



To support or oppose renewable energy projects? A systematic literature review on the factors influencing landscape design and social acceptance

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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 somewhat general 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, which is 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*.

1. Introduction

The transition to renewable energy, following from (inter-) national policies and agreements (e.g. the Paris Climate Agreement), leads to landscape transformations [1,2]. 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 [3,4].

The local implementation of renewable energy projects often lacks public support [5–8]. Many scholars affirm that public support is a key for a successful and timely transition to renewable energy [5,7,9–12]. 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 [9]. 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. [9,13–15]). 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 [15–19]. Bertsch et al. [20] 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 [21–24]. 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. [19,20]), the role of design in this landscape transformation receives little attention [6]. This is remarkable, because in many countries, such as the UK, The Netherlands, and Germany, landscape transformations

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are the outcome of a deliberate process in which various considerations are discussed and recorded in drawings, 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 we explore the relation between landscape design and acceptance of renewable energy projects. The study presents a novel theoretical synthesis [25] between the fields of ‘acceptance studies on renewable energy’ and ‘landscape design studies’. We study how these fields currently acknowledge each other, what overlaps exist between the fields in terminology and considered topics, 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 in these two domains. Additionally, the study provides an opportunity to relate our findings to the daily practice of policy-makers, practitioners and other stakeholders in both fields.

In the next section we introduce ‘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. 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.

2.1. Landscape design and renewable energy

The term landscape varies in status, meaning and usage [26,27]. Landscape can be referred to as (a) an indication of a place or terrain (e.g. [27]), (b) the visual perception, scenic value or experience of a place (e.g. [19]), 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) [28], 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 that influences local acceptance (e.g. [29–31]).

Scognamiglio [32] 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 [33]. In a recent study, Oudes & Stremke [33] 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 [34] 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 [4] 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 [4] 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 [4] is used as a basis in several landscape design studies on renewable energy landscapes (e.g. [23,35]).

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. [36] 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. [9,37]) that changes over time (e.g. [16,38]) and varies according to different geographical scales (e.g. [39]). Bertsch et al. [20] 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 [9,37], which can differ on geographical scales [39], that can be influenced [6], and can change over time [16,38].

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 [37]. However, many studies distinguish more specific factors for defining and measuring acceptance of renewable energy projects. Perlaviciute & Steg [14] 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 [41] presents a framework of project-related factors that influence local acceptance of renewable energy projects, namely place attachment, impact, trust, and procedural justice. Gözl & Wedderhoff [9] 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 [42] advanced the framework by Wüstenhagen et al. [8] 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. [15] 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. 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

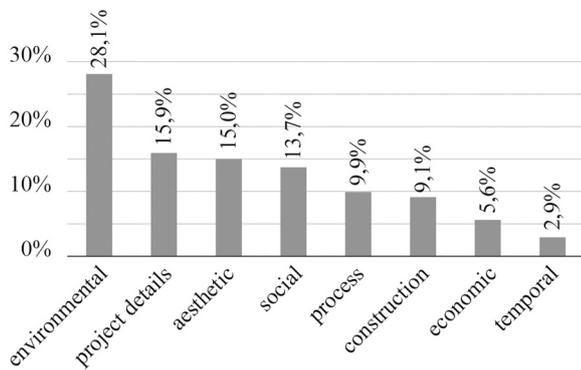


Fig. 1. Percentages of factors (i.e. determinants of community acceptance), from the public on a case study of a solar power plant [15].

literature. Interestingly, the factor environmental 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 always provide a definition of what they consider landscape to be (e.g. [43]). 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. [44,45]). 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 [6,16,46,63]. Bevk & Golobič [6] stress that landscape design should receive more attention when solar power plants are developed. Devine-Wright [47] 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.

3. Methods

This paper is based on a systematic literature review [48–50,52], 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 [50]: (1) search strategy development & implementation; (2) relevance & quality assessment; and (3) data extraction & synthesis.

