Lacey-Barnacle, 2020; Walker & Baxter, 2017).

There are (at least two) ways to operationalize this: Either policymakers provide better definitions and mandate inclusion of socio-cultural and environmental values such as landscape quality and multifunctional land-use; Or they delegate that responsibility to a committee of experts which together with local stakeholders foster trajectories towards more environmentally sustainable and socially just deployment of renewable energy technologies for the energy transition.

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CRediT authorship contribution statement

Merel Enserink: Conceptualization; Data curation; Methodology; Investigation; Project administration; Visualization; Writing - original draft; Writing - review & editing. Rudi van Etteger: Conceptualization; Writing - review & editing; Supervision. Sven Stremke: Conceptualization; Funding acquisition; Investigation; Writing - review & editing; Supervision.

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photo SPP Midden-Groningen, Hoogezand-Sappemeer (NL).

From promise to practice.

A perspective on discrepancies between permit and built solar power plants.

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Chapter 5

Abstract: Over the past years, the implementation of solar energy technology in the landscape has increased significantly. Landscape quality is included as objective for solar power plant (SPP) development in The Netherlands. In this study, we examine the discrepancies of five Dutch SPPs through post-occupancy evaluation and structured interviews. We found 79 discrepancies in spatial measures. Interviewees attributed discrepancies to the business case, permit procedures, regulation, enforcement, and maintenance. We make two recommendations to improve policy and simultaneously strengthen the mandate of landscape planning and design with regards to SPP development. First, sharper definitions should be provided as permit requirements to prioritize broader societal concerns in SPP development. Secondly, design visualisations by landscape architects need to improve to foster communication and transparency among stakeholders. These changes in policy and SPP development practice are needed to maintain landscape quality as stipulated for example by the European Landscape Convention.

Keywords: solar energy; landscape quality; design visualisation; post-occupancy evaluation; energy policy

From promise to practice.

A perspective on discrepancies between permit and built solar power plants.

5.1. Introduction

The transition to renewable energy technologies has led to landscape transformations (Bridge et al., 2013; Nadaï & Van Der Horst, 2010). Over the past years, the implementation of ground-mounted solar energy technology in the landscape has increased significantly (Brandenburg et al., 2023). In countries with high population densities, such as The Netherlands, it is challenging to allocate space for renewable energy. In such countries renewable energy has to compete with other spatial claims such as food production, urban expansion, and climate adaptation (Sijmons et al., 2017a). Moreover, the scarcity of space makes it is difficult to allocate renewable energy developments in locations where these will not bother local inhabitants and other landscape users. Scholars found that the transformation of the daily environment can be difficult for (local) stakeholders to accept (Bertsch et al., 2016). In The Netherlands, the development of solar power plants (SPP) is largely left to market forces: developers and landowners. They often consider the deployment of renewable energy infrastructure to be a technical and economic development.

The ambition in The Netherlands is to create sustainable energy landscapes (e.g. Rijksoverheid, 2024). Simply implementing solar energy technologies in a landscape does not render the energy transition to be sustainable (Stremke, 2015; Stremke & Picchi, 2017). To be considered sustainable, the SPP development should include broader societal concerns related to environmental and socio-cultural objectives, besides technical and economic objectives (Stremke, 2015). In this research, the definition of Stremke & Van den Dobbelsteen (2013) is used, stating that sustainability refers to the manner how solar energy technologies are sited in the landscape: by acknowledging existing landscape qualities and the values of local inhabitants and other landscape users, and doing so without compromising biodiversity, food production, and other life-supporting ecosystem services. Landscape quality is defined by the functional, experiential, ecological, and temporal dimensions of a landscape (after Bakx et al., 2023). Oudes & Stremke (2020) refer to landscape quality as a key concept to help shape the design of large-scale landscape transformation for renewable energy. They base their argument on previous large-scale landscape transformations, such as the Dutch 'Room for the River' project (in Dutch: Ruimte voor de Rivier). Here, the inclusion of landscape quality as requirement for development has helped to implement functional-technical solutions that simultaneously contribute to broader societal concerns (Klijn et al., 2013; Sijmons et al., 2017b; Van den Brink et al., 2019).

Currently, a broader set of societal concerns articulated as 'landscape quality' is also informing Dutch energy policy on SPP development[3]. Landscape quality is stipulated by the European Landscape Convention as an important factor that should be accounted for in landscape transformations (Council of Europe, 2000). On several Dutch levels of government administration this concept is implemented. At the national level, landscape quality is formulated as an ambition in SPP development (RVO, 2024b; Rijksoverheid, 2019a). Several provinces have interpreted this to guidelines for multifunctional land-use, nature inclusive development, and strengthening of landscape elements (e.g. Provincie Noord Holland, 2019). These guidelines are translated by municipalities to match the renewable energy objectives of their municipality and comply with local expectations (Fig.5.1). These municipal objectives, in turn, are used as criteria for the permit approval of SPPs (e.g. Gemeente Assen, 2020). However, the permit criteria leave room for interpretation such as: "existing parcellation and vegetation structures are leading in the design" (Gemeente Assen, 2020, p.8). Similarly, the necessity for multifunctional land-use lacks clear criteria: "At least one additional subject – ecology, recreation, agriculture, or water – needs to

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3 See for example MOOI Nederland 'Energienetwerken: ruimtelijk vormgeven energietransitie', https://www.mooinederland.nu/longread/energienetwerken-ruimtelijk-vormgeven-energietransitie, accessed 24 July 2024.

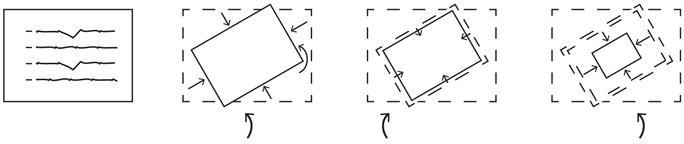

Figure 5.1 Representation of the interpretation of landscape quality on different scale levels, from national ambitions to local built reality.

be addressed in the design. The municipal council evaluates whether this objective is met sufficiently" (Gemeente Assen, 2020, p.9). Several scholars have put the question forward whether these documents offer the right 'means' to realize the broader societal concerns, such as landscape quality, in SPP development (Moussa et al., 2020; Pasqualetti & Stremke, 2018; Scognamiglio, 2016; Stremke & Picchi, 2017; Stremke & Schöbel, 2019). Recent studies (De Vries et al., 2023; Oudes et al., 2022) address the lack of landscape quality found in current SPPs. Moreover, a recent study by Enserink et al. (2024) evidences that spatial measures addressing broader societal concerns such as multifunctional land-use are easily downsized or removed during the development process. A first glance at the current state of Dutch SPPs emphasizes the differences between constructed SPPs and the landscape design submitted for permit approval. Tall fences and auxiliary infrastructure (e.g. transformers and sub stations) suddenly appear at the edges of SPPs, planted vegetation lacks cues of care, and inhabitants turn to the municipality complaining about SPPs that look different than agreed upon in the permit documentation[4].

With this study we explore the extent of these discrepancies that appear in built SPPs and what their causes are. This allows us to critically reflect and formulate recommendations that inform policy and practice of future SPP developments on the inclusion of environmental and socio-cultural objectives. The following research

4 See for example Nieuwsuur Season 2023 Episode 4304 segment "Bezwaren tegen zonneparken" (19:07-27:14min), 13 April 2023. https://npo.nl/start/serie/nieuwsuur/seizoen-2023/nieuwsuur_4304/afspelen accessed 8 July 2024.

question guided the research: What can be learned from the discrepancies between permit documentation and built reality of SPPs in The Netherlands to better balance techno-economic objectives with environmental and socio-cultural objectives? In this study, we research the reoccurring discrepancies between permit documentation and built reality of five SPPs in The Netherlands. The aim of our study is to improve our understanding on how to include environmental and socio-cultural objectives in SPP development. The next section presents the methods used. After the methods section, we elaborate on the found discrepancies and their causes according to key stakeholders, presented along the four dimensions of landscape quality. We then discuss our findings and provide recommendations to improve future policy and practice before we conclude the paper in the final section.

5.2. Methods and materials

5.2.1. Case selection and desk research

Cases were selected within the province of Gelderland (central-east in The Netherlands) as spatial data of SPPs in this province were available in the context of a five-year research program on the quality of SPPs[5]. In 2021, the province of Gelderland hosted 46 SPPs larger than 1 MW and has formulated guidelines on the importance of landscape quality (Provincie Gelderland, 2019). In the first step of case selection, a longlist of 31 cases was created that met two selection criteria: 1) project documentation was available, and 2) project documentation contained descriptions of landscape-inclusive elements, such as spatial measures to improve biodiversity, to align with existing landscape structures, or to reduce visibility for landscape-users. In the next step, the available permit documentation of the cases on the longlist was

[5] Research program by Wageningen University & Research and Provincie Gelderland, 'Gelderse Aanpak Zonnevelden met Omgevingskwaliteit', https://www.wur.nl/nl/onderzoek-resultaten/projecten/wageningen-solar-research-programme/gazo-prijsvraag.htm, accessed 9 July 2024.

compared with satellite imagery to scan for discrepancies. This reduced the longlist to 20 cases.

In the comparison of the permit documentation with satellite imagery, we identified a total of 189 spatial measures. The comparison revealed that for 140 measures (74%) discrepancies exist between the permit documentation and the satellite imagery of the built SPP:

- 70 spatial measures were constructed differently than described in the permit documentation (37%);
- 60 spatial measures were not constructed (32%), and;
- 10 spatial measures were constructed that were not described in the permit documentation (5%).

In a final step of case selection, we analysed the discrepancies to identify similar discrepancies occurring across cases. To this end, we coded the discrepancies to groups of similar spatial elements (after Enserink et al., 2024)Enserink et al., 2024). Then, we examined the groups of similar elements on the absolute and relative occurrence of discrepancies as 'constructed differently' and 'not constructed' in the cases. Of the remaining 20 cases, we selected five cases for the post-occupancy evaluation that together showcase the variety of discrepancies and cover the most common discrepancies.

5.2.2. Post-occupancy evaluation

We then performed a post-occupancy evaluation (Chen et al., 2023; Deming & Swaffield, 2011; Roberts et al., 2019) on the five selected SPPs in Gelderland (Fig.5.2). The post-occupancy evaluation helped to analyse the extent of the discrepancies and find patterns in more commonly appearing discrepancies between the embedded cases. To this end, we compared the design drawings and descriptions of the permit documentation with data from field visits and drone images.

Figure 5.2 Selection of five embedded cases in Gelderland (NL). Photo credit dronewageningen, published with permission.

First, we followed up with the desk research to further extract and synthesize data from the permit documentation. We thoroughly scanned the selected documents for descriptions, maps, sections, and visuals that provided specifications on proposed spatial measures. The identified spatial measures and their specifications were recorded in an Excel spreadsheet. Furthermore, we redrew a landscape design map of each case to support comparison of design visualisations in permit documentation. Second, we conducted systematic site observations and collected data for all spatial measures found in the previous step. All site visits were conducted in early July 2023, ensuring similar seasonal conditions. Notes and photographs were taken during those site visits. We complemented the site observations with drone images of the five cases to triangulate data, the drone images were taken in October 2022. In some cases, not all parts of the SPP were accessible or visible during the site visit. Here, the drone images helped to analyse whether spatial measures materialized as described in the permit documentation. Of each case, we drew comparable 'observation maps' that illustrate spatial measures identified in the field. Third, we compared the gathered data from the two previous steps to identify patterns in more commonly appearing discrepancies. All discrepancies were recorded per case in an Excel spreadsheet.

5.2.3. Structured interviews

Subsequently, we interviewed a selection of key stakeholders from the five cases to identify the causes for the found discrepancies. We ensured that the sample included different types of stakeholders. The interviewees were selected based on their role in the SPP development and willingness to participate. The sample is a valid representation of involved stakeholders, including developers, civil servants, landscape designers, and a contractor. This variety of stakeholders enabled us to draw conclusions on the extent of these discrepancies happening in SPP development and their related causes. In total, we conducted eleven structured interviews (Fowler, 2012; Weller, 2007). The structured interviews allowed us to compare the responses. Moreover, it allowed us to identify patterns by analysing quotes from different stakeholders through thematic content analysis (Braun & Clarke, 2006). The interview transcripts were imported into and organized with Atlas.ti software. We performed four steps in the thematic content analysis: scanning, initial coding, potential themes, and reviewing & defining (Braun & Clarke, 2006).

5.3. Results

Across the five cases, we found a total of 79 discrepancies from a total of 85 identified spatial measures (93%). Of this large share of agreed upon spatial measures 37% of spatial measures did not materialize, 44% of spatial measures materialized differently than documented, and 12% of spatial measures were found on site that were not part of the permit documentation. In the following, we present four exemplary discrepancies that occurred in multiple cases and that potentially have adverse effects on landscape quality. The exemplary discrepancies are categorized by the four dimensions of landscape quality - functional, experiential, ecological, and temporal dimensions (Bakx et al., 2023) - to provide a clear example discrepancy for each dimension.

5.3.1. The functional landscape: PV system lay-out

The first main finding is that the PV system lay-out in the field displays many discrepancies with the PV system lay-out presented in the permit documentation. We found that the drawn PV system in the permit documentation functions as a ‘placeholder’. In all

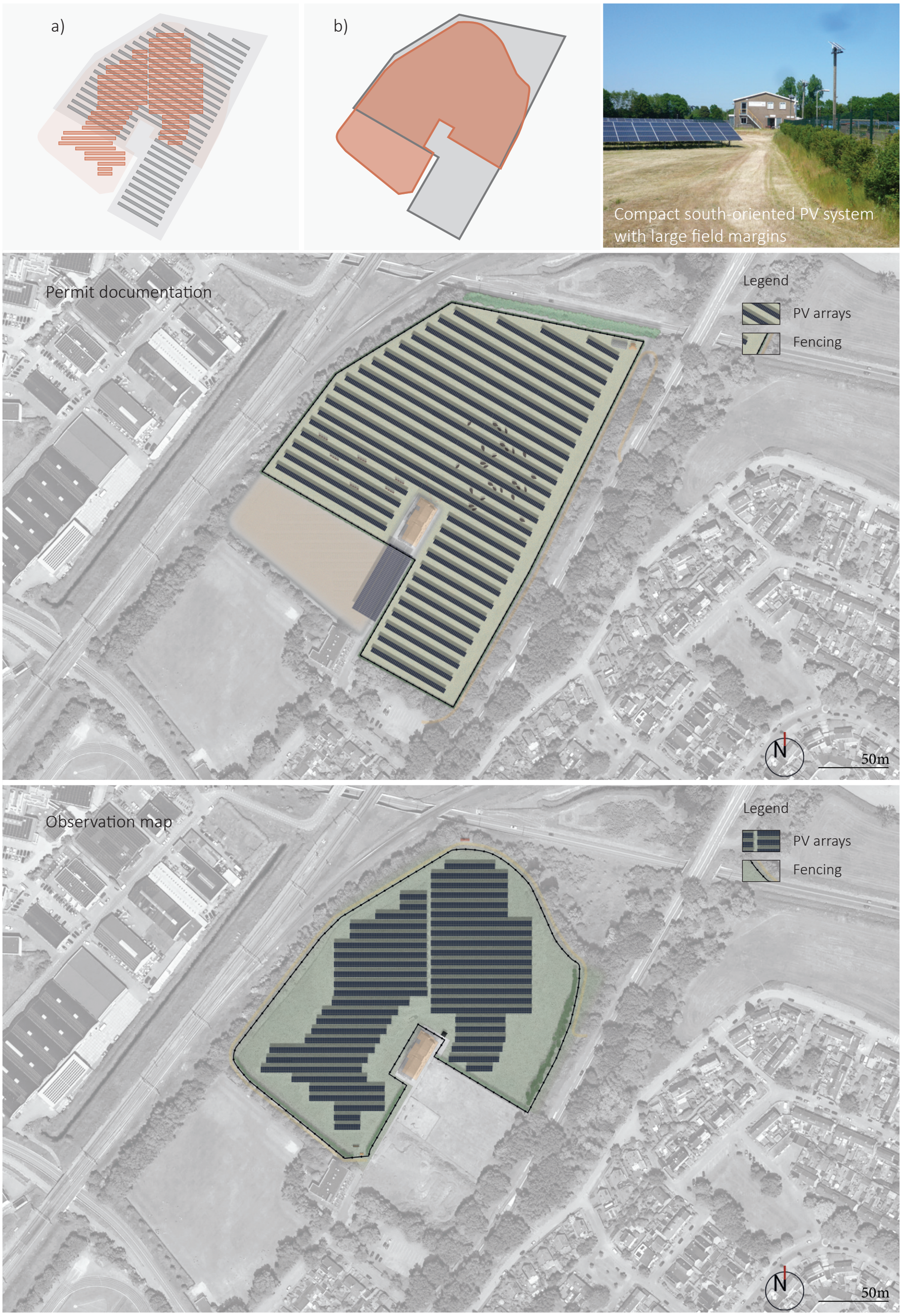

Figure 5.3 Case #3: The orientation of PV arrays does no longer align with the existing parcellation (a); The project boundary has changed significantly (b); The row distance changed from 7,5m to 3m, with a large field margin between fence and PV system.

five cases we find, sometimes major, discrepancies related to the PV system lay-out (Fig.5.3). In four cases, the permit documentation suggest an alignment of the PV system with the existing parcellation. This alignment only materialized in case #5. In another case the orientation of the system was slightly altered (case #1). However, in case #3 and #4 we find that the orientation of the PV systems was changed to a standard south orientation, leading to a misalignment with existing landscape patterns (Fig.5.3a). Furthermore, in three cases (case #1; #3; #4) the project outline changed significantly compared to what was presented in the permit documentation (Fig.5.3b). In all three cases, this boundary change also affected the PV system lay-out. Lastly, in three cases (case #3; #4; #5) the row distances changed; ranging from an increase in row distances of 60 cm to a decrease in row distances of 4,5 m.