3.1. Search strategy development & implementation

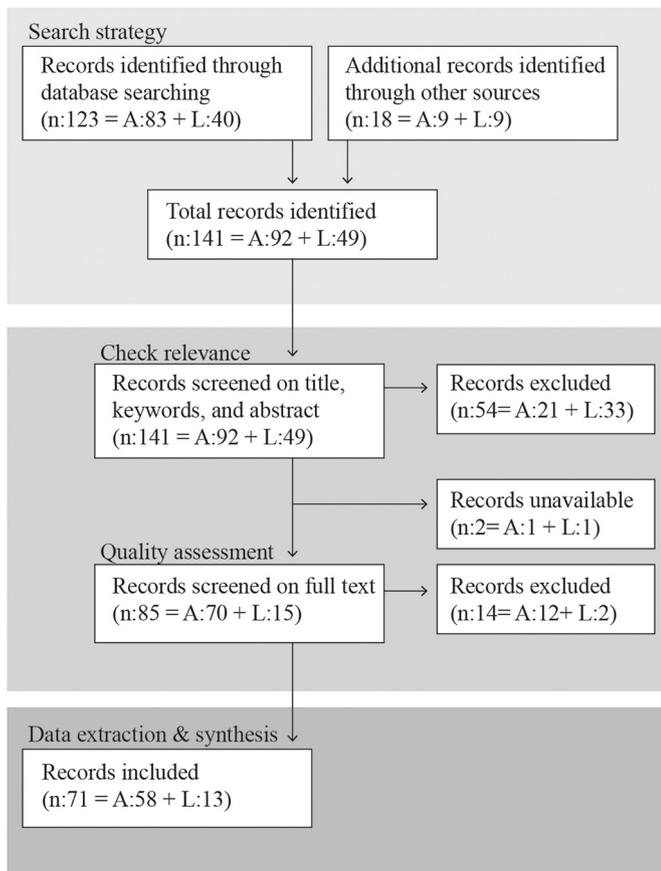
We performed two separate searches in the online database *Web of Science*. We used this database because it is considered to be the most sophisticated scientific search engine within The Netherlands, our university, and research domain. Moreover, *Web of Science* only includes

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. Because the literature search did not retrieve all records known by the authors we used a snow-ball technique to find additional relevant literature [51] 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 (Fig. 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 [48,50]. 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 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



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

Fig. 2. Process overview literature search, relevance & quality assessment, and data extraction & synthesis.

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.

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 [53]. 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. 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 [4], to examine how the factors relate to a theory from landscape design. And, secondly, categorizing the

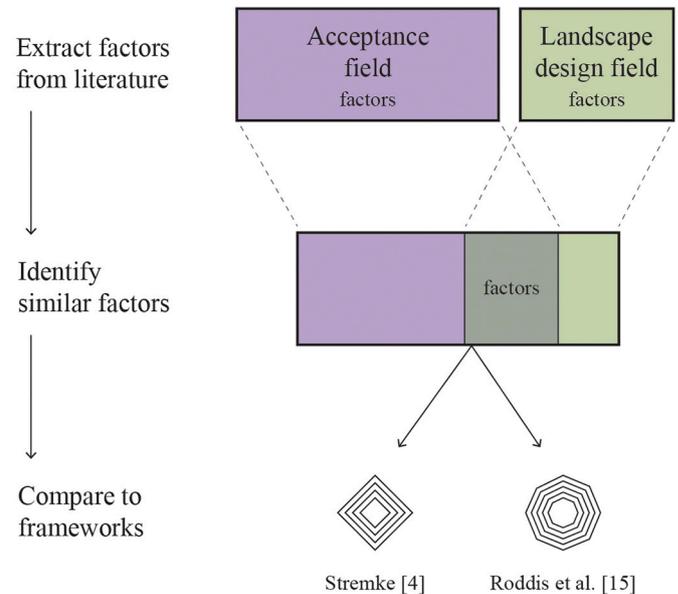


Fig. 3. Overview of steps performed during data extraction & synthesis.

factors according to the community acceptance framework by Roddis et al. [15], to perform a similar comparison with a framework from acceptance studies. In the comparison, we worked with percentages to deal with the 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.

4. Results

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 1).

4.1.1. Factors mentioned in acceptance studies

Overall the acceptance studies on renewable energy range from considering a few general factors (e.g. [9,54]) all the way to 28 specific determinants [15]. 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. [14,38,55]) and by others defined more specifically as *trust in the developer* (e.g. [41,45,46]), or as *trust in politics & institutions* (e.g. [16,56]). 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.