Based on the interviews, the lack of binding agreements for the permit allows for discrepancies to occur in the PV system lay-out (82%). One of the civil servants acknowledges that they probably did not provide enough requirements for the level of detail of the permit documentation (interviewee #4). Moreover, the long time span between permit approval and construction makes it unrealistic to make a technical design before the permit. Interviewees describe that this would simply be too costly. Therefore, a final technical design is made before the construction phase, which needs to be approved by the municipality and other stakeholders. (e.g. interviewee #5). Several landscape designers acknowledge that it is standard practice that the technical design is produced just before the construction. Furthermore, the landscape designer, who was involved for the permit application, is no longer involved in this project phase (e.g. interviewee #11). Lastly, most interviewees (82%) identify the lack of enforcement of the specifications in the building permit as a common cause. Many reasons are given for this cause such as a lack in capacity, priority, and knowledge at the municipality. Interviewee #7 describes that up front there is a list of requirements, but that there is no capacity to make the audits and evaluate if the requirements are sufficiently met. That makes it impossible to verify if construction matches with the permit documentation.

Figure 5.4 Case #5: Screening measures are executed differently on the north and east edges; only smaller plants were found, planted scattered along the fence; The wintergreen hedge has not materialized; On the south side, the small plantings were overgrown with reed.

The discrepancies in the PV system lay-out are an example of a discrepancy in the functional dimension of the SPP development. The alterations are mostly done to improve the efficiency of the SPP. However, the altered PV system lay-out can have negative implications for the multifunctionality of the site. Functions that were presented to be realized in-between the arrays, such as herb- and or flower-rich grassland, cannot be executed and are either moved to another location or do not materialize at all. Furthermore, the identified discrepancies can lead to a very different experience compared to what is envisioned in the permit documentation. When PV systems have a different row distance or when arrays are higher it can become (much) more visible in the landscape. Finally, these discrepancies can have negative implications for the ecological values, for example when row-to-row distances are smaller this will decrease the amount of rain water and solar irradiation reaching the soil.

5.3.2. The experiential landscape: screening vegetation

The second main finding relates to the proposed screening of PV systems with vegetation. Screening is a spatial measure often proposed to meet concerns on visual impact and encourage local acceptance (Enserink et al., 2023). In the five cases we found 13 screening measures, all materializing differently than presented in the permit documentations. Three spatial measures were not realized (case #3; #5) and seven spatial measures were realized differently (case #2; #3; #5). Moreover, during the fieldwork we found three spatial measures that were not described in the permit documentation (case #1; #3), but fulfilled a screening purpose such as a fence with climbers or a hedge. When measures were realized differently, we found five situations in which the planted vegetation was too small to fulfil the screening purpose that was described and visualized in the permit documentation (case #2; #5) (Fig.5.4). In case #5 we found that different plant species were used instead of the proposed wintergreen vegetation. In case #3 a different type of vegetation was planted: climbers were replaced by a hedge.

Interviewees identified that a common cause for discrepancies in screening measures relates to the requirements for the permit approval. Several municipalities have high standards for screening vegetation to address local concerns (e.g. Gemeente Apeldoorn, 2020; Gemeente Montfoort, 2022). To sufficiently meet these criteria, the permit documentation shows the full-grown situation. Even though, interviewees admit that the vegetation screening the SPP will not look like that, at least not in the first years (e.g. interviewee #3). Several interviewees confirmed this cause, adding that they often include in wording that this is a final image and not the situation directly after construction (45%). Moreover, very small planting material is used to reduce costs. Reasons given to work with young vegetation are because this is cheaper and often more resilient than older, larger plants (e.g. interviewee #2). The practice of using small plants is confirmed by other interviewees (55%). Another often identified cause is that during construction of the SPP the installation of the PV panels is prioritized rather than planting the screening vegetation (73%). For example, several interviewees mention that not all developers take the soil and planting conditions into account in the execution (55%). A cause identified by most interviewees is the lack of proper maintenance (82%), while this is considered an essential aspect for vegetative screening measures (e.g. interviewee #11). Several interviewees noted that recently certain municipalities have improved their policy to counter some of these discrepancies in screening vegetation, for example by requiring a maintenance plan with the permit application (e.g. interviewee #4; #9).

The discrepancies in screening vegetation relate mostly to the experiential dimension of landscape quality. The lack of proper screening vegetation influences the landscape experience. When vegetation lacks cues of care, when vegetation dies or is not (well) maintained, it might negatively affect social acceptance through time (Wolsink, 2007). Furthermore, when such spatial measures are either not realized, are relocated, or when too small plants are used, this can have implications for the ecological quality and larger connectivity at a landscape scale. For example, screening vegetation can have a double function as habitat or even become part of ecological corridors. Lastly, discrepancies in screening vegetation can affect landscape quality in the long-term.

To illustrate, screening measures in the form of hedges, often restore former vegetation structures and subsequently strengthen existing landscape patterns. When discrepancies occur in terms of location (e.g. not following the existing parcellation) or materialization (e.g. use of not-native species) historical landscape characteristics may be negatively affected.

5.3.3. The ecological landscape: measures to increase biodiversity

TThe third main finding is that spatial measures for biodiversity are not executed (50%) or executed differently (39%) than documented. When we refer to spatial measures for biodiversity this includes measures for insect habitats, herb- and flower-rich grassland, and ecological banks. Of all 18 spatial measures identified in the permit documentation, only one measure was executed as described. We found that nine spatial measures did not materialize at all, this occurred in all five cases. Seven spatial measures were executed differently than proposed (case #1,#2, #5). Discrepancies are that spatial measures have been relocated, reshaped, or downsized, or that a spatial measure is missing cues of care and/or lacking proper maintenance (Fig.5.5). The latter made it hard to establish if measures were implemented or not, because of overgrown banks and areas (case #1; #5). One additional spatial measure was found: a herb- and flower-rich grassland that was not described in the permit documentation (case #4).

The most identified cause for discrepancies in biodiversity measures relates to the low priority that these ecological measures are given during the SPP development (82%). Interviewees illustrate that they are seen by developers as inessential to realize the SPP, and that the energy generation is the main focus and main revenue model (e.g. interviewee #8). Many interviewees (63%) identify a certain nonchalance in constructing these measures. Here again, they point at the lack of consideration of proper soil, planting, and seeding conditions by developers (e.g. interviewee #9). Elements like insect hotels are referred to as ‘additives’, and a developer will simply use one that is inexpensive and available immediately. Most interviewees identified a lack of local policies and criteria for enforcement of these spatial measures in the

Figure 5.5 Case #2: Strip with herb-rich grassland is relocated and fenced off for grazing sheep; Insect hotels are downsized and not aligned with the PV system; Natural banks proposed along the river are not constructed, and responsibilities are transferred to a third party without binding obligation to construct these banks.

building permit (82%). Some developers even encourage municipalities to improve their requirements, because they admit that if it is not obligatory and presses on the business case it will receive a low priority in the construction (e.g. interviewee #9).

The discrepancies in biodiversity measures mainly relate to the ecological dimension of landscape quality. These discrepancies have implications for the biodiversity in the area and can have effects on the soil conditions as well as the ecological connectivity. Moreover, these discrepancies can also affect the functionality of the SPP. Namely, the multifunctionality of a site is affected when spatial measures such as natural habitats are not executed. An SPP development cannot be considered multifunctional when only the PV system is built and the other functions are ignored during construction and maintenance (Oudes et al., 2022). Additionally, these discrepancies can have implications for the experiential dimension. For example, a SPP with herb- and flower-rich grassland potentially enables a more pleasant landscape experience (Van den Berg & Tempels, 2022). When these measures materialize differently or not at all, the landscape experience will be a different one than what was agreed upon. Lastly, properly realized and maintained biodiversity measures grow and mature over the twenty or thirty years the SPP is operational. Discrepancies in these measures lead to an unrealized potential of biodiversity measures contributing to the future use of the site, either when the SPP is decommissioned or repowered (Semeraro et al., 2018).

5.3.4. The temporal landscape: long-term landscape elements

The fourth main finding is that spatial measures intended to strengthen existing characteristics and qualities of the host landscape did not materialize (Fig.5.6). These measures, often larger vegetation structures such as tree lines, aim to strengthen landscape character beyond the (economic) lifetime of a SPP and relate to the temporal dimension of landscape quality. We identified five long-term spatial measures that address structural, larger landscape development: rows of trees (e.g. case #1; #2), larger hedgerows (case #1; #4) and ecological zones (case #5). The small number of spatial measures identified across the five cases exposes a limited consideration of the temporal dimension in SPP development. Even though scholars have argued

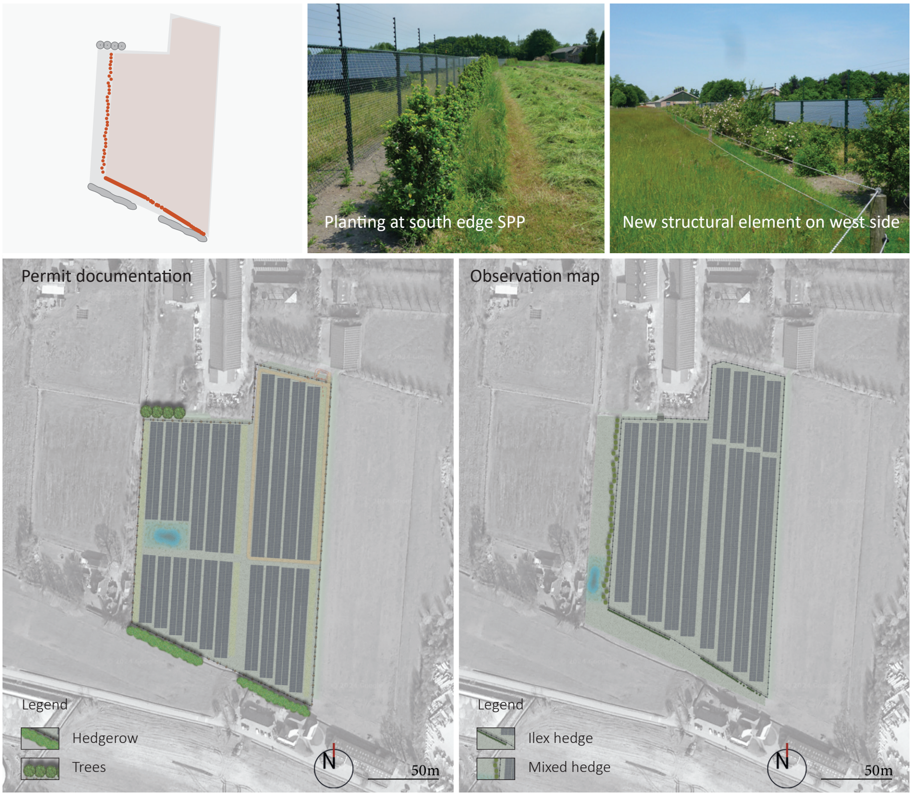

Figure 5.6 Case #1: Trees are missing on north side of the parcel; New hedge on west side presenting a new line element in the landscape; The proposed hedgerow did not materialize and is altered to a formal Ilex hedge on the south edge of the SPP.

that these landscape elements can potentially strengthen the future landscape even after decommissioning of the solar infrastructure, especially when they materialize early-on during the construction of the SPP (Oudes & Stremke, 2021). Moreover, in case #1 the replaced measures on the west and south edges of the plot introduce vegetation structures that are not aligning with existing characteristics but instead strictly relate to the configuration of the SPP (Fig.5.6).

The interviewees pointed to the strong focus of the developer on energy generation and financial feasibility (73%) as a common cause for discrepancies in long-term landscape elements. Interviewees note that the developer addresses landscape integration because they have to, not because they think it is important (e.g. interviewee #7). Moreover, these measures are seen as costly; Interviewee #5 illustrates that for example a hedgerow of 40 meters wide and 300 meters long will weight on the business case and that the national subsidy for SPPs does not cover or contribute to the costs of these landscape elements. In the assessment of the national subsidy scheme, they evaluate only the technical and financial feasibility of the SPP (RVO, 2023). Another commonly identified cause relates to the permit procedure (45%). Municipalities request several additional features to compensate for the SPP development, if these are not present in the permit documentation they will not give a permit. However, interviewees note that these measures are not necessarily profitable for the SPP development and that involved parties will include them in the documentation, but will reconsider executing them once the permit is approved (e.g. interviewee #1). Another cause identified by many stakeholders is the lack of clear permit requirements that lead to design drawings and documentation that are indicative at most and only contain limited specifications on how these measures should materialize (73%).

The discrepancies in long-term landscape elements affect the temporal dimension- or long-term quality- of a landscape. When measures misalign with existing characteristics and qualities of the host landscape the future use of the landscape is affected. When the SPP has reached end-of-life, the landscape contains 'alien' structures instead of improving existing landscape character. In case of decommissioning and restoring the original land-use (reversibility) the required vegetation removal leads to biodiversity decrease and another cycle of landscape change. This is a missed opportunity for 'upcycling' (Pasqualetti & Stremke, 2018), where performance of the present landscape exceeds that of the previous stage. However, much is still unclear about what will happen once the end-of-life of a SPP is reached since most cases have not reached this point yet. Furthermore, these measures are dominant in the design drawings and influence the interpretation of local stakeholders of what a SPP would look like. These measures not materializing can therefore have negative implications for the experience of landscape users. Lastly, this group of discrepancies has implications for ecological values, for example, larger rows of trees would improve biodiversity and wildlife habitats, as well as ecological connectivity.

5.4. Discussion

Together, these exemplary discrepancies provide an overview of the implications of built SPPs being different than agreed upon in the permit documentation and how this can affect the landscape quality. In particular landscape experience (experiential dimension) is under pressure, for example due to increased visibility of a SPP and the possibility of changing landscape characteristics, such as openness. However, all dimensions are affected: the multifunctionality of the SPP can decrease in comparison to the permit application (functional dimension); the SPP cannot deliver the prospected ecological connectivity (ecological dimension); and the SPP can become an alien structure in the landscape with limited connection to the host landscape (temporal dimension). Scholars have stressed that landscape quality is an important factor for local inhabitants to support landscape transformation (e.g. Bertsch et al., 2016). And that former negative experiences can nurture resistance and local opposition towards new SPP initiatives (Roth et al., 2018; Wolsink, 2007). Our findings present a clear call for strengthening the requirements and enforcement of permit procedures. This would ensure that broader societal concerns that are addressed by certain spatial measures in the permit documentation actually materialize on site. Future research could compare if improved permit requirements result in fewer discrepancies.

The causes that have been identified by the interviewees are related to different aspects and phases of the SPP development, for example the business case, permit procedures, regulation, enforcement, and maintenance. Firstly, the interviewees described a traditional techno-economic focus in the development of SPPs. Which meant that the business case outweighed broader societal concerns in decision-making (Enserink et al., 2024). This narrow approach to SPP development has implications for landscape quality, such as a diminished multifunctionality and less attention to measures to increase biodiversity or wildlife habitats. Although objectives for nature-inclusive measures are part of the national and municipal objectives for SPP development, they are not prioritized as a criterion in the national subsidy schemes (RVO, 2023). Secondly, it becomes obvious that there is a lack of clear, feasible permit objectives for the SPP landscape design, as well as a lack of requirements for detailed landscape designs. Current permit documentation includes a range of design drawings and visualisations, varying in scale level, detailing, and visualisation techniques. The presented measures and specifications are indicative. Moreover, from the interviews we learned that the landscape architect is obliged to present certain spatial measures to ensure permit approval, even when committed parties (e.g. a developer) know that these measures are not feasible in their business case. Presenting unfeasible spatial measures will not be beneficial for the local support of renewable energy projects on the long-term, when it appears that presented design drawings cannot be trusted (Enserink et al., 2023). Thirdly, the interviewees identified a lack in regulation and enforcement of the permit. Monitoring, evaluation, and clear consequences when discrepancies are identified is mostly absent due to a lack of knowledge, capacity and priority with the municipality. There are examples from wind energy developments in the USA of organized exchange between municipalities (Elmallah & Rand, 2022), which can benefit both the knowledge and capacity of municipal authorities to handle these type of complex developments. This exchange could for example be shaped as a community of practice within a certain region. Lastly, most interviewees (82%) referred to the inadequate landscape maintenance as common cause for discrepancies. Maintenance was either not well-arranged in advance, not considered in the design, not required by the municipality, or because more generally the priority was given to the technical aspects of the SPP.

Our results illustrate that the policy and subsidy requirements can be improved to enhance the inclusion of broader societal concerns in SPP design and development and simultaneously mandate landscape planning and design in this process. We see potential improvements along three lines:

The first, and larger prospect is to reformulate the assignment for SPP development on the national level. The new assignment could give a higher priority to broader societal concerns materializing in SPP development. This should compel developers to involve landscape planners and designers to work together until the final technical design iteration. In the next round of revisions of the national subsidy in The Netherlands a quality budget is included (RVO, 2024b), that can be an incentive for landscape designers to remain involved. A reformulation of the assignment could reposition landscape planning and design in the development process of SPPs and provide her/him with mandate and more freedom to truly site and design SPPs as a whole in their contextual landscape.

The second prospect would be to formulate sharper definitions and feasible requirements for the landscape design that is needed for the municipal building permit. For example, policymakers can require more detailing in the design on spatial measures that address these broader societal concerns, such as landscape quality. The requirements can be formulated as criteria for the level of detail in the design, such as map drawings and sections on a certain scale. These visualisations should be accompanied with clear communication and explanation of the different spatial elements, including their purpose and value for the larger landscape. Additionally, descriptions can include minimal standards for the quality and size of planting material considering the different types of vegetation. This second prospect also suggests a more explicit consideration of 'time' in design visualisations. Scholars have addressed both the necessity to visualize developments through time (Van Dooren & Nielsen, 2019) as well as consider the message a visualisation sends to its audience (Raaphorst et al., 2019). Misinterpretations of presented visuals by local stakeholders can influence their trust in the development (Enserink et al., 2023). Therefore, landscape designers should do more than note that these are final images in their documentation, which is the current approach to deal with this shortcoming (e.g. interviewee #11). Landscape designers need to propose and visualize only measures that are both realistic and robust to be executed. Moreover, they need to provide appropriate images of the different stages of (landscape) development, to foster communication and transparency among stakeholders and manage expectations. Furthermore, planners and designers need to be aware of the difficulties of lay-audiences to interpret visualisations and use visual aids in a careful and considered manner (Raaphorst et al., 2019). Earlier studies have shown that transparent communication through design visualisation can help to gain local support for SPP developments (Enserink et al., 2023). Additionally, a transparent cost estimation of these spatial measures, including costs for maintenance, can be requested as part of the business case. This would ensure that these costs are included early-on and would make it easier to evaluate their feasibility.

Lastly, the third prospect is that municipalities need to conduct audits on the constructed SPPs to monitor what spatial measures materialize and to enforce agreements that are not yet met. Preferably, audits will take place in at least two rounds: directly after construction and several years after completion. Municipalities can cooperate in regional networks or communities of practice to exchange knowledge and capacity (Elmallah & Rand, 2022). These procedural changes can motivate the SPP developer to continue working in close collaboration with local authorities and landscape designers, to ensure that requirements on broader societal concerns are well-embedded in the design and development of the SPP.

5.5. Conclusion

In conclusion, we found 79 discrepancies in five cases between what is agreed upon in the permit documentation and what is constructed on site. Through structured interviews we identified common causes for these discrepancies, relating to different aspects and phases of the design and development process of SPPs. Interviewees attributed discrepancies to the business case, permit procedures, regulation, enforcement, and maintenance. Overall, we conclude that the discrepancies in spatial measures have negative implications for the quality of their host landscape. Moreover, we found that visualisations present in permit documentation are often unrealistic, they lack a temporal perspective and only present the final landscape. This can lead to misinterpretations by local stakeholders, when they expect full-grown vegetation that screens the SPP and instead find small, scattered plants along a fence (Fig.5.4). Several studies stress the importance of visualisations being a form of communication and their increasing importance for trust of local stakeholders in the SPP developments (Enserink et al., 2023; Raaphorst et al., 2019).

To improve future practice, we suggest to reformulate the assignment of SPP development on national level, by prioritizing broader societal concerns in SPP development. This would compel SPP developers to work together with landscape designers until the construction phase, to coordinate and shape the technical and landscape design of the SPP along side each other. This would reposition landscape planning and design in the SPP development process and ensure a stronger mandate and more freedom to site and design landscape-inclusive SPPs Moreover, municipal permit requirements can be sharper defined to limit the room for interpretation and increase the chance of spatial measures materializing. These changes in policy and SPP development practice, are needed to maintain landscape quality as stipulated for example by the European Landscape Convention (Council of Europe, 2000). Moreover, improved practices will give rise to new solar landscapes that can count on increased local acceptance.

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CRediT authorship contribution statement

Merel Enserink: Conceptualization, Methodology, Validation, Investigation, Data curation, Visualization, Writing – original draft; Vincent Klaaskate: Methodology, Investigation, Visualization; Dirk Oudes: Conceptualization, Writing – review & editing, Supervision; Sven Stremke: Funding acquisition, Conceptualization, Writing – review & editing, Supervision.

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photo SPP De Kwekerij, Hengelo (NL). Photo credit D. Oudes.

Discussion and conclusion

A critical reflection on the rise of solar landscapes.

Chapter 6

Discussion and conclusion

A critical reflection on the rise of solar landscapes.

With this thesis, I address the gap between environmental and socio-cultural objectives held by society and described in policy guidelines on the one hand and the current practice of solar power plant (SPP) development in The Netherlands on the other hand. The following research question guided the work presented in this thesis: What are the key activities to advance the co-designing of solar landscapes[6] in which techno-economic objectives are balanced with environmental, and socio-cultural objectives? The research question informed four research modules in which I examined the design and development process of recent SPP projects in The Netherlands. The research modules were guided by four sub research questions:

1. What is the synthesis between the fields of acceptance studies on renewable energy and landscape design studies and how do these bodies of knowledge complement each other?
2. What is the influence of a co-designed full-scale prototype on the local support of a SPP?
3. What are the benefits and limitations of participatory design processes in SPP development in The Netherlands, and what are the possible implications for energy policy?
4. What can be learned from the discrepancies between permit documentation and built reality of SPPs in The Netherlands to better balance techno-economic objectives with environmental, and socio-cultural objectives?

[6] Solar landscapes are, in contrast to SPPs, ground-mounted PV systems that are designed as an element of the host landscape by using an integral design approach (Scognamiglio, 2016).

In this final chapter, I first summarize the findings from the four research modules in section 6.1.1. Then, I reflect on these findings by placing them in the larger perspective of transition management (after Loorbach, 2007, 2010) (section 6.1.2). Transition management presents a framework that distinguishes four types of activities that work in an iterative manner to organize a transition: strategic, tactical, operational, and reflexive activities (Loorbach, 2007, 2010). This framework allows me to illustrate where current SPP development exposes shortcomings and opportunities and to articulate key activities that give rise to solar landscapes. These key activities are described and discussed in section 6.1.3. In section 6.2 I discuss the limitations of the research presented in this thesis. In section 6.3, I provide recommendations that offer a foundation for the key activities to advance the co-designing of solar landscapes. In section 6.4, I discuss the scientific and societal relevance of the research in this thesis. Lastly, in section 6.5, I present the main conclusion regarding the advancement of current SPP development practices.

6.1. Discussion

6.1.1. Main findings of the research modules

In the first research module (chapter 2), I explored the synthesis between acceptance studies on renewable energy and landscape design studies through a systematic literature review (Gough et al., 2017; Grant & Booth, 2009; Mengist et al., 2020). Scholars in both fields acknowledge the large impact that renewable energy technologies can have on people's daily environments, and that it can be difficult for local stakeholders to support such landscape transformations (e.g. Bertsch et al., 2016; Pasqualetti & Stremke, 2018). Both fields acknowledge that local support is a key for a successful and timely transition to renewable energy (e.g. Apostol et al., 2017; Scognamiglio, 2016). In total, I found over 80 factors in the peer-reviewed literature that influence the acceptance (support or opposition) of renewable energy projects. The identified acceptance studies describe 45 unique factors such as transparency and trust. The landscape design studies describe 16 unique factors such as landscape narrative and multifunctional land-use. The two fields describe 25 similar factors. When comparing these factors described in the peer-reviewed literature to a recent study on community perception of a SPP by Roddis et al. (2020), I found a gap between the emphasis placed on factors by laypersons and the current research agenda. Moreover, the results showed that both fields could benefit from more collaboration between these fields of study. Furthermore, acceptance studies could research the influence of design processes on local support and opposition, and landscape design studies could acknowledge a larger set of factors that are currently overlooked in design practice.

In the second research module (chapter 3), I explored the influence of a co-designed full-scale prototype on the local support of a SPP in one real-life case: Nauerna (NL). The research involved embedded action research (Deming & Swaffield, 2011; Riel, 2019). The findings evidence that the full-scale prototype helped to break the status quo bias (see Linnerud et al., 2019) by improving the local understanding of the proposed landscape transformation and its potential visual impact on the daily environment (Fig.6.1). The prototype and related design interaction had a positive influence on local opinions regarding the development of a SPP: 81% of the participants responded positive or very positive to this SPP development in their direct surroundings (Box 6.1). Based on these results, I conclude that a full-scale prototype has a positive influence on local support. Moreover, the active involvement of the local community proved to be important for local support, which is in line with the work of other scholars (Fenton et al., 2016; Macarthur, 2016; Oughton, 2008). Furthermore, I found that even in the face of initial local opposition, an inclusive participatory design process can provide possibilities to address opposing views at early stages and to investigate design alternatives. These research findings are in line with studies on procedural justice (e.g. Peuchen et al., 2024; Walker & Baxter, 2017), and illustrates that the active involvement of local stakeholders in the siting, design, and development of SPPs - in which they can truly affect the outcomes - presents an important factor in strengthening local support.

Box 6.1 Possibilities to design a SPP

The In My Backyard Please project (IMBYP) in Nauerna had an innovative character, which allowed the participants more possibilities in designing a SPP. For example, by providing the possibility to design prints on the PV panels (Fig.6.1). These prints reduce the efficiency of the PV panels with approximately 15%. The survey evidenced that local inhabitants preferred the printed panels over the regular PV panels (90,5%). Respondents also acknowledged that adding the printed panels in the design would make it possible to build the SPP on this contested location. On locations where SPP development is strongly contested by local stakeholders, it presents a valuable intervention to discuss the use of prints on PV panels to allow for a SPP to be built, opposed to not constructing a SPP at all. To the best of the authors knowledge, present-day ground-mounted SPP developments do not yet make use of prints on PV panels at any significant scale.

Figure 6.1 Full-scale prototype built on site that showcases different design ideas developed in co-design sessions with local inhabitants. Photo credit R. Van Etteger.

In the third research module (chapter 4), I rendered a number of recommendations for energy policy based on the assessment of the benefits and limitations of participatory design processes in SPP development in The Netherlands. Here, action research and research through designing (RTD) were employed (Deming & Swaffield, 2011; Lenzholzer et al., 2017) while I worked as an embedded designer in the three cases of the EnergyGarden-project. Based on this multiple-case study, I found that participatory design processes benefit local inhabitants to mandate their concerns related to the perspective SPP development. The inclusion of professionals secured more attention to environmental and socio-cultural objectives, which is a relevant advancement in the sustainable development of SPPs (Scognamiglio, 2016; Stremke & Schöbel, 2019). Moreover, the involvement of several stakeholder groups contributed to the procedural justice, which is in line with Knudsen et al. (2015) and Walker & Baxter (2017). However, I also found that concerns mandated by local inhabitants at project level (e.g. visibility) do not always align with broader societal concerns such as landscape quality. In one case, inhabitants argued for large screening vegetation along the parcel edge to reduce the visibility of the PV system from the surroundings. This measure, however, does not fit with the character of the open polder landscape in which this SPP would be located. Moreover, the participatory processes illustrated a disbalance in stakeholders' abilities to affect the outcomes. Which meant that measures proposed by professionals were more likely altered or removed from the design than those proposed by local inhabitants. Furthermore, I found a lack of clear definitions for environmental and socio-cultural objectives in policy, and that these objectives are not considered binding requirements for a building permit nor for the renewable energy subsidy. This further decreases the chance of spatial measures addressing environmental and/or socio-cultural objectives to materialize in SPPs. Based on these findings, I recommend improving municipal policy, or directly changing national subsidy requirements. First, by providing better definitions of environmental and socio-cultural objectives as binding requirements for permit or subsidy requests. Second, by improving the balance of involved stakeholder groups and their abilities to affect the decision-making in SPP design processes.

In the fourth research module (chapter 5), I examined five constructed SPPs in The Netherlands on the discrepancies between legal permit documentation and built reality. The employed post-occupancy evaluation (Chen et al., 2023; Roberts et al., 2019) exposed 79 discrepancies in spatial measures (e.g. adjusting the row distances of the PV system, or planting smaller screening vegetation). The causes for discrepancies were identified through structured interviews (Fowler, 2012; Weller, 2007) with key stakeholders. The causes relate to a broad range of stages in the SPP development process where discrepancies arise. The results illustrate that the discrepancies can have negative implications for landscape quality. In this particular research module, landscape quality was used as a proxy for broader societal concerns, covering environmental and socio-cultural objectives. The tension on landscape quality showcased an imbalance of objectives materializing in current SPP development processes. These results point towards what one may call a 'conventional approach' to SPP development that is focussed on techno-economic objectives, and in which many environmental and socio-cultural objectives disappear. Based on these findings, I argue to improve the position of landscape architects, to provide them with more mandate and possibilities to use their knowledge of the landscape and skills in (participatory) designing to design solar landscapes. Landscape architects can bridge various gaps in the SPP development processes (e.g. Kempenaar et al., 2024; Van den Brink et al., 2019). They can play an important role in spanning the boundary between stakeholders, as well as closing the gap between permit documentation and built reality. To realize this mandate and improve current SPP practices, I recommend a higher priority of environmental, and socio-cultural objectives on national level and stricter definitions of these objectives in binding permit requirements on the municipal level.

6.1.2. Status quo of SPP development: shortcomings and opportunities

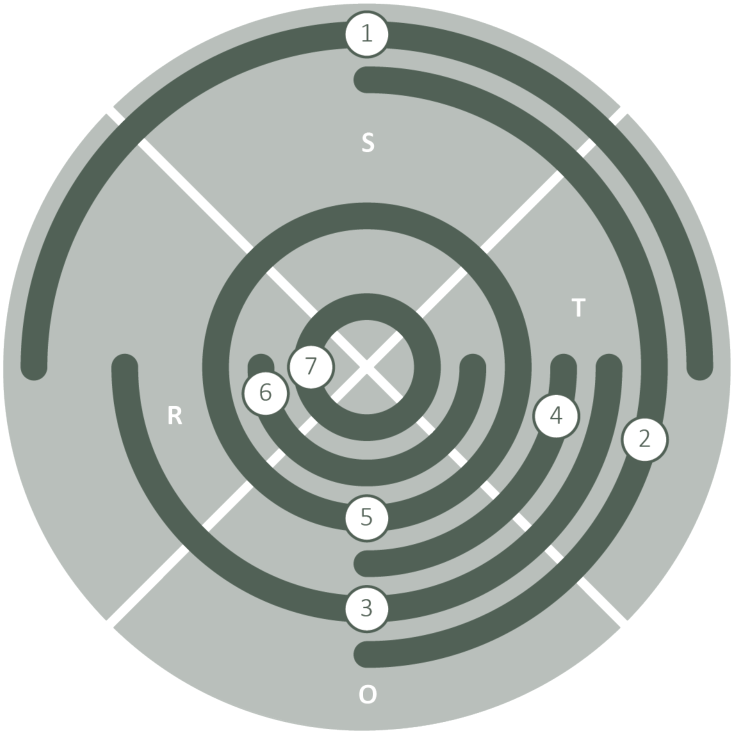
Based on the findings of the research modules, I detected gaps between established knowledge and current practice of SPP development. There is a large body of scholarly work on sustainable energy landscapes arguing the importance of including environmental and socio-cultural objectives (e.g. Oudes et al., 2022; Scognamiglio, 2016; Stremke, 2015; Stremke & Van den Dobbelsteen, 2013). Moreover, there is a substantial body of scholarly work on transition management, stating the importance of well-organized processes to guide a transition (e.g. Ernst et al., 2016; Loorbach, 2010; Proka et al., 2018; Wittmayer & Loorbach, 2016). The findings from the research modules, however, evidence a gap between environmental and socio-cultural objectives as well as knowledge on organizing this transition on the one hand, and current practices of SPP development in The Netherlands on the other hand. Several practices in the SPP development expose shortcomings. These shortcomings are, for example, the imbalance of local and broader societal concerns in participatory design processes, and discrepancies between permit documentation and built reality of SPPs. More often than not, the environmental and socio-cultural objectives that were stated at the beginning of SPP projects are disappearing during the SPP development. Many results in this thesis point towards a techno-economic focus in SPP project development which makes it difficult for other objectives relevant to society to materialize. To address the imbalance between techno-economic objectives with environmental, and socio-cultural objectives in SPP development, it is necessary to initiate change through a series of key activities.

I used the transition management framework developed by Loorbach (2007, 2010) to reflect on the findings of the research modules. This framework enabled me to consider a SPP development process as a system, which allows me to discuss where shortcomings occur in the overall approach of SPP development and where different activities can advance the co-designing of solar landscapes. The research performed in this thesis relates to different types of activities of transition management, described by Loorbach (2010) as *strategic*, *tactical*, *operational*, and *reflexive* activities. The research presented in chapter 2 represents agenda setting, a *tactical activity*, emphasizing the factors that should be addressed in SPP development to gain local acceptance. The research presented in chapter 3 and 4 comprises experimental pilots, an *operational activity*, in which different approaches are tested with the aim to learn and implement the findings in future SPP development. The research presented in chapter 5 evaluated the status quo of built SPPs, a *reflexive activity*, concerning discrepancies and their causes, to signal deficiencies in the construction of SPPs and to reflect on the role of landscape architects.