4.1.2. 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

Table 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 %)		<i>Community involvement & participation;</i>
often (40–60 %)	<i>Economic benefits; environmental impact; visual impact;</i>	<i>Aesthetics & scenic quality; community values; environmental concerns; perception of landscape change;</i>
Sometimes (20–40 %)	<i>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;</i>	<i>Economic benefits; visual impact; environmental impact; landscape quality; place attachment; attitudes (towards RE); economic impact; jobs; nuisance; project size; recreation and community activities;</i>
Seldom (< 20 %)	<i>Health & well-being; process; site selection; temporal dimension; transparency; moral & ethical values; design; landscape characteristics; trust; visibility; Attitudes (towards RE); landscape quality; wildlife habitats & -creation; CO2 emissions; knowledge & understanding of RET; price; perception of risk; project size; recreation & community activities;</i>	<i>Designing renewable energy landscapes; close collaboration with local authorities; involving farmers; landscape architect as facilitator; multifunctional land-use; Knowledge & understanding of RET; communication; CO2 emissions; decision making; landscape values; perception of risks; price; procedural justice; wildlife habitats & -creation;</i>
	<i>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.</i>	<i>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.</i>

describe several factors that influence acceptance (e.g. [23,30,57]). 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 [58]. Scognamiglio [32] 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*.

4.2. Similarities and differences between fields

When comparing both fields, 25 factors are literally similar or can be interpreted similarly (Table 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 [41]. 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). 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*.

4.3. Comparison of categorized factors

Lastly, we categorized the factors according to the four dimensions of the sustainable energy landscape framework [4] (Table 3), and to the conceptual framework of community acceptance [15] (Table 4). When we compare these categorizations some differences in focus on certain

Table 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

Table 3
Factors sorted according to dimensions of the sustainable energy landscapes framework [4].

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	12 %	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; visual impact; visual preference.	50 %	64 %	36 %

Table 4
Factors sorted according to main factors of the community acceptance framework [15].

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;	8 %	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; visual impact; visual preference.	8 %	7 %	50 %

aspects between both fields become visible (Fig. 4). Analysing the results with the framework on sustainable energy landscapes [4] 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 (14 % difference) and environmental aspects (6

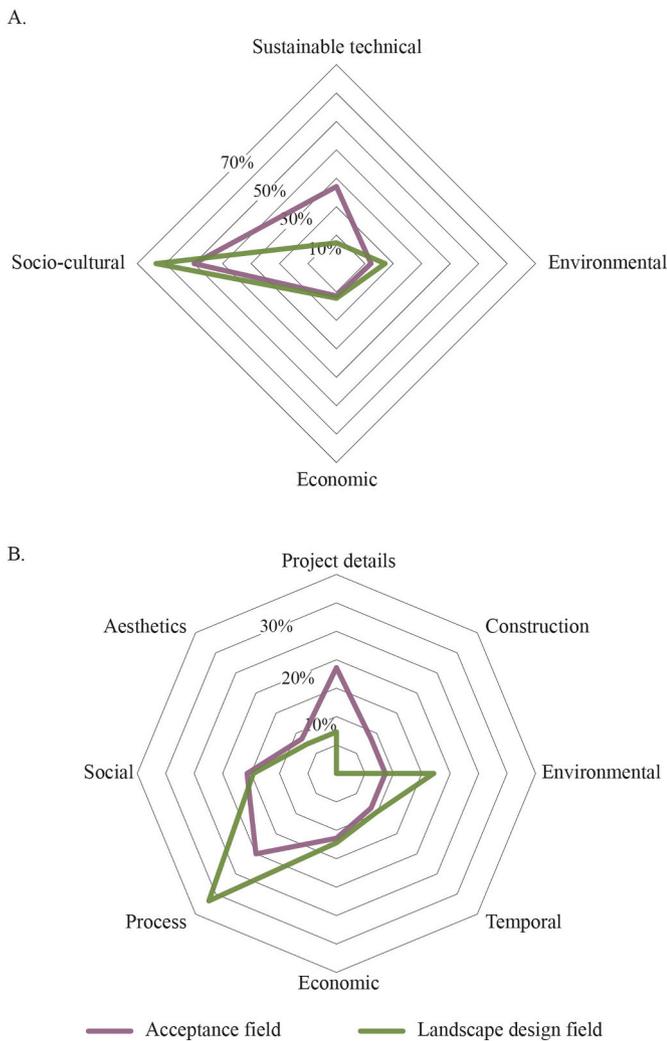


Fig. 4. Factors categorized according to the conceptual frameworks of (A) sustainable energy landscape [4] and (B) community acceptance [15].