When reflecting on the findings from the research modules with regards to the transition management framework, I identify challenges for each of the four types of activities in current SPP development. Regarding the *strategic activities*, I find that environmental and socio-cultural objectives lack priority in policy documents to be included in SPP development. Policymakers are unaware of the imbalance between the environmental, and socio-cultural objectives that they describe as ambitions in policy guidelines, and the techno-economic objectives with which they assess new project plans for permit or subsidy approval (chapter 4 & 5). The latter is reflected in *tactical activities* too, where policy documents lack definitions and binding requirements for environmental and socio-cultural objectives for SPP development. Furthermore, the agenda setting of SPP development should address the imbalance between stakeholders' abilities to affect decision-making in participatory design processes of SPPs (chapter 4). Regarding *operational activities*, I detect that the potential of co-designing is not yet utilized in SPP development, nor is the importance fully recognized of early and inclusive participatory processes and their potential to address status quo bias, local values, and place attachment (chapter 3). Moreover, the findings from chapter 5 point to a lack in enforcement of permit agreements at constructed SPPs, which cultivates discrepancies in built SPPs. The latter also relates to *reflexive activities*, where I discovered a lack of monitoring of built SPPs (chapter 5). Overall, I identified a lack of reflection and feedback between the different activities in SPP development. The lack of feedback mechanisms makes it difficult to implement lessons learned in future SPP development processes. At the same time, the findings from the research modules present opportunities that can support advancing current SPP practice. The findings of the research modules provide a starting point for a critical reflection on the current quantitative and qualitative targets of SPP development (chapter 2 & 5). Moreover, the recommendations from the co-design processes tested in chapter 3 & 4 provide guidance for a co-design approach that addresses the procedural justice of participatory processes, in which early participation, inclusion of local inhabitants, ability to affect outcomes, transparency, and trust are important factors. Lastly, the research shows that the skills and knowledge of landscape architects can be better utilized, by providing them with more mandate and possibilities to design SPPs as a whole in their contextual landscapes (chapter 4 & 5). These shortcomings and opportunities indicate the necessity of and possibilities for a better SPP development process. A process, that addresses the current imbalance of techno-economic objectives with environmental, and socio-cultural objectives and that guides the implementation of solar landscapes in people's daily environments. Based on the research findings, I call for adaptations in the different practices related to the implementation of SPPs to become more sustainable.

6.1.3. Key activities to advance the co-designing of solar landscapes

Based on the research presented in this thesis, I articulate seven key activities that advance the co-designing of solar landscapes. These key activities establish a balance of techno-economic objectives with environmental, and socio-cultural objectives and address co-designing processes to include both local and broader societal concerns. The seven key activities are: 1) Composing a vision for co-designed solar landscapes; 2) Defining criteria for environmental and socio-cultural objectives; 3) Facilitating early and inclusive participation of stakeholders; 4) Balancing stakes and stakeholders in decision-making; 5) Empowering the landscape architect; 6) Organizing quality control and monitoring; And 7) Establishing feedback mechanisms. Each of the key activities is linked to multiple types of activity as described by Loorbach (2010): strategic, tactical, operational, and reflexive activities. The key activities often require the interaction between these different modes of operation to be established and function well (Fig.6.2). In the following, each key activity is discussed individually and in coherence as these activities together advance the co-designing of solar landscapes.



Strategic, **T**actical, **O**perational, and **R**eflexive activities:

- ① Composing a vision for co-designed solar landscapes
- ② Defining criteria for environmental and socio-cultural objectives
- ③ Facilitating early and inclusive participation of stakeholders
- ④ Balancing stakes and stakeholders in decision-making
- ⑤ Empowering the landscape architect
- ⑥ Organizing quality control and monitoring
- ⑦ Establishing feedback mechanisms
- ▬ Connection to other modes of operation

Figure 6.2 Overview of seven key activities to advance the co-designing of solar landscapes, which are placed in the transition management framework to identify with the types of activities: Strategic, Tactical, Operational, and Reflexive (after Loorbach, 2010).

Activity 1 Composing a vision for co-designed solar landscapes

The research findings point towards the lack of a clear vision on co-designed solar landscapes (chapter 3-5). So far, SPP development is driven by a conventional techno-economically oriented approach, which results in the development of monofunctional SPPs. Recent policy requirements, however, state that new SPPs should realize multiple functions to be eligible for a permit (Rijksoverheid, 2023). This necessitates a reformulation of both quantitative and qualitative targets for SPPs on the national scale, giving rise to solar landscapes. A vision that refocuses from technical to social modes of thinking (Bickerstaff et al., 2024; Linnerud et al., 2019).

This new vision needs to incorporate and balance all four dimensions of sustainability described by Stremke (2015): technical, economic, environmental, and socio-cultural. The vision could draw from the concept of a landscape inclusive energy transition by Oudes (2022). Furthermore, when composing a new vision one should be aware of the present-day attention of many scholars to a selected group of factors for acceptance of renewable energy that differs from laypeople's interpretation (see chapter 2). The vision for co-designed solar landscapes will benefit from clearer definition and consideration of the many factors influencing local support and opposition.

The key activity "composing a vision for co-designed solar landscapes" is considered a strategic effort, but also requires tactical and reflexive modes of operation (e.g. evaluating current experiences and translating the insights into new agendas). A first step would be to evaluate the current national target for SPP development in a network of representative stakeholders. The efforts of creating such a vision can rely on earlier experiences and lessons learned in other endeavours, such as the Dutch Klimaatakkoord (Rijksoverheid, 2022) and Regional Energy Strategies (Nationaal Programma RES, 2024b).

Activity 2 Defining criteria for environmental and socio-cultural objectives

With the research presented in chapters 4 and 5, I show that today's policy lacks regulations and clear definitions to effectively incorporate environmental and socio-cultural objectives in SPP development. The emphasis of permit and subsidy requirements on techno-economic objectives withholds the materialization of both environmental and socio-cultural objectives in the current practices of SPP development.

Permit and subsidy requirements need to include environmental and socio-cultural objectives to stimulate the co-designing of solar landscapes. First, the assessment criteria of the national subsidy scheme need to be adapted to valorise its full potential. A first step in this direction is recently established by including a 'quality budget' for environmental measures in the last revision round of the national subsidy scheme (RVO, 2024b). Second, the criteria for environmental and socio-cultural objectives need to be sharper defined in municipal permit requirements. With sharper definitions it becomes easier to apply these definitions as binding criteria for project development to assess the plans that are submitted for permit approval.

The key activity "defining criteria for environmental and socio-cultural objectives" relates to tactical, strategic, and operational efforts. The typology of SPPs by Oudes et al. (2022), among others, can help to define criteria for assessing plans for new SPPs on their impact on and contribution to the existing landscape. The authors make a distinction between mixed-production, nature inclusive, and landscape inclusive SPPs (Oudes et al., 2022). Moreover, in the permit application these criteria for environmental and socio-cultural objectives must be assessed to improve their chance of materialization (see also key activity 6). As described in chapter 4, this assessment can be done by civil servants or this responsibility can be delegated to a committee of experts and local stakeholders. In The Netherlands, there are valuable experiences with so-called 'quality teams' for instance in the field of water management (Klijn et al., 2013).

Activity 3 Facilitating early and inclusive participation of stakeholders

The findings of chapter 3 point to the importance of early and inclusive participation to strengthen local support of SPPs, which is in line with earlier studies (e.g. Fenton et al., 2016; Oughton, 2008; Walter, 2014). Early and inclusive processes have the potential to address status quo bias, local values, and place attachment. However, co-designing is not yet common practice in SPP development (chapter 2 & 3), and socio-cultural factors for local support and opposition of SPPs such as trust are hardly considered in current practices (chapter 2).

In The Netherlands, at this point in time, the facilitation of participatory processes is the responsibility of the developing party (Rijksoverheid, 2019b). That is why developers need to be made aware of the benefits of organizing early and inclusive participatory processes. That will increase their understanding that additional effort early-on in these processes helps to build trust and support in the SPP development and can even reduce local opposition (and associated risks) in later phases, as experienced in the EnergyGarden-project.

The key activity "facilitating early and inclusive participation of stakeholders" requires operational, tactical, and reflexive efforts. To implement this key activity, municipal policy guidelines must be improved by clarifying the aim for the participation and the expected output of these processes (Uittenbroek et al., 2019). Moreover, these participatory processes can draw from studies as presented in chapter 3. First, by considering factors of procedural justice when arranging participatory processes (Walker & Baxter, 2017). And second, by initiating an iterative design process in which involved stakeholders can learn together while designing. This ensures the inclusion of local knowledge in the design and positively influences the support of stakeholders (Breukers & Wolsink, 2007; d'Hont & Slinger, 2022).

Activity 4 Balancing stakes and stakeholders in decision-making

Based on the research in chapter 4, I observe an imbalance between stakes and stakeholders' abilities to affect the decision-making. In this research, I find that local concerns are often individually oriented (e.g. visibility) and do not always align with broader societal concerns, such as landscape quality. The critical position of the local inhabitant was earlier discussed by Oudes (2022), who argues to consider the concerns of the landscape user instead of focusing on inhabitants only. In the EnergyGarden-project (chapter 4), the input of professionals ensured more attention for broader societal concerns. However, this is not yet common practice in The Netherlands. For SPP development to become more procedurally just, different stakeholder groups must be mandated in the decision-making related to the stakes that they represent.

Policy can facilitate a balance of stakeholders to be included in the participation and their abilities to affect the decision-making. Moreover, policymakers can provide guidelines on the expectations and aim of participatory processes, as stressed by Uittenbroek et al. (2019). This would contribute to establishing procedural justice in SPP developments (Walker & Baxter, 2017).

The key activity "balancing stakes and stakeholders in decision-making" requires both tactical and operational efforts. Policy should establish requirements on the (mandatory) inclusion of certain professionals who can mandate broader societal concerns, such as ecologists or nature and/or landscape NGOs. However, the balance of stakeholders and their stakes can vary per project, based on the local context. This balance needs careful consideration when operationalized. The systemic view of four participatory repertoires developed by Metze et al. (2023) can help to bridge the gap between policy and society, and clarify the expectations and aim of participatory processes.

Activity 5 Empowering the landscape architect

The research in chapter 4 and 5 points toward the limited role and little mandate of landscape architects in present-day SPP development in the Netherlands, if any. Building on the findings of this thesis, I argue that the discipline of landscape architecture should have a more prominent role in the SPP design and development based on their knowledge and skills in landscape development and ability to address complex challenges such as co-designing solar landscapes (e.g. Scognamiglio, 2016; Stremke & Schöbel, 2019).

The qualitative target for SPP development must be reformulated on the national level, providing landscape architects with more mandate and possibilities to fully utilize their knowledge and skills to design solar landscapes as a whole in their host landscapes. This also relates to key activity 1 and 2. The discipline of landscape architecture must advocate to become a primary partner in the siting, design, and development of SPPs because it is capable to deliver designs at relevant scale levels, bridge differences between stakeholders, and clearly communicate the narrative of this landscape transformation (Sijmons & Van Dorst, 2013).

The key activity "empowering the landscape architect" requires operational, strategic, reflexive, and tactical modes of operation. First, the qualitative target for SPP development should be critically reviewed and reformulated to create more mandate for landscape architects. As suggested above with respect to activity 2, such a mandate can be established by adapting the national subsidy requirement and municipal permit criteria, to compel developers to collaborate with landscape architects. Furthermore, landscape architects are of value, offering their knowledge and skills to strengthen earlier mentioned quality teams (see key activity 2) or to envision long-term landscape transformation perspectives that include the deployment of solar landscapes (Baptist et al., 2019; Stremke et al., 2012; Voskamp et al., 2023).

Activity 6 Organizing quality control and monitoring

The findings of chapter 5 daylight discrepancies between what has been built and what was agreed upon and documented in the permit application of SPPs. An often-acknowledged cause for discrepancies is the lack of monitoring and enforcement of municipal permits for constructed SPPs. The municipal practice of audits or monitoring is mostly absent, which sustains the imbalance of environmental and socio-cultural measures materializing in SPPs. Moreover, it can even counteract possible efforts in associated participatory processes to a procedural just SPP development, by not constructing the locally agreed upon design of the SPP.

Municipalities are responsible for the building permit and should therefore gain capacity and knowledge on monitoring and enforcing these legal agreements. When municipalities are unable to establish their own monitoring, they could cooperate in regional networks or communities of practice to exchange capacity and knowledge between municipalities (see Elmallah & Rand, 2022). Based on the research in chapter 5, I argue that municipalities should conduct at least two audits on the constructed SPP (e.g. directly after construction and several years after completion) to enforce agreements that are not yet met.

The key activity "organizing quality control and monitoring" requires reflexive, tactical, and operational efforts. On the municipal level, there should be guidelines on how to assess permit agreements and conduct audits. Municipalities should acquire knowledge and capacity for these assessments. Moreover, municipalities must evaluate if regulations of the permit are followed, and to enforce the permit agreements or consider to withdraw permits when requirements are not met within an acceptable time after net connection of the SPP. This practice can build on the experiences of other spatial policy developments such as pilots of the Dutch Environment and Planning Act (e.g. Gemeente Staphorst, 2019) and earlier mentioned quality teams (e.g. Klijn et al., 2013).

Activity 7 Establishing feedback mechanisms

Based on the findings of all research modules, I identify a lack in reflection on current practices and a lack of feedback mechanisms in SPP development. These lacks hinder SPP practices to become more sustainable and avert the rise of co-designed solar landscapes. Without well-functioning institutionalized feedback mechanisms, it will remain difficult to implement lessons learned in future policy and other practices.

To establish feedback mechanisms, one can draw lessons from the yearly evaluation of the national policies performed by the Dutch Environmental Assessment Agency (in Dutch: Planbureau voor de Leefomgeving). They assess to what extend policy is working and advise on possible adjustments, such as the monitor for the Dutch Regional Energy Strategies (Matthijsen et al., 2023). The success of these monitors relies, among others, on the independent position of this agency. A similar practice can be established for SPP development, to increase the feedback between different authorities, regions, and involved stakeholders, as well as between different activities that are performed in SPP development.

The key activity "establishing feedback mechanisms" relates to reflexive, strategic, tactical, and operational efforts. Institutionalizing a feedback mechanism in SPP development requires impartial reflection on current practice and facilitation of exchange between involved stakeholders. All relevant data and previous experiences should be recorded in an online, open access database to further strengthen the learning capacity of involved stakeholders (Taanman, 2014; Wittmayer & Loorbach, 2016).

When initiating the seven key activities, it should be considered that they relate to different levels of authority (e.g. national, provincial, municipal), scales (e.g. national, regional, local), and different stakeholders (e.g. developers, policymakers, landscape architects, and civil servants). Moreover, the implementation of key activities requires a reflexive practice (Prominski, 2019; Riel, 2019) to better understand what happens when an activity is implemented and examine what other (key) activities, authorities, and stakeholders it affects. Initiating the key activities can be seen as a first proposition. The key activities need reflection to improve them while they cannot be all-encompassing. Simply because there are so many factors and activities influencing SPP development: Each project context is different, each process is different, and therefore each result will be different. Nonetheless, the potential and positive effects of implementing these key activities in SPP development are abundant in the research presented in this thesis. These are reflected in the local response on the participatory design processes in the EnergyGarden-project (chapter 4), and in the local support for a SPP on a contested location in the IMBYP-project (chapter 3). These cases show small steps forward in the co-designing of solar landscapes, by refusing the status quo of current SPPs and challenging both the development process and design of SPPs. Of course, as these are pilot projects, not all ambitions and objectives materialize. However, the results highlight the potential of mandating broader societal concerns, environmental and socio-cultural objectives, and designing solutions through early and inclusive participatory processes.

6.2. Limitations

The research presented in this thesis had its limitations in resources and time. Moreover, the research took place in a dynamic context employing in-depth case-studies and action research which clearly benefited the presented research but also implied additional limitations.

6.2.1. Designing SPPs in real-life projects

The focus of this thesis was on densely populated countries, with The Netherlands as example (see section 1.6.2). The research was conducted in The Netherlands because of the opportunity to participate as an embedded action researcher in two real-life projects focussing on co-designing perspective solar landscapes: IMBYP and EnergyGardens. To conduct embedded action research, the researcher needs to be able to join without too much hindrance of travel, logistics, and language (Chevalier & Buckles, 2019; Kindon et al., 2007). However, the findings of this research are somewhat limited by the choice to perform the research in a specific country with a high-population density and a scarcity of space to allocate renewable energy infrastructure. Thus, the findings of the thesis primarily relate to the context of The Netherlands and to some other western countries with comparable conditions. Furthermore, the research was set in a country where democratic processes and local consultations are mandatory in the planning and development of SPPs. This further limits the findings to countries where residents feel called upon to participate and oppose certain landscape changes, because they can be concerned beyond functional or economic values that are represented in a landscape. Although this scope is narrow, the larger premiss of balancing techno-economic objectives with environmental, and socio-cultural objectives in SPP development is not limited to the Dutch context (Virah-Sawmy & Sturmberg, 2025). Several studies affirm the necessity to improve the quality of SPP development to strengthen local support for SPPs (e.g. Bevk & Golobič, 2020; Scognamiglio, 2016), as well as the embedding of SPPs in the larger host landscape (Oudes et al., 2022; Stremke & Schöbel, 2019; Stremke & Van den Dobbelsteen, 2013).

In the set-up of the research projects, the intended RTD was affected by the real-life setting of the projects. RTD is practiced through an iterative process in which designing informs the research (Lenzholzer et al., 2013, 2017). RTD was initiated in the EnergyGarden-project, to improve the learning capacity of the project. The iterative process of RTD ensured that participants in one case could learn, and by phasing the design sessions of the three cases there would be feedback loops to enable that cases could learn from each other. In practice, the reflection and lessons learned were mostly limited to a single case. The additional reflection between the cases and the internal dissemination of knowledge was challenged by daily practice. Project partners in one case would ask for a new design iteration at a for them suitable moment, which was not necessarily aligned with the intended feedback loops. This limited the cross-case learning. However, the RTD strengthened the co-design process of the single cases, where it allowed for reflection within the local context to implement lessons learned in the set-up of next sessions.

Furthermore, participatory processes are seen as the most ethically defensible way to transform the daily landscape (Macarthur, 2016). However, the procedural justice of such processes is dependent on the way people can participate (Walker & Baxter, 2017). In this research, the procedural justice of the co-design process was evaluated in the IMBYP-project (see chapter 3). The importance of procedurally just participatory processes had been acknowledged in the EnergyGarden-project. Being embedded in these three participatory design processes, I witnessed many different approaches to establish procedural justice in these cases. I observed that the people involved acted to the best of their knowledge. However, these processes could be further improved if they are properly consulted during the timeframe of the project and evaluated afterwards on how they managed to establish procedural justice.

6.2.2. Employing in-depth case studies

The choice to employ in-depth cases studies in which the researcher is embedded in real-life processes potentially challenges the validity of the results (Kumar, 2014). The choice for embedded action research limited the number of studied cases, because this type of research approach is known to be time intensive (Chevalier & Buckles, 2019; Kindon et al., 2007). A limited number of cases can make it difficult to generalize broader knowledge. Flyvbjerg (2006) counters this argument to some extend by stressing the value of studying a case in-depth to gain more detailed knowledge. By embedding myself in four cases, I gained unique data sets on these local processes (Thering & Chanse, 2011). It allowed me to study the particularities of these cases to better understand the local dynamics. With these insights the research contributes to broader applicable knowledge for co-design processes in the development of solar landscapes.

Being embedded as a designer meant that I not only influenced the design process, but that I also delivered one pivotal outcome of this process: the design. As designer, I facilitated design sessions, provided design plans and documentation, sparred with project partners, and provided feedback on the process and development of the plans. At the same time, as researcher, I needed to observe what was happening in the process and describe this in an objective manner. This double role of researcher and designer was challenging at times. However, the insights gained through embedded action research could not have been achieved by only observing the process or by analysing a certain moment in these processes (Thering & Chanse, 2011). The embeddedness provided me with insights in the considerations that were made along the way, it made me aware of alternatives that were discarded in the process, and being a designer I could actively influence the alternatives considered. To limit the influence of my bias on the results, I kept personal logs of all meetings, and during most design sessions several researchers were involved to ensure triangulation of the data to safeguard the validity of the findings (Kumar, 2014). Moreover, in all cases the (preliminary) results were shared with project partners to receive their feedback and validate that the interpretation of the researcher aligned with others (Creswell, 2009; Kumar, 2014).

6.2.3. Working in a changing, dynamic context

The larger context in which the research for this thesis took place was very dynamic and had implications for the performance of the research, the data collection, and resulting conclusions. In my research, I dealt with local dynamics in the contexts of the two projects, as well as larger dynamics that affected the broader society: Covid-19 and a changing political situation. The chosen research approach, embedded action research, needs to be performed in real-life situations to deliver genuine insights. The results would not be as valuable when the study was performed in a controlled environment, isolated from these dynamics, because the context determines the success or failure of a certain process and the resulting product (i.e. the design) (Reason & Bradbury, 2008; Riel, 2019).

The research performance and the overall planning of the research were affected by the Covid-19 pandemic and associated regulations. The Covid-19 regulations necessitated some of the work to be done at distance, in online settings. This caused challenging situations in the interaction with local stakeholders. In chapter 3, I refer to these difficulties because the online setting could have affected the local response on the presented visuals in one of the sessions. In hindsight, the online setting did not change the participants interpretation of the visuals, but did make it more challenging to facilitate a conversation and truly understand each other (Raaphorst et al., 2019). More generally, I missed the face-to-face interaction with peers and supervisors during Covid-19, which was limited due to having to work from home. In addition, the informal exchanges with colleagues became non-existent. This did not negatively affect the quality of the work but did slow down the progress of the work. The resulting additional time and efforts were not compensated by the university and/or the Dutch government.

Lastly, during the timeframe of my research there were fundamental shifts in the Dutch political landscape that affected the object of my research. In 2022, there was a shift on provincial level which was mirrored in the Dutch national elections of 2023. The new political climate resulted in an embargo for new monofunctional ground-mounted SPPs (Rijksoverheid, 2023). This embargo illustrates how important a good development process is to balance techno-economic with environmental and socio-cultural objectives, as argued earlier by Stremke (2015), as well as to address both broader societal and local concerns, as earlier argued by Wolsink (2007) and De Waal et al. (2015). The embargo puts the outcomes of this thesis in a different perspective. It will, at least temporarily, limit new SPP developments. However, the findings from this research still hold valuable insights for SPP initiatives that were in development when the new policies became effective and can therefore continue, and for existing SPPs that can be improved or in time need to be re-designed in case of permit extension or repowering (Windemer, 2019). Moreover, with the research presented in chapter 5, I expose the many discrepancies between permit documentation and built reality. The findings from this research stress the need for better regulations and enforcement of permit agreements (see key activity 6). A recommendation that is valid for today's practices and for the (near) future.

6.3. Recommendations to enable the key activities

The research presented in this thesis addresses the imbalance of techno-economic objectives with environmental and socio-cultural objectives in current SPP development and articulates key activities to advance the co-designing of solar landscapes. The key activities, outlined in section 6.1.3, are a set of recommendations distilled from the findings of the research modules. In this section, I outline three additional recommendations that offer a foundation to enable these key activities. The recommendations in this section address underlying potential and relate more to a particular subject. Moreover, these recommendations address different stakeholders that relate to the different findings of this research: (national) policymakers and agencies, SPP developers, and researchers working on acceptance of renewable energy landscapes.

6.3.1. Provide a base by developing a plan for spatial allocation of SPPs

The spatial allocation of SPPs in The Netherlands is currently left to market forces. SPPs are developed on land that becomes available, rather than based on comprehensive spatial planning (RVO, 2024a). The result is that SPPs are developed in seemingly random locations. Locations where SPPs do not necessarily fit within the characteristics of a landscape or within the energy system. This way of allocating SPPs can fragment the landscape and create alien structures that do not fit with the existing landscape qualities (Apostol et al., 2017; Mérida-Rodríguez et al., 2015). Moreover, this lack of a plan for spatial allocation of SPPs can contribute to local opposition towards new projects, for example, when local stakeholders do not understand the decision to develop a SPP on a certain location and feel excluded from the decision-making on the siting. The current approach in which SPPs appear randomly in the landscape contradicts with the extensive scholarly work describing local support as a key for a successful and timely transition to renewable energy (e.g. Gölz & Wedderhoff, 2018; Schumacher et al., 2019; Sütterlin & Siegrist, 2017). In chapter 3, the importance is stressed of including local stakeholders in the siting process, to directly address local values when allocating space to SPP development, which aligns with earlier studies on the siting of wind energy (e.g. Müller et al., 2020). The IMBYP-project included a step in the co-design process to address the siting of the perspective SPP (Appendix B), which resulted in several sites being appointed as potential locations. At the same time, the program of the Regional Energy Strategy (RES) assigned zones to develop renewable energy projects in the same locations. However, this RES zoning plan was opposed by the local community in Nauerna because they were not included in the deliberations of that plan. This local response is in line with other recent studies emphasizing the importance of the ability for local stakeholders to affect decision-making and more generally the transparency on decision-making processes (e.g. Peuchen et al., 2024). Therefore, it becomes essential to review the current spatial allocation of SPPs. A first step to establish a plan for spatial allocation of SPPs would be to evaluate the effects of the current practice and whether and how local stakeholders are represented in these processes. And then to explore the possibilities of including local stakeholder, as well as the possible benefits of a plan for spatial allocation of SPPs on a regional or national scale.

6.3.2. Align the technical and landscape designs

The findings of this thesis emphasize the necessity of a better alignment between the technical and landscape designs of SPPs. In current SPP development these two types of designs are created at different moments in time and with different people involved (see chapter 5). This allows for spatial measures addressing environmental and/or socio-cultural objectives to disappear during the development process, due to hand-overs and a lack of consistency in involved experts. That can lead to incompleteness of plans and a lack of commitment and felt responsibility for the end result by involved stakeholders. To establish an alignment of technical and landscape designs, SPP developers and their technical experts need to cooperate with landscape designers to exchange knowledge and materials. In the research presented in this thesis, I identify several benefits of such an alignment. One benefit of aligning these types of designs is that it offers opportunities to innovate the design of the PV system and can provide more possibilities to design SPPs (chapter 3). When landscape architects and technical experts cooperate, they can create a plan that is technical and economically feasible and simultaneously incorporates local and broader societal concerns (chapter 4). A second benefit is the inclusion of auxiliary infrastructure, such as transformers and sub-stations, in the landscape design. The auxiliary infrastructure is often missing in landscape design plans submitted in permit documentation (see chapter 5). However, this infrastructure has a large influence on the experience of landscape users (Oudes et al., 2022). Cooperation between involved experts ensures that the placing of these auxiliary features is carefully considered and becomes part of the overall design vision. A third benefit is a higher probability of the construction of the SPP happening according to the agreed upon permit documentation. The feasibility of the landscape design is improved by including all costs in an early phase and the commitment of several stakeholders to carry out the agreed upon plan, as seen in the EnergyGarden-project (chapter 4). A fourth benefit is that inclusion and construction of additional measures can improve, because the landscape architect is still involved at the later stages of development and can mandate these interventions (see chapter 5). These benefits stress the potential of cooperation between SPP developers and landscape architects to align landscape and technical designs of SPPs, which is essential if current practice wants to advance and become more sustainable.

6.3.3. Increase collaboration between fields of social science and landscape design

Future research could benefit from more exchange and interdisciplinary research between social sciences and landscape design. The research presented in this thesis connects two academic domains: the fields of social science, concerned with support and opposition of renewable energy projects, and landscape design, contributing to the physical appearance of renewable energy landscapes. The systematic literature review indicated that the current collaboration is limited between these fields (see chapter 2). I found that these fields align with each other for certain factors that they describe, but often remain separate domains in their research. Based on the findings of this research, I recommend that the scope of social sciences is broadened by studying the design processes of renewable energy projects. These processes remain a blind spot in current acceptance studies, where the focus is often limited to one moment in time. I found that most acceptance studies either study the moment before a change will take place (e.g. Ferrario & Castiglioni, 2017; Liebe & Dobers, 2019; Sütterlin & Siegrist, 2017) or after completion of the renewable energy development (e.g. Lothian, 2020; Roddis et al., 2018). A closer collaboration of these fields of study on (participatory) design processes can further advance the knowledge base of these processes and can lead to a better understanding of the influence of design processes on local acceptance of SPPs. Furthermore, the field of landscape design could benefit from acknowledging a larger set of factors that influence local support and opposition in their design practices. The design discipline could pay more attention to factors that are not spatially explicit, but rather cultural or emotional such as trust. Moreover, I recommend future research to examine the gap between the factors dominating the current research agenda and those considered most important by laypersons who deal with landscape transformations in their daily environments (see Roddis et al., 2020). These differences in emphasis between laypersons and scholars raises the question if the current research agenda on landscape transformation and acceptance of renewable energy is addressing the most relevant challenges and if not, more attention should be given to factors that matter most to laypeople.

6.4. Scientific and societal relevance

The research presented in this thesis advances the knowledge base for the co-designing of solar landscapes which represents one specific type of energy landscape within the broader scholarly work on energy landscapes. This research contributes to the theoretical concept of sustainable energy landscapes (Stremke, 2015). The findings of this research further specify the four dimensions of sustainable energy landscape - technical, economic, environmental, and socio-cultural - with factors related to local acceptance found in peer-reviewed literature (chapter 2) and tested in in-depth case studies (chapter 3 & 4). Moreover, the research provides novel insights on the current practice of SPP development, including a better understanding of participatory processes, the designs, and built reality of SPPs in The Netherlands. The research in chapter 5 presents a post-occupancy evaluation of today's built reality of SPPs in which I found many discrepancies between the constructed SPP and the permit documentation. In this study, I discuss the many gaps in current practices that cause environmental and socio-cultural objectives to disappear, and how these discrepancies affect landscape quality (after Bakx et al., 2023). The research in chapter 4 presents new insights on local considerations in the participatory processes of SPP developments and provides clear evidence on how these do not always align with broader societal concerns. Which is in stark contrast with earlier studies that emphasize the awareness of local inhabitants of broader societal concerns (e.g. Ryder & Devine-Wright, 2022). The research in chapter 3 presents a novel intervention of constructing a co-designed full-scale prototype and how this affects the procedural justice of participatory processes. Based on the findings, I can conclude that a co-designed full-scale prototype helps to break status quo bias and positively influences local acceptance of a SPP. Furthermore, the research as a whole provides valuable new knowledge to improve the balance between techno-economic objectives, environmental, and socio-cultural objectives. These findings are articulated in key activities that answer my main research question. The key activities build on previous research (e.g. Oudes, 2022; Scognamiglio, 2016; Stremke & Schöbel, 2019) and contribute to this body of scholarly work with new insights. Moreover, the key activities expand the current scholarly debate on local acceptance of SPPs from a landscape architecture perspective. Additionally, the research evidences the potential contribution of landscape architecture research to other sciences that work on sustainable energy landscapes in general and SPPs in particular. Currently, the potential of the discipline of landscape architecture is not fully utilized in the energy transition. This is, for example, illustrated by the limited number of factors that refer to landscape and landscape design in acceptance studies (see chapter 2) and the limited interaction between these two fields of study (see section 6.3.3). Several of the findings of this research emphasize the potential of the discipline of landscape architecture to reflect on SPP development and advance the process of co-designing solar landscapes. The research in this thesis provides new research questions for landscape architecture scholars to further study the landscape designing of SPPs and the effects on landscape and landscape users.

Moreover, the research in this thesis is relevant because it applied action research in the field of energy research where this is not yet common practice. To the best of the author's knowledge, this is the first study that performed embedded action research for co-design processes in SPP development in The Netherlands. The research presents novel insights on being embedded as a designer, with which it contributes to new knowledge and the operationalization of research methods in landscape architecture research (Deming & Swaffield, 2011; Van den Brink et al., 2017). Furthermore, the research presented in this thesis contributes to the broader academic discussion on RTD and its application in real-world practice. So far, RTD is mostly employed in controlled environments and experimental design set-ups (e.g. Cortesão & Lenzholzer, 2022). As described earlier (section 6.2.1), performing RTD in real-life settings can be challenging, due to the dynamic nature of daily practice. However, the research also showcased the value of an iterative research approach by delivering new knowledge in the design process, new insights in a particular design, and a better understanding of the process of designing.

The research in this thesis is also relevant for the wider society. On a local level, the research contributed to the position of local stakeholders in the involved cases. Within both the IMBYP and EnergyGardens-project, locals were offered a better position in a participatory design process to mandate their concerns in the SPP development, as well as professionals where they partook. Moreover, local stakeholders had the opportunity to learn along during the process (Itten et al., 2020). Furthermore, I actively disseminated the results and contributed to bridging the gap between academia and practice. Throughout my research, I had many opportunities to present and discuss my (preliminary) findings with other academics, professionals, and laypersons. This exchange made it possible to disseminate the new insights in a more accessible way and get reflections from others on my work and the work to be done. By facilitating several workshops on integral and inclusive designing of SPPs, I contributed to the operationalization of my findings in the work field that deals with the challenges in SPP development on a daily basis.

Lastly, well-designed solar landscapes present a means to reach the transition goals and (solar) energy targets of The Netherlands in a more sustainable manner. The research provides a much-needed perspective on SPP development, which is based on an inclusive design approach that balances techno-economic objectives with environmental, and socio-cultural objectives. In doing so, this thesis builds on the work of other scholars (e.g. Scognamiglio, 2016; Stremke, 2015; Stremke & Schöbel, 2019). The work in this thesis presents a critical contribution to mitigate the potential stand-still of SPP development in The Netherlands. With the research findings, I present a relevant outlook, by suggesting the early acknowledgment of stakeholders and the inclusion of environmental, and socio-cultural objectives in the commonly techno-economic dominated development of SPPs. The focus of this research on SPPs might seem of limited relevance when new policies are placing a quasi-embargo on the development of new monofunctional ground-mounted SPPs. However, while the near future of SPPs in The Netherlands is uncertain, the country will rely on ground-mounted SPPs for many decades to come.

6.5. Conclusion

This thesis aimed to outline key activities to advance the co-designing of solar landscapes in which techno-economic objectives are balanced with environmental, and socio-cultural objectives. To articulate these key activities, I researched current SPP development processes in The Netherlands. With the findings of this research, I illustrate gaps between environmental and socio-cultural objectives as well as knowledge on organizing this transition on the one hand, and current practices of SPP development in The Netherlands on the other hand. These gaps not only affect the sustainability of SPPs but also limit the possibilities for co-designing solar landscapes. At the same time, opportunities have been identified in this research to advance current SPP practice to become more sustainable. Strikingly, I noticed many good intentions in the studied cases to initiate the co-designing of solar landscapes. However, these were often counteracted by current practices that are focussed on techno-economic objectives. Although policy acknowledges both environmental and socio-cultural objectives and invites new initiatives to incorporate these in their plans, these objectives are freely interpretable and the extent to how they are included is not evaluated properly. Moreover, the existing renewable energy subsidy criteria and municipal permit requirements focus on technical and economic feasibility. Overall, I identified a lack of reflection and feedback mechanisms in SPP development, within and across the different relevant practices. Signals from current projects are inadequately communicated to higher levels of authority and anyhow take a long time to be addressed (e.g. quality budget for environmental objectives in the national subsidy scheme (RVO, 2024b)). This lack becomes evident in the discrepancies between designed plans and built reality, in which environmental and socio-cultural objectives have largely disappeared. Altogether, the development process of SPPs over the past ten years or so in the Netherlands has led to formidable local opposition.

Based on the research presented in this thesis, I articulate seven key activities to advance the co-designing of solar landscapes. These key activities can help to establish more mandate for environmental and socio-cultural objectives, and balance participatory processes to include both local and broader societal concerns. The seven key activities are: 1) Composing a vision for co-designed solar landscapes; 2) Defining criteria for environmental and socio-cultural objectives; 3) Facilitating early and inclusive participation of stakeholders; 4) Balancing stakes and stakeholders in decision-making; 5) Empowering the landscape architect; 6) Organizing quality control and monitoring; and 7) Establishing feedback mechanisms. These seven key activities will help independently in a certain moment in a SPP development process to address objectives or concerns that threaten to disappear in the design or construction of the SPP. However, the key activities are strongest when all are implemented to advance the co-designing of solar landscapes. That way, the activities can strengthen each other. Moreover, on a general level a cyclical and continuous learning process should be initiated to stimulate adapting the key activities in each iteration to advance practices. The key activities need reflection to improve them while they cannot be all-encompassing. Simply because there are so many factors and activities influencing SPP development: each project context is different, each process is different, and therefore each result will be different. Nonetheless, the potential and positive effects of implementing these key activities in SPP development are abundant in the research presented in this thesis. These are reflected in the local response on the participatory design processes in the EnergyGarden-project (chapter 4), and in the local support for a SPP on a contested location in the IMBYP-project (chapter 3). These cases illustrate the potential of mandating local and broader societal concerns, as well as environmental and socio-cultural objectives, while stakeholders together design solutions for more sustainable solar power plants or, put differently, solar landscapes.