% 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 [15] 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 construction (8 % difference), and project details (12 % difference). Landscape design studies have a stronger emphasis on environmental (8 % 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.

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 exist between the fields in terminology and considered topics, 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 1). The literature clearly shows that the discussion on these factors is still ongoing. Across both fields, but also within individual studies, much variation exists in the interpretation of factors as well as which factors are included or excluded when studying 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 1; Appendix A). We also illustrated that the attention to the factors differs for the two fields (Table 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 [4]. Moreover, both fields seem to place a similar emphasis on temporal, economic, social, and aesthetic factors when comparing the main factors to the community acceptance framework [15]. This indicates some alignment between the acceptance studies and studies on landscape design (Table 4; Fig. 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. Landscape architects that are conscious about the factor *trust* will gain a better understanding of the local situation and relations among the stakeholders. Social scientists could study the factor *process* more thoroughly, examining if more inclusive design processes indeed influence the local acceptance of renewable energy projects [6]. That is not to say that public engagement will secure public support for renewable energy developments [47].

Moreover, when we compare the scholarly research foci to the findings of the case study by Roddis et al. [15] (Section 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. [66] 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. [12], 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 or 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 [38], 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. [7,61,62]) or the moment when a landscape transformation has happened (e.g. [63]). 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 situation. 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 [32] 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 [65] 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). 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 [5]. Moreover, the *process* itself could get more attention. Many factors in the landscape design studies refer to the processes [21,22,55–57], 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. Future research should, among others, examine the influence of involving landscape architects and other 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 to realize procedural justice in the transition towards a post carbon future.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Overview of factors of acceptance of renewable energy

Ordered to relative difference between fields.

Only mentioned in Acceptance field
 Only mentioned in Landscape design field

Factors ↓	Study →	Acceptance field																				Landscape design field												Both fields											
		Bertsch et al. (2016)	Bevk & Golobic (2020)	Calvert et al. (2019)	Caporale et al. (2020)	Devine-Wright (2013)	Fast (2013)	Ferraro & Castiglioni (2017)	Firsirotu et al. (2018)	Gilz & Wedderhoff (2018)	Herby et al. (2012)	Kelly et al. (2016)	Ketzer et al. (2020a)	Konigsmann et al. (2014)	Liebs & Dobers (2019)	Lothian (2020)	Pasquanti (2014)	Perlovicina & Szig (2014)	Petrova (2016)	Roddis et al. (2020)	Sherren et al. (2019)	Spaeth (2018)	Spicthofer et al. (2021b)	Terrapone-Pfaff et al. (2019)	Wolank (2007)	Zoellner et al. (2008)	Total references in field (n)	Studies mention factor in field	Booch et al. (2020)	Oades & Stremke (2020)	Loebacero et al. (2019)	Picchi et al. (2019)	Stremke & Schibbe (2019)	Oades & Stremke (2018)	Picchi (2018)	Scogiamiglio (2016)	De Wael et al. (2015)	Ozgan et al. (2015)	De Wael & Stremke (2014)	Stremke & Kohn (2011)	Seimur (2010)	Total references in field (n)	Studies mention factor in field	Studies mention factor	
Health & well-being		1																										6	sometimes												0	never	seldom		
Moral & ethical values		1																										6	sometimes														0	never	seldom
Process		1	1																									6	sometimes														0	never	seldom
Site selection			1	1																								6	sometimes														0	never	seldom
Temporal dimension		1	1																									6	sometimes														0	never	seldom
Transparency			1	1																								6	sometimes														0	never	seldom
Design		1	1																									5	sometimes													0	never	seldom	
Landscape characteristics		1																										5	sometimes													0	never	seldom	
Trust																												5	sometimes													0	never	seldom	
Visibility (distance)		1																										5	sometimes													0	never	seldom	
Economic benefits		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	often	1	1	1										5	sometimes	often	
Visual impact		1																										11	often	1	1	1											5	sometimes	often
Environmental impact																												11	often	1	1											4	sometimes	sometimes	
Landscape values			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	sometimes		1											1	seldom	sometimes	
Decision making			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	sometimes													1	seldom	sometimes	
Procedural justice				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	sometimes													1	seldom	sometimes	
Communication		1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	sometimes													1	seldom	seldom	
Cultural heritage																												4	seldom													0	never	seldom	
Demographic characteristics		1																										4	seldom													0	never	seldom	
Fairness																												4	seldom													0	never	seldom	
Information		1	1																									4	seldom													0	never	seldom	
Regional added value																												4	seldom													0	never	seldom	
Technology		1																										4	seldom													0	never	seldom	
Trust in developer					1		1																					4	seldom													0	never	seldom	
(Cost) efficient				1																								3	seldom													0	never	seldom	
Geographical locations		1	1																									3	seldom												0	never	seldom		
Impact on agricultural land use																												3	seldom													0	never	seldom	
Property values																												3	seldom													0	never	seldom	
Safety of plant		1																										3	seldom													0	never	seldom	
Social values																												3	seldom													0	never	seldom	
Tourism																												3	seldom													0	never	seldom	
Air pollution		1																										2	seldom													0	never	seldom	
Construction		1																										2	seldom													0	never	seldom	
End-of-life																												2	seldom													0	never	seldom	
Landscape modification		1																										2	seldom													0	never	seldom	
Noise pollution		1																										2	seldom													0	never	seldom	
Physical characteristics of energy alternative																												2	seldom													0	never	seldom	
Project details																												2	seldom													0	never	seldom	
Trust in politics & institutions			1																									2	seldom													0	never	seldom	
Alternative options																												1	seldom													0	never	seldom	
Business model																												1	seldom													0	never	seldom	
Cumulative impacts																												1	seldom													0	never	seldom	
Flooding																												1	seldom													0	never	seldom	
Functional efficiency					1																							1	seldom													0	never	seldom	
Legacy																												1	seldom													0	never	seldom	
Light pollution																																													