From the EnergyGarden-project, only the solar landscape Assen has been built within the timeframe of the research in this thesis. When looking at this solar landscape (Fig.6.3-4), several comments can arise on what has materialized (e.g. accessibility to the landscape is limited by the fences). However, one should also realize that this solar landscape is one of a kind. There are very few examples of current SPPs that are

Figure 6.3 Selection of photos from a site visit in June 2024 of the solar landscape in Assen, that was under construction at the time of the visit.

developed through an early and inclusive design process in which techno-economic objectives are balanced with environmental, and socio-cultural objectives. Moreover, in this solar landscape the PV system is adjusted to align with the parcellation and respects existing landscape elements. There are large zones to increase biodiversity and create natural habitats (Fig.6.4). There are parts accessible for visitors to recreate and there is an educational route about the nature development as well as the energy generation. The solar landscape in Assen would not have been possible without extended efforts of the municipality, the commercial developer, and the Nature and Environment Federation (NMF). They understood the value of creating something more than a common SPP, to advance current practices. They decided to invest themselves to make this happen. However, this type of action cannot be expected to happen everywhere, and therefore it is necessary that these co-designed solar landscapes are stimulated and facilitated. Here, the seven key activities provide the foundations to advance SPP practices to realize environmental and socio-cultural objectives while meeting techno-economic objectives and doing justice to local stakeholders, landscape, culture, and values. In other words, supporting practices that give rise to solar landscapes.

Figure 6.4 A third photo from a site visit in June 2024 of the solar landscape in Assen, that was under construction at the time of the visit.

CRediT authorship contribution statement

This chapter is solely authored by Merel Enserink.

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W-Z

Appendices

Appendix A Overview of factors of acceptance of renewable energy

The full overview of factors of acceptance of renewable energy- as published in Energy Research and Social Science (doi: 10.1016/j.erss.2022.102740)- is displayed on the following pages. Moreover, the full table is available online in two parts via:

https://ars.els-cdn.com/content/image/1-s2.0-S2214629622002444-fx2.jpg

https://ars.els-cdn.com/content/image/1-s2.0-S2214629622002444-fx3_lrg.jpg

Overview of the studies included in the systematic literature review:

Acceptance studies: Bertsch et al. (2016); Bevk & Golobič (2020); Calvert et al. (2019); Caporale et al. (2020); Devine-Wright (2012); Fast (2013); Ferrario & Castiglioni (2017); Firestone et al. (2018); Gölz & Wedderhoff (2018); Horbaty et al. (2012); Keilty et al. (2016); Ketzer et al. (2020); Kontogianni et al. (2014); Liebe & Dobers (2019); Lothian (2020); Pasqualetti (2011); Perlaviciute & Steg (2014); Petrova (2016); Roddis et al. (2020); Sherren et al. (2019); Späth (2018); Spielhofer et al. (2021); Terrapon-Pfaff et al. (2019); Wolsink (2007); Zoellner et al. (2008).

Landscape design studies: Bosch et al. (2020); De Waal et al. (2015); De Waal & Stremke (2014); Lobaccaro et al. (2019); Oudes & Stremke (2018, 2020); Ozgun et al. (2015); Picchi (2018); Picchi et al. (2019); Scognamiglio (2016); Selman (2010); Stremke & Koh (2011); Stremke & Schöbel (2019).

Acceptance field

Factors ↓ Study →	Bertsch et al. (2016)	Bevk & Golobic (2020)	Calvert et al. (2019)	Caporale et al. (2020)	Devine-Wright (2013)	Fast (2013)	Ferrario & Castiglioni (2017)	Firestone et al. (2018)	Gölz & Wedderhoff (2018)	Horbaty et al. (2012)	Keilty et al. (2016)	Ketzer et al. (2020a)	Kontogianni et al. (2014)	Liebe & Dobers (2019)	Lothian (2020)	Pasqualetti (2011)	Perlaviciute & Steg (2014)	Petrova (2016)	Roddis et al. (2020)	Sherren et al. (2019)	Spaeth (2018)
Health & well-being	1									1			1						1	1	
Moral & ethical values		1							1		1					1	1				
Process		1		1				1			1								1		
Site selection				1		1						1	1				1				
Temporal dimension		1	1				1				1								1		
Transparency				1			1	1		1									1		
Design		1		1								1			1				1		
Landscape characterisitcs		1										1				1			1		
Trust												1	1				1		1		
Visibility (distance)		1				1	1						1							1	
Economic benefits	1			1		1		1		1		1	1			1	1				1
Visual impact		1				1	1			1		1			1			1	1	1	
Environmental impact					1	1	1			1			1				1	1	1		1
Landscape values			1			1		1			1					1		1	1		
Decision making				1		1		1		1			1								
Procedural justice					1			1		1						1	1	1			
Communication	1					1		1		1			1								
Cultural heritage											1					1			1		
Demographic characteristics	1												1	1						1	
Fairness							1	1	1												
Information	1			1							1										
Regional added value									1	1	1										
Technology		1										1							1		

factors only mentioned in acceptance studies

factors only mentioned in landscape design studies

						Landscape design field															Both fields
Spielhofer et al. (2021)	Terrapon-Pfaff et al. (2019)	Wolsink (2007)	Zoellner et al. (2008)	Total references in field (n)	Total references in field	Bosch et al. (2020)	Oudes & Stremke (2020)	Lobaccaro et al. (2019)	Picchi et al. (2019)	Stremke & Schöbel (2019)	Oudes & Stremke (2018)	Picchi (2018)	Scoglamiglio (2016)	De Waal et al. (2015)	Ozgun et al. (2015)	De Waal & Stremke (2014)	Stremke & Koh (2011)	Selman (2010)	Total references in field (n)	Total references in field	Studies mention factor
	1			6	sometimes														0	never	seldom
			1	6	sometimes														0	never	seldom
			1	6	sometimes														0	never	seldom
			1	6	sometimes														0	never	seldom
		1		6	sometimes														0	never	seldom
			1	6	sometimes														0	never	seldom
				5	sometimes														0	never	seldom
		1		5	sometimes														0	never	seldom
		1		5	sometimes														0	never	seldom
				5	sometimes														0	never	seldom
	1		1	12	often	1	1	1							1	1			5	sometimes	often
		1	1	11	often				1	1			1			1		1	5	sometimes	often
	1		1	11	often		1		1				1			1			4	sometimes	sometimes
		1		8	sometimes				1										1	seldom	sometimes
	1	1		7	sometimes							1							1	seldom	sometimes
			1	7	sometimes								1						1	seldom	sometimes
				5	sometimes									1					1	seldom	seldom
		1		4	seldom														0	never	seldom
				4	seldom														0	never	seldom
		1		4	seldom														0	never	seldom
			1	4	seldom														0	never	seldom
	1			4	seldom														0	never	seldom
			1	4	seldom														0	never	seldom

** table continues on next pages*

A

Trust in developer					1			1													
(Cost) efficient				1																	1
Geographical locations	1			1																1	
Impact on agricultural land use											1								1		
Property values										1	1								1		
Safety of plant	1																1				
Social values																1			1		
Tourism										1	1								1		
Air pollution	1																		1		
Construction		1																	1		
End-of-life											1								1		
Landscape modification	1																				
Noise pollution	1																		1		
Physical characteristics																	1				
Project details												1							1		
Trust in politics & institutions				1							1										
Alternative options																			1		
Business model																			1		
Cumulative impacts																			1		
Flooding																			1		
Functional efficiency				1																	
Legacy																			1		
Light pollution																			1		
Mitigation measures																			1		
NIMBY														1							
Quality of energy provision																	1				
Stable energy provision				1																	
Traffic (construction nuisance)																			1		
Visual preference																					
Wildlife habitats & -creation				1						1								1	1		
CO2 emissions				1															1		
Knowledge of energy transition						1															

factors only mentioned in acceptance studies

factors only mentioned in landscape design studies

	1	1	4	seldom					0	never	seldom
		1	3	seldom					0	never	seldom
			3	seldom					0	never	seldom
	1		3	seldom					0	never	seldom
			3	seldom					0	never	seldom
	1		3	seldom					0	never	seldom
	1		3	seldom					0	never	seldom
			3	seldom					0	never	seldom
			2	seldom					0	never	seldom
			2	seldom					0	never	seldom
			2	seldom					0	never	seldom
		1	2	seldom					0	never	seldom
			2	seldom					0	never	seldom
		1	2	seldom					0	never	seldom
			2	seldom					0	never	seldom
			2	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
			1	seldom					0	never	seldom
1			1	seldom					0	never	seldom
			4	seldom		1			1	seldom	seldom
			2	seldom	1				1	seldom	seldom
	1		2	seldom			1	1	2	seldom	seldom

* *table continues on next pages*

Perception of risk																1					
Price						1											1				
Nuisance (light, glare, noise)				1				1		1			1					1	1		
Economic impact	1				1			1		1											
Jobs										1	1		1						1		
Place attachment					1	1	1							1			1		1		
Business case																					
Energy security																					
Forced expansion																					
Key role of public associations																					
Landscape narrative																					
Local initiatives																					
Multi-stakeholder process																					
Ecological compensation																					
Ecosystem services																					
Environmental (in)justice																					
Bottom-up processes																					
Attitudes (towards RE)								1						1		1					
Landscape quality												1			1						
Project size																			1		
Recreation & activities																			1		
Aesthetics & scenic quality			1		1		1	1			1				1				1	1	
Community values								1		1	1				1						1
Perception of landscape change						1	1				1			1		1					
Environmental concerns	1													1		1				1	
Collaboration with authorities																					
Involving farmers																					
Designer as facilitator																					
Multifunctional land-use																					
Designing RE landscapes																					
Community involvement						1	1			1		1	1								1
TOTAL	12	9	3	15	6	13	10	14	3	17	16	10	12	6	5	11	11	6	37	7	5

factors only mentioned in acceptance studies

factors only mentioned in landscape design studies

				1	seldom								1						1	seldom	seldom
				2	seldom	1													1	seldom	seldom
	1	1		8	sometimes			1					1			1			3	sometimes	sometimes
			1	5	sometimes								1		1	1			3	sometimes	sometimes
	1			5	sometimes	1		1					1						3	sometimes	sometimes
				6	sometimes	1							1				1	1	4	sometimes	sometimes
				0	never										1				1	seldom	seldom
				0	never								1						1	seldom	seldom
				0	never	1													1	seldom	seldom
				0	never			1											1	seldom	seldom
				0	never													1	1	seldom	seldom
				0	never							1							1	seldom	seldom
				0	never					1									1	seldom	seldom
				0	never	1												1	2	seldom	seldom
				0	never				1			1							2	seldom	seldom
				0	never	1	1												2	seldom	seldom
				0	never							1		1					2	seldom	seldom
		1		4	seldom				1			1	1						3	sometimes	seldom
1		1		4	seldom		1			1					1	1			4	sometimes	sometimes
				1	seldom							1	1					1	3	sometimes	seldom
				1	seldom				1						1			1	3	sometimes	seldom
1				9	sometimes		1		1	1	1					1		1	6	often	sometimes
	1	1		7	sometimes		1		1	1	1		1					1	6	often	sometimes
1				6	sometimes	1			1	1		1	1					1	6	often	sometimes
	1			5	sometimes	1	1	1	1				1					1	6	often	sometimes
				0	never		1	1								1			3	sometimes	seldom
				0	never			1						1		1			3	sometimes	seldom
				0	never					1		1				1			3	sometimes	seldom
				0	never		1		1				1						3	sometimes	seldom
				0	never						1		1		1	1			4	sometimes	seldom
		1		7	sometimes		1	1	1		1	1	1	1	1	1		1	10	very often	often
4	14	13	15			9	10	9	13	7	4	9	17	4	8	12	1	12			

A

Appendix B Evaluation of procedural justice in IMBYP-project

Supplementary data on the results of the survey and supplementary data on the analysis of procedural justice elements in all the project phases of the IMBYP-project can be found online at https://doi.org/10.1016/j.solener.2023.0 5.016.

Table B1.1 Analysis of the procedural justice elements in the interviews (A1).

Elements procedural justice	Description
Information sharing	The project team did not share much on the project aims with the local community. The project team collected values concerning place attachment for both social and physical landscape.
Possibilities to participate	A representative sample of the local community was interviewed, existing of inhabitants and local entrepreneurs.
Ability to affect outcomes	There were no outcomes to affect yet. However, interviewing the local community before starting to develop any plans did give them a serious voice to begin with.
Dealing with landfill owner	There was no site chosen yet. The relation between the local stakeholders was addressed by several of the interviewees.

Table B1.2 Analysis of factors influencing local acceptance in A1.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	A selection was made which had a good representation of the local community	++				
Visual impact	-					
Aesthetics	-					
Community values	An inventory was made of place attachment		+			
Trust	The project team communicated transparently and willing to listen to the local stories. This created first bonds of trust. The difficulties were acknowledged in the relationship between local stakeholders and past conflicts.			+/-		

Table B2.1 Analysis of the procedural justice elements in the landscape analysis (P1).

Elements procedural justice	Description
Information sharing	Besides desk-research, the project team made several field visits. A
Possibilities to participate	group of representatives of all stakeholders was updated regularly and involved in preparation of A2.
Ability to affect outcomes	There were no possibilities to participate. However, the field visits allowed for interaction between members of the local community and the project team.
Dealing with landfill owner	The relation between stakeholders was fine.

Table B2.2 Analysis of factors influencing local acceptance in P1.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	During field visits there was interaction with members of the local community. Updates were shared with representatives of the local stakeholders.			+/-		
Visual impact	An extensive analysis was made of the possible locations for a SPP and the related visual impact.		+			
Aesthetics	Important values on scenery and aesthetics of the landscape were collected.		+			
Community values	-					
Trust	-					

Table B3.1 Analysis of the procedural justice elements in co-design sessions (A2).

Elements procedural justice	Description
Information sharing	The project team shared their inventory and analysis on sites and sizes for a SPP. The project team shared their knowledge on designing SPPs. The participants shared their values for in-future situations.
Possibilities to participate	All households were invited to join the sessions. Approximately 40-50 people joined the sessions, which is a good representation of the 92 households.
Ability to affect outcomes	The participants had the opportunity to make statements and set conditions about the aesthetics, the location, and the size of the SPP.
Dealing with landfill owner	A representative of the landfill owner was present, this was not appreciated by all participants, they felt less comfortable to speak freely.

Table B3.2 Analysis of factors influencing local acceptance in A2.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	Good representation of the local community. The session had an open, exploring character with open conversations about possibilities, choices, and decisions.	++				
Visual impact	Visibility of the SPP was discussed related to several scenarios and locations.		+			
Aesthetics	The mood boards with reference images were an easy means to use by the local community. The boards gave a good overview of (un)desired SPP development by the local community.	++				
Community values	The possibilities to discuss several scenario's allowed room to reflect on shared community values and conditions.		+			
Trust	The setting and the fact that there were no plans made yet favoured the project team. However, the attendance of a representative of the landfill owner was not well perceived by some members of the local community.			+/-		

Table B4.1 Analysis of the procedural justice elements in the idea development (P2).

Elements procedural justice	Description
Information sharing	There was a longer period with minimal communication. This was partly caused by delays in the project due to the Covid-19 pandemic.
Possibilities to participate	Due to restrictions of the Covid-19 pandemic it was not possible to organize on-site participation at this time.
Ability to affect outcomes	There were no possibilities for the local community to affect the outcomes.
Dealing with landfill owner	Outside the scope of the project new issues arose between the local stakeholders. This affected the trust in the project negatively.

Table B4.2 Analysis of factors influencing local acceptance in P2.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	Very limited possibilities to sketch with local community, due to Covid-19 regulations.					--
Visual impact	The project team used the input on location and size. On the latter, feasibility was taken into account as well.			+/-		
Aesthetics	The project team translated the input on aesthetics in design principles and used these in the design concepts.		+			
Community values	The project team translated the input on community values in design principles and used these in the design concepts.		+			
Trust	The low frequency in communication and the minimal possibilities to interact affected trust in the project team. Moreover, other issues arose between the local stakeholders which negatively influenced trust in the research project as well.				-	

Table B5.1 Analysis of the procedural justice elements in the validation sessions (A3).

Elements procedural justice	Description
Information sharing	In an online session, the results of P1 were presented to the local inhabitants via Zoom.
Possibilities to participate	All households were invited to join and discuss the design ideas. Only 12 people joined, with a possible overrepresentation of opposing members of the community.
Ability to affect outcomes	Interaction through online polls, questions, and discussion. The participants found themselves unable to make a decision based on the virtual material, they showed a preference for the minimal change scenario.
Dealing with landfill owner	The landfill owner was not invited nor present, this was appreciated.

Table B5.2 Analysis of factors influencing local acceptance in A3.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	Only limited possibilities to interact and possible overrepresentation of opposing members of the community					--
Visual impact	The on screen 3D visualisations were not enough for the local community to judge the visual impact. They questioned the reality of the design concepts.				-	
Aesthetics	The different design options were appreciated, but difficult to evaluate.			+/-		
Community values	-					
Trust	Some participants were doubting the intentions of the project team. Trust between local stakeholders was low.				-	

Table B6.1 Analysis of the procedural justice elements in the prototype development (P3).

Elements procedural justice	Description
Information sharing	The project team ensured regular updates on the progress, development and construction of the prototype. The communication was transparent about the difficulties and challenges.
Possibilities to participate	Representatives of the local community were involved to provide feedback on the prototype development.
Ability to affect outcomes	Options were limited. However, the project team kept in contact with the local community and used the feedback from the local representatives.
Dealing with landfill owner	The local stakeholders were in conflict, concerned issues outside the scope of the research project.

Table B6.2 Analysis of factors influencing local acceptance in P3.

		Evaluation of influence session on acceptance				
Factors	Description	++	+	+/-	-	--
Community involvement	Communication was increased with regular updates on the progress. Some community members were involved in the development of the prototype.			+/-		
Visual impact	-					
Aesthetics	The prototype presented several possibilities for the design.		+			
Community values	-					
Trust	The transparent communication helped to restore some trust in the project team. However, the issues between local stakeholders continued and trust between them declined.				-	

Appendix C Overview of codes of spatial measures

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Solar infrastructure	
S1	Increasing ha of PV
S2	Decreasing ha of PV
S3	Adding/altering additional elements (transformers etc.)
S4	Adding/altering orientation of PV
S5	Adding/altering row distance of PV
S6	Adding/altering lay-out of PV
S7	Removing PV due to safety issues (gas lines, etc)
S8	Combining PV with another form of RE
S9	Adding/altering experimental PV elements (innovation)

Infrastructure	
I1	Altering location and/or orientation of main road (car access)
I2	Adding/altering public parking spaces
I3	Adding/altering bicycle path(s)
I4	Adding/altering pedestrian routes (in PV patch)
I5	Adding/altering bridges
I6	Improving existing pedestrian routes
I7	Adding new entrance to site (pedestrians/cyclists)
I8	Adding/altering fences
I9	Adding/altering dock

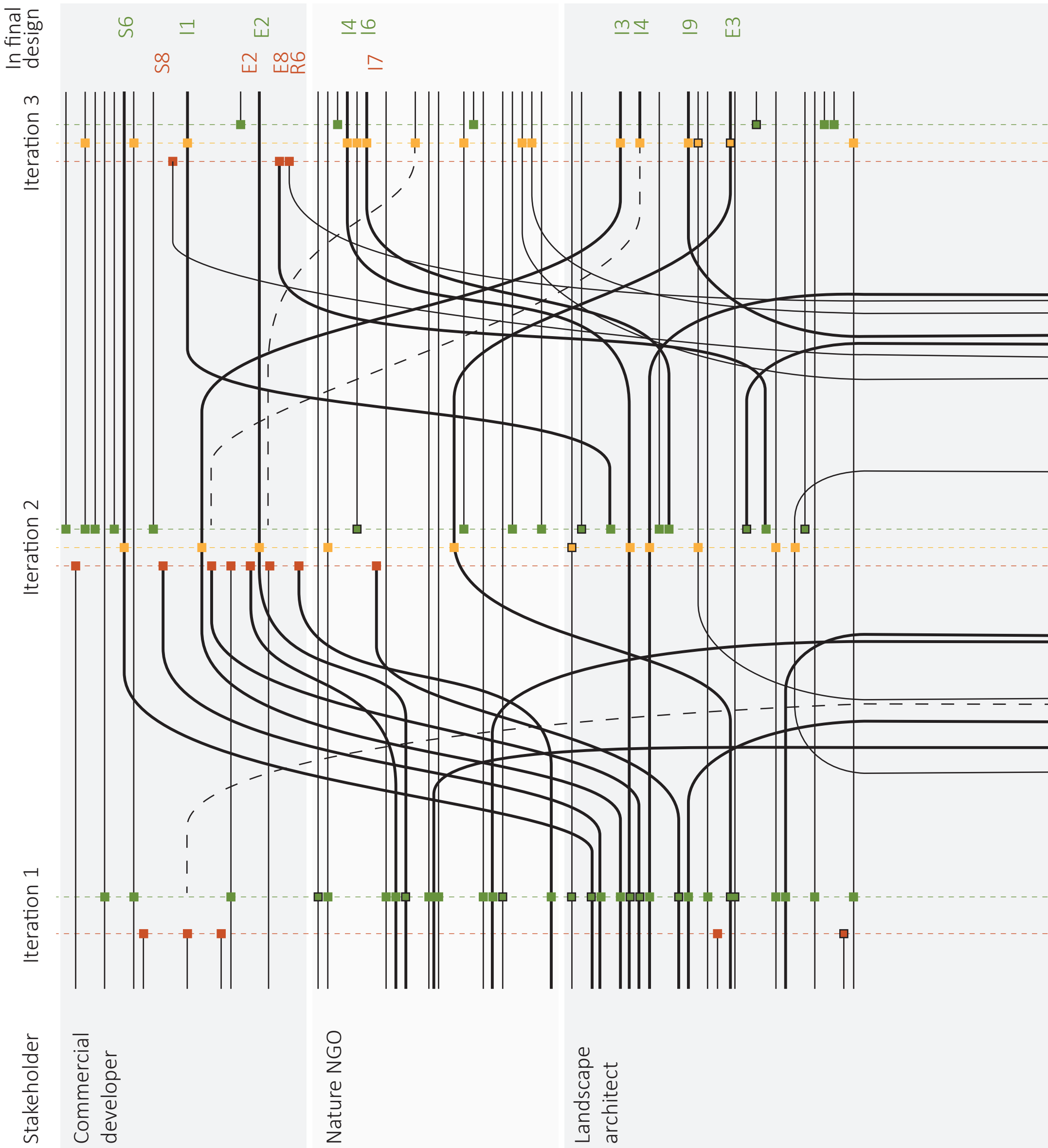
Landscape & ecological functions	
E1	(Re)Introducing landscape elements (wooded banks, tree rows, lanes)
E2	Strengthening landscape elements (wooded banks, forest patches)
E3	Strengthening ecological features
E4	Increasing biodiversity by sowing herbs & flowers
E5	Increasing biodiversity by planting shrubs
E6	Increasing biodiversity by planting solitary trees
E7	Increasing ha of extensive meadow
E8	Increasing existing water structure
E9	Altering shape/size of forested area(s)

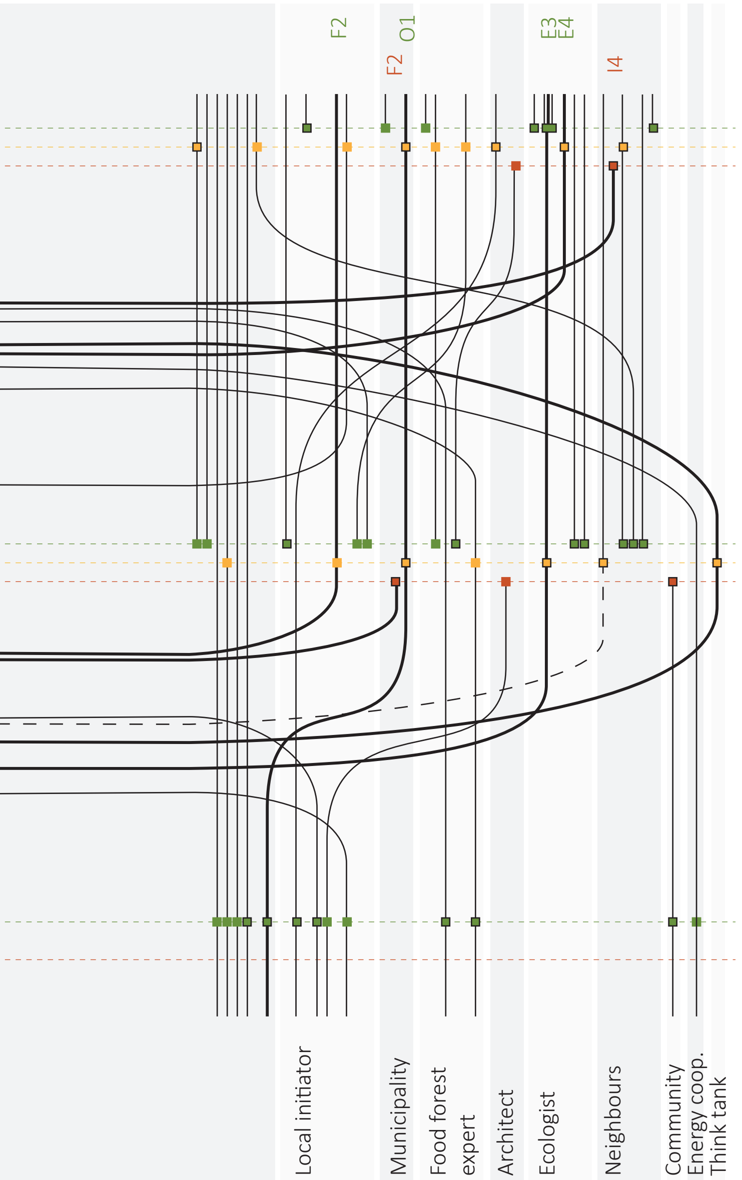
Recreation	
R1	Adding/altering (entrance) signs
R2	Adding/altering recreational features (benches, information panels)
R3	Adding/altering recreational features (e-bike loading point)
R4	Adding/altering recreational features (play elements)
R5	Adding/altering recreational features (outdoor activities)
R6	Adding/altering sheltered or indoor information point
R7	Adding/altering viewpoint
R8	Adding/altering vista's (sight lines)
R9	Shielding PV from sight by trees and hedges
R10	Shielding PV from sight by (small) dikes

Food production	
F1	Increasing ha food forest (elements)
F2	Adding/altering fruit trees/orchard
F3	Increasing ha crop land
F4	Adding/altering green house and/or farm elements
F5	Adding/altering barn yard
F6	Altering parcellation

Other function	
O1	Adding/altering housing to site
O2	Selling land (part of the site)

Appendix D Overview of spatial measures in EnergyGarden-project





Legend

Proposing to add/alter/remove

Dynamics of spatial measures through three design iterations

Proposal of landscape architect and nature NGO, altered by another stakeholder

Decision by another stakeholder

Spatial measure re-added

Timeline of spatial measures presented in three studied design iterations. The spatial measures that were first proposed by the landscape architect and nature NGO are accentuated, emphasizing alterations or removal of spatial measures by other stakeholders throughout the participatory design processes.

A

Summary

The transition to renewable energy sources leads to landscape change. In general, there seems to be high public support for renewable energy. However, local implementation of renewable energy infrastructure is often faced with local opposition. Many scholars consider local support as one of the keys to a successful and timely transition to renewable energy and stress the value of participatory processes. Moreover, for this transition to be considered sustainable, there should be attention to techno-economic objectives as well as to environmental, and socio-cultural objectives. At the moment of writing this thesis, there is a potential stand still in the deployment of large scale solar energy technologies in The Netherlands, due to a political embargo on new monofunctional ground-mounted solar power plants (SPP). The embargo is the result of persistent local opposition towards the landscape transformations associated with renewable energy infrastructure. This response of local stakeholders was forecasted by experts and scholars, while they noted a lack of quality in newly built SPPs and a malfunctioning of guiding policy documents and national subsidy schemes to include environmental, and socio-cultural objectives. A stand still in SPP development in The Netherlands would make it very difficult, if not impossible, to reach the stated renewable energy targets for 2030, and will make it extremely challenging to reach those of 2050. These recent events in The Netherlands illustrate that current practice of SPP development is not inclusive of environmental and socio-cultural objectives that are held by society and (partly) addressed by policy. Moreover, it also indicates a gap between that current practice of SPP development and the scholarly work on a sustainable energy transition. Several scholars call to design a sustainable energy transition in which solar infrastructure is integrally designed as a part of their host landscape to be considered solar landscapes. These gaps between practice, society, and science call for a critical reflection on current SPP development to outline

activities that can advance these practices. The main research question guiding the study was: What are the key activities to advance the co-designing of solar landscapes in which techno-economic objectives are balanced with environmental, and socio-cultural objectives? This research question was divided in four research modules, each studying different aspects of the design and development process of recent SPP projects in The Netherlands.

In the first research module, I performed a systematic literature review to better understand whether and how acceptance studies on renewable energy and landscape design studies on renewable energy landscapes complement each other. In the literature, scholars from both fields describe the large impact that renewable energy infrastructure can have on people's daily environments, and that it can be difficult for local stakeholders to support such landscape transformations. Both fields acknowledge that local support is a key for a successful and timely transition to renewable energy. In total, I found 80+ factors that influence support or opposition of renewable energy projects. The acceptance studies describe 45 unique factors such as transparency and trust. The landscape design studies describe 16 unique factors such as landscape narrative and multifunctional land-use. The two fields describe 25 similar factors. When I compared the factors described in the literature to a recent study on community perception of a SPP, I found a gap between the emphasis placed on factors by laypersons in that study and the current literature. Moreover, the results showed that both fields could benefit from more collaboration between these fields of study.

In the second research module, I explored the influence of a co-designed full-scale prototype on local support of a SPP in one real-life case: Nauerna. The research involved action research, a method in which the researcher is embedded in relevant practice. The findings evidenced that the full-scale prototype helped to break the status quo bias - a general preference to preserve the old situation - because the prototype improved the local understanding of the proposed landscape transformation and the potential visual impact on the daily environment. The prototype and related design process had a positive influence on local opinions regarding the development of a SPP:

81% responded (very) positive to this SPP development in their direct surroundings. Based on these results, I conclude that a full-scale prototype has a positive influence on local support. Moreover, the active involvement of the local community proved to be important for local support. I found that even in the face of initial local opposition, this type of inclusive participatory design process can provide possibilities to address opposing views at early stages and to investigate design alternatives. These research findings illustrate that the active involvement and ability to affect the outcomes present important factors for strengthening local support.

In the third research module, I described recommendations for energy policy based on an evaluation of the benefits and limitations of participatory design processes in SPP development in The Netherlands. I worked as an embedded designer in the three pilots of the EnergyGarden-project. Here, I applied research through designing which is a scientific method for design research. Based on this multiple-case study, I found that participatory design processes benefit local inhabitants to mandate their concerns related to the perspective SPP development. The inclusion of professionals secured more attention to environmental and socio-cultural objectives, which is a relevant advancement in the sustainable development of SPPs. Moreover, the involvement of several stakeholder groups contributed to the procedural justice. However, I also found that concerns put forward by local inhabitants at project level (e.g. visibility) do not always align with broader societal concerns such as landscape quality. Moreover, the participatory design processes illustrated a disbalance in stakeholders' abilities to affect the outcomes. This meant that measures proposed by professionals were more easily altered or removed from the design than those proposed by local inhabitants. Furthermore, I found a lack of clear definitions for environmental, and socio-cultural objectives in policy, and that these objectives are not considered binding requirements for a building permit or subsidy request. This further decreases the chance of spatial measures addressing environmental and/or socio-cultural objectives to materialize in the SPPs. Based on these findings, I recommend improving municipal policy, or directly changing national subsidy requirements. First, by providing better definitions for environmental and socio-cultural objectives to be implemented as binding requirements for permit or subsidy requests. Second, by improving the balance of involved stakeholder groups and their abilities to affect the decision-making in SPP design processes.

In the fourth research module, I examined five recently constructed SPPs in The Netherlands on the discrepancies between permit documentation and built reality. The employed post-occupancy evaluation exposed 79 discrepancies in spatial measures, such as adjustments to the PV system, or planting smaller screening vegetation. The causes for discrepancies were identified through structured interviews with key stakeholders. The causes relate to a broad range of moments and aspects in the SPP development process where discrepancies arise. The results illustrate that the discrepancies can have negative implications for landscape quality. In this research module, landscape quality was used as a proxy for broader societal concerns. The tension on landscape quality showcased an imbalance of objectives materializing in the current SPP development processes. These results point towards a conventional approach of SPP development that is focussed on techno-economic objectives, and in which environmental and socio-cultural objectives can disappear in the development process. Based on these findings, I argue to improve the position of landscape architects, to provide them with more mandate and possibilities to use their knowledge of the landscape and skills in (participatory) designing to design solar landscapes. Landscape architects can bridge various gaps in the SPP development process. They can play an important role in spanning the boundary between stakeholders, as well as between permit documentation and built reality. To realize this mandate and improve current SPP practice, I recommend a higher priority of environmental, and socio-cultural objectives on national level and stricter definitions in binding permit requirements on the municipal level.

Based on the findings of the research modules, I illustrate several shortcomings in today's SPP development processes. These shortcomings become visible, for example, in the imbalance of local and broader societal concerns in participatory design processes and discrepancies between permit documentation and built reality of

SPPs. More often than not, the environmental and socio-cultural objectives that were stated at the beginning of SPP projects are disappearing at different moments in the SPP development. Many results in this thesis point towards a techno-economic focus in current SPP project development which makes it difficult for other objectives to materialize. In one of the studied cases the measures that increased biodiversity, as an example of an environmental objective, where scaled down in the design process to become more affordable. In another case, recreative facilities, as an example of a socio-cultural objective, were removed from the plan to optimize the business case. To address this imbalance in SPP development, it is necessary to initiate different activities that rebalance these objectives in future SPP development.

I used the transition management framework, that distinguishes strategic, tactical, operational, and reflexive activities, to reflect on the findings of the four research modules. Based on the research, I articulate seven key activities. These key activities establish a balance of techno-economic objectives with environmental, and socio-cultural objectives, and address co-designing processes to include both local and broader societal concerns. First, current SPP practice lacks a vision for co-designed solar landscapes. A new vision should address and balance the four dimensions of sustainability - technical, economic, environmental, and socio-cultural - as well as a larger set of factors that influence local acceptance. Second, policymakers need to define criteria for environmental, and socio-cultural objectives as binding permit and subsidy requirements. Third, the established importance of early and inclusive participatory processes should be implemented in current SPP practice to better facilitate involvement of stakeholders. Fourth, in these participatory processes the stakes and abilities of stakeholders to affect the decision-making need to be balanced to improve procedural justice. Fifth, the knowledge and skills of landscape architects can be better utilized in the design and development of solar landscapes by providing them with more mandate and possibilities to design and facilitate co-design processes. Sixth, municipalities should organize quality control and monitoring on constructed SPPs to enforce agreements that are not yet met. And lastly, SPP development needs institutionalized feedback mechanisms to implement lessons learned in future practice. These key activities will help independently at a certain moment in a SPP development process to address an aspect where objectives can disappear. However, the key activities are strongest when all are introduced. That way the key activities can strengthen each other. Initiating the key activities can be seen as a first proposition to advance the co-designing of solar landscapes. The key activities need reflection to improve them while they cannot be all-encompassing. The seven key activities provide the foundations to advance SPP practices to realize environmental and socio-cultural objectives while meeting techno-economic objectives and doing justice to local stakeholders, landscape, culture, and values. In other words, supporting practices that give rise to solar landscapes.. In other words, supporting practices that give rise to solar landscapes.

Samenvatting

De transitie naar hernieuwbare energiebronnen leidt tot grootschalige landschapsverandering. In het algemeen is er breed draagvlak voor hernieuwbare energie. Echter, op lokaal niveau is er vaak weerstand tegen hernieuwbare energieprojecten. Veel wetenschappers beschrijven lokaal draagvlak als een belangrijke sleutel voor een succesvolle en tijdige transitie naar hernieuwbare energie. Daarnaast is het voor een duurzame transitie belangrijk dat er aandacht wordt besteed aan de technische en economische doelstellingen, als ook aan de omgevings- en sociaal-culturele doelstellingen. Op het moment dat ik mijn dissertatie afrond is er in Nederland een mogelijke stilstand in de ontwikkeling van grootschalige zonne-energieprojecten op land. Er is een politiek embargo op monofunctionele grondgebonden zonnevelden. Het embargo is een gevolg van de volhardende lokale oppositie tegen de landschapsontwikkeling die geassocieerd wordt met de aanleg van hernieuwbare energieprojecten. Experts en academici hadden deze negatieve lokale reactie eerder al voorspeld, omdat zij een tekort aan kwaliteit zagen in nieuw ontwikkelde zonnevelden, en onvoldoende steun vanuit beleid en subsidie eisen voor het realiseren van omgevings- en sociaal-culturele doelstellingen. Een stilstand in de ontwikkeling van zonnevelden in Nederland zou het heel moeilijk maken, zo niet onmogelijk, om de gestelde hernieuwbare energiedoelen van 2030 te halen. Tevens zal het ontzettend uitdagend worden om zo de doelen van 2050 te bereiken. Deze recente gebeurtenissen in Nederland laten zien dat de huidige praktijk van zonneveld ontwikkeling niet inclusief is voor omgevings- en sociaal-culturele doelstellingen die worden gedragen door de maatschappij en (gedeeltelijk) worden beschreven in huidig beleid. Tegelijk laat het ook een hiaat zien tussen de huidige praktijk van zonneveld ontwikkeling en wetenschappelijke studies over een duurzame energietransitie. Verschillende wetenschappers beargumenteren het belang van ontwerpen aan

een duurzame energietransitie waarin zonne-energie systemen integraal worden ontworpen zodat zij een onderdeel worden van het landschap, zogenaamde zonne-landschappen. De leemtes tussen praktijk, maatschappij en wetenschap vragen om een kritische reflectie op de huidige ontwikkeling van zonnevelden, op basis waarvan activiteiten kunnen worden bepaald die zorgen voor een vooruitgang in deze praktijk. De onderzoeksvraag van deze dissertatie luidt: Wat zijn de sleutel activiteiten om voortgang te creëren in het participatief ontwerpen aan zonne-landschappen, waarin technisch-economische doelstellingen in evenwicht zijn met omgevings- en sociaal-culturele doelstellingen? Deze onderzoeksvraag is opgedeeld in vier onderzoeksmodules. Waarvan elk een ander aspect van het ontwerp- en ontwikkelingsproces van recente zonne-energieprojecten in Nederland bestudeerd.

In de eerste onderzoeksmodule heb ik een systematisch literatuuronderzoek gedaan om beter te begrijpen of en hoe acceptatie studies over hernieuwbare energie en landschapsontwerp studies over hernieuwbare energielandschappen elkaar aanvullen. In de literatuur, besteden wetenschappers uit beide studievelden aandacht aan de grote impact van hernieuwbare energie infrastructuur op het landschap, als ook hoe het lastig is voor lokale stakeholders om een dergelijke landschapstransformatie te steunen. Beide studievelden beschrijven hoe lokaal draagvlak een sleutel is in de transitie naar hernieuwbare energie. In totaal heb ik in de literatuur meer dan 80 factoren gevonden die van invloed zijn op lokaal draagvlak voor of weerstand tegen hernieuwbare energieprojecten. De acceptatie studies beschrijven 45 unieke factoren zoals transparantie en vertrouwen. Landschapsontwerp studies beschrijven 16 unieke factoren zoals landschap narratief en multifunctioneel landgebruik. De twee studievelden beschrijven 25 vergelijkbare factoren. Wanneer ik de factoren uit de literatuur vergelijk met een recente studie over lokaal draagvlak voor een SPP, vind ik een hiaat tussen de factoren die daarin worden benadrukt door de lokale gemeenschap en de huidige onderzoeksagenda. Bovendien laten de resultaten zien dat beide studievelden baat hebben bij meer samenwerking tussen deze wetenschappelijke disciplines.

In de tweede onderzoeksmodule heb ik gereflecteerd op de invloed van een participatief ontworpen, op ware grootte gebouwd, prototype op het lokaal draagvlak voor een zonneveld in één casus: Nauerna. In dit onderzoek maakte ik gebruik van action research, een methode waarbij je volledig geïntegreerd bent in de praktijk. De resultaten van het onderzoek tonen aan dat het prototype heeft geholpen om de status quo bias te doorbreken – een voorkeur voor het behouden van de huidige staat - doordat het prototype het inzicht van lokale stakeholders vergrootte in de fysieke impact van dit ontwerp en zij een beter beeld kregen van de visuele impact op hun leefomgeving. Het prototype en gerelateerde ontwerpproces hadden een positieve invloed op de lokale opinie over een zonneveld ontwikkeling: 81% reageerde (heel) positief op de zonneveld ontwikkeling in hun directe omgeving. Hierdoor kan ik concluderen dat een prototype, gebouwd op ware grootte, een positief effect heeft op lokaal draagvlak. Daarnaast was de actieve betrokkenheid van de lokale gemeenschap een zeer belangrijke factor voor lokaal draagvlak. Zelfs met aanvankelijke lokale weerstand, maakte dit type inclusief ontwerptraject de verschillende perspectieven bespreekbaar in een vroeg stadium en kon er gezamenlijk worden gezocht naar alternatieve ontwerpoplossingen. De onderzoeksresultaten tonen aan dat een actieve deelname en de mogelijkheid om de uitkomsten te beïnvloeden belangrijke factoren zijn voor het versterken van lokaal draagvlak.

In de derde onderzoeksmodule heb ik aanbevelingen beschreven voor energiebeleid op basis van een evaluatie van de voor- en nadelen van participatieve ontwerpprocessen in zonneveld ontwikkeling in Nederland. Ik werkte als ontwerper in drie pilots van het Energietuinen NL project, waarbij ik research through designing toepaste, een gerenommeerde methode voor ontwerpend onderzoek. Gebaseerd op deze meervoudige case studie heb ik aangetoond dat huidige participatieve ontwerpprocessen met name voordelig zijn voor lokale omwonenden om hun zorgen over de beoogde SPP ontwikkeling te agenderen. De deelname van professionals zorgde voor meer aandacht in het ontwerpproces voor omgevings- en sociaal-culturele doelstellingen, wat een relevante vooruitgang is in de duurzame ontwikkeling van zonnevelden. Bovendien droeg de betrokkenheid van verschillende belangengroepen bij aan de procedurele rechtvaardigheid. Desalniettemin heb ik ook vastgesteld dat de belangen die door lokale omwonenden worden geagendeerd, zoals zichtbaarheid, niet altijd overeenkomen met bredere maatschappelijke belangen, zoals landschapskwaliteit. Daarnaast vertoonden de participatieve ontwerpprocessen een disbalans in de mogelijkheden van deelnemende belanghebbenden om uitkomsten te beïnvloeden. Dit betekende dat voorstellen van professionals makkelijker werden aangepast of uit het ontwerp werden verwijderd in tegenstelling tot voorstellen van lokaal omwonenden. Daarnaast blijkt dat het huidige beleid geen duidelijke definities geeft voor omgevings- en sociaal-culturele doelstellingen en dat deze doelstellingen niet gelden als bindende eisen voor een bouwvergunning of subsidie aanvraag. Dit bemoeilijkt de verwezenlijking van omgevings- en sociaal-culturele doelstellingen in de aanleg van zonnevelden. Gebaseerd op deze bevindingen doe ik aanbevelingen om gemeentelijk beleid te verbeteren en/of direct de eisen van de nationale hernieuwbare energie subsidie aan te passen. Door eerst scherpere definities te bepalen voor omgevings- en sociaal-culturele doelstellingen die kunnen gelden als bindende eisen voor vergunning- en subsidie aanvragen. En vervolgens de balans te verbeteren van betrokken belangengroepen en hun mogelijkheden om de uitkomsten te beïnvloeden in participatieve ontwerpprocessen rondom zonnevelden.

In de vierde onderzoeksmodule heb ik vijf recent gebouwde zonnevelden in Nederland geëvalueerd om de discrepanties te analyseren tussen de documentatie van de omgevingsvergunning en de gebouwde realiteit. In deze evaluatie komen 79 discrepanties naar voren in fysieke ingrepen, zoals aanpassingen in de lay-out van het zonne-energie systeem, of de aanplant van kleinere afschermingsvegetatie dan getekend. De oorzaken voor deze discrepanties heb ik onderzocht door middel van gestructureerde interviews met sleutelpersonen betrokken bij de ontwikkeling van deze vijf zonnevelen. De oorzaken verwijzen naar veel verschillende momenten en aspecten in het ontwikkelingsproces van zonnevelden. De analyse toont aan dat de gevonden discrepanties een negatief effect kunnen hebben op de landschapskwaliteit. In deze onderzoeksmodule heb ik landschapskwaliteit gebruikt as proxy voor bredere maatschappelijke waarden. De druk op landschapskwaliteit laat een disbalans zien in bereikte doelstellingen in de huidige zonneveld ontwikkeling. De resultaten verwijzen naar een conventionele aanpak in zonne-energie ontwikkeling waarbij de focus ligt op technisch-economische doelstellingen, en waarin omgevings- en sociaal-culturele doelstellingen kunnen verdwijnen gedurende het ontwikkelingsproces. Op basis van deze bevindingen beargumenteer ik een versterking van de positie van de landschapsarchitect. Door te zorgen voor een groter mandaat en meer mogelijkheden om hun kennis over het landschap en (participatieve) ontwerp vaardigheden in te zetten bij het ontwerpen aan zonnelandschappen. Landschapsarchitecten kunnen vele verschillen overbruggen in het zonneveld ontwerp- en ontwikkelingsproces. Zij kunnen een verbindende rol oppakken, waarbij ze de verschillen tussen belanghebbenden adresseren, als ook de verschillen tussen vergunningsdocumentatie en gebouwde realiteit van zonnevelden. Om dit mandaat en een betere zonneveld ontwikkeling te realiseren is een hogere prioriteit nodig voor omgevings- en sociaal-culturele doelstellingen op nationaal niveau en striktere definities als bindende eisen in vergunningstrajecten op gemeentelijk niveau.

De bevindingen van de onderzoeksmodules verwijzen naar verschillende tekortkomingen in de huidige praktijk van zonneveld ontwikkelingen. Deze tekortkomingen worden bijvoorbeeld zichtbaar in de disbalans tussen lokale en maatschappelijke belangen in participatieve ontwerpprocessen en in de grote discrepanties tussen vergunningsdocumentatie en gebouwde realiteit van zonnevelden. Veelal worden de omgevings- en sociaal-culturele doelstellingen, die aan het begin van een project worden vastgesteld, gedurende het project ter zijde geschoven. Veel resultaten verwijzen naar een focus op technisch-economische doelstellingen, die het moeilijk maakt om additionele doelstellingen te behalen. Zo werd in één van de cases de maatregelen om biodiversiteit te vergroten, een voorbeeld van een omgevingskwaliteit, deels teruggedraaid en in oppervlakte verkleind om kosten te besparen. In een andere casus werden recreatieve voorzieningen, een voorbeeld van een sociaal-culturele kwaliteit, weggelaten om de business case te verbeteren. Om deze scheve balans in zonneveld ontwikkeling te herstellen is het nodig om andere activiteiten te initiëren zodat de balans in doelstellingen kan worden verbeterd in toekomstige zonneveld ontwikkelingen. Ik heb gebruik gemaakt van transitie management als raamwerk om op mijn bevindingen te reflecteren. In transitie management worden strategische, tactische, operationele, en reflectieve activiteiten beschreven. Op basis van de onderzoeksmodules kan ik zeven sleutel activiteiten definiëren die de balans tussen technisch-economische doelstellingen en omgevings- en sociaal-culturele doelstellingen verbeteren en die aanpassingen voorstellen voor participatieve ontwerpprocessen om zowel lokale als maatschappelijke belangen te adresseren. Allereerst toont het onderzoek aan dat er een visie mist op participatief ontworpen zonnelandschappen. Een dergelijke visie moet aandacht besteden aan alle vier dimensies van duurzaamheid – techniek, economie, omgeving, en sociaal-cultureel – als ook een bredere set van factoren die lokaal draagvlak beïnvloeden. Ten tweede moeten beleidsmakers scherpere definities stellen voor omgevings- en sociaal-culturele doelstellingen als bindende eisen voor vergunnings- en subsidie aanvragen. Ten derde toont dit onderzoek het belang aan van vroege en inclusieve ontwerpprocessen welke geïnitieerd moeten worden in de zonneveld ontwikkeling om de betrokkenheid van belanghebbenden te verbeteren. Ten vierde is het van belang om te zorgen voor een betere balans in de mogelijkheden van belanghebbenden om de uitkomsten van een proces te beïnvloeden om zo de procedurele rechtvaardigheid te vergroten. Ten vijfde kan de positie van de landschapsarchitect worden verbeterd in het ontwerp en ontwikkelingsproces van zonnevelden door te zorgen voor een groter mandaat en meer mogelijkheden om te ontwerpen en participatieve ontwerpprocessen te faciliteren. Ten zesde moeten gemeenten een praktijk van monitoren en audits realiseren om overeengekomen afspraken met ontwikkelaars na te komen. Tenslotte is er behoefte aan geïnstitutionaliseerde feedback systemen om geleerde lessen te implementeren in de toekomstige praktijk van zonneveld ontwikkelingen. Deze sleutel activiteiten helpen individueel op een bepaald moment om een specifieke doelstelling te behartigen. Echter, de sleutel activiteiten zijn het sterkst wanneer zij allen worden geïntroduceerd, zo kunnen zij elkaar versterken. Het initiëren van de sleutel activiteiten kan worden gezien als een eerste bod om de participatieve ontwerpprocessen van zonnelandschappen te agenderen. De sleutel activiteiten hebben reflectie nodig om ze door de tijd heen te verbeteren, omdat ze niet meteen alles omvattend kunnen zijn. De zeven sleutel activiteiten vormen een aanpak die de huidige praktijk van zonneveld ontwikkeling verbeterd door meer ruimte te bieden aan omgevings- en sociaal-culturele doelstellingen terwijl technisch-economische doelstellingen nog steeds behaald worden, tegelijk doen ze recht aan de lokale belanghebbenden, het landschap, de lokale cultuur en waarden. In andere woorden, ze stimuleren een praktijk die ruimte geeft aan het ontstaan van zonnelandschappen.

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SENSE PhD Courses

- Environmental research in context (2019)
- Research in context activity: ‘Organising workshops with professionals for knowledge exchange on integral and inclusive design processes’ (2022)

Other PhD and Advanced MSc Courses

- Research Data Management, Wageningen Graduate Schools (2020)
- Scientific Writing, Wageningen Graduate Schools (2021)
- Intensive Writing Week, Wageningen Graduate Schools (2021)
- Transformative and participatory qualitative research approaches and methods, WASS (2022)

Management and Didactic Skills Training

- Stakeholder meeting EnergyGarden Mastwijk (2019)
- Series of three design workshops EnergyGarden Assen-Zuid (2020)
- Mock-up stakeholder sessions In My Backyard Please (2021)
- Chair group representative at the WIMEK PhD council (2020-2022)
- Supervising four MSc students (2020-2024) and three BSc students (2021) with thesis

Oral Presentations

- *Participatory design of sustainable solar landscapes: Experiences from The Netherlands.* PECSLR 2020/21, 29-30 September 2021, Jaén and Baeza (online), Spain
- *In My BackYard Please: Influencing local acceptance through a co-creative design process for a solar power plant.* SIET 2021, 18-19 November, Delft (online), The Netherlands
- *Scale matters: using a mock-up in participatory design of a solar power plant.* ECLAS 2022, 11-14 September 2022, Ljubljana, Slovenia
- *In my backyard please! The influence of visualization techniques in a participatory design process of a solar power plant in The Netherlands.* VRSC 2023, 13-15 November 2023, Chicago, United States of America

Colophon

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