Only mentioned in Acceptance field
 Only mentioned in Landscape design field

Factors ↓	Study →	Acceptance field																Landscape design field																Both fields																
		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)	Horbath et al. (2012)	Kelly et al. (2016)	Ketzer et al. (2020a)	Kontogianni et al. (2014)	Liebe & Dobers (2019)	Lothian (2020)	Pasqualetti (2011a)	Perlaviciute & Steg (2014)	Petrova (2016)	Roddis et al. (2020)	Sherrin et al. (2019)	Spaeth (2018)	Spielhofer et al. (2021b)	Terrapon-Pflaff et al. (2019)	Wolsink (2007)	Zoellner et al. (2008)	Total references in field (n)	Studies mention factor 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)	Scogliamiglio (2016)	De Waal et al. (2015)	Ozgun et al. (2015)	De Waal & Stremke (2014)	Stremke & Koh (2011)	Selman (2010)	Total references in field (n)	Studies mention factor in field	Studies mention factor						
Environmental (in)justice																												0	never	1	1															2	seldom	seldom		
Inclusive and bottom-up processes																												0	never							1	1											2	seldom	seldom
Attitudes (towards RE)							1						1			1										1	4	seldom			1			1	1									3	sometimes	seldom				
Landscape quality												1			1										1	4	seldom	1			1					1	1						4	sometimes	sometimes					
Project size																									1	1	seldom						1	1						1	3	sometimes	seldom							
Recreation and community activities																									1	1	seldom			1					1				1	3	sometimes	seldom								
Aesthetics & scenic quality				1	1		1	1							1					1	1				1	9	sometimes	1	1	1	1	1					1			1	6	often	sometimes							
Community values				1	1		1	1	1						1					1					1	7	sometimes	1	1	1	1	1		1					1	6	often	sometimes								
Perception of landscape change					1	1								1		1				1					1	6	sometimes	1		1	1	1	1	1					1	6	often	sometimes								
Environmental concerns		1												1		1				1					1	5	sometimes	1	1	1	1			1					1	6	often	sometimes								
Collaboration with local authorities																											0	never		1	1										3	sometimes	seldom							
Involving farmers																											0	never			1				1	1					3	sometimes	seldom							
Landscape architects as facilitator																											0	never				1		1						3	sometimes	seldom								
Multifunctional land-use																											0	never	1		1			1							3	sometimes	seldom							
Designing RE landscapes																											0	never					1	1	1	1	1				4	sometimes	seldom							
Community involvement & participation								1	1				1	1	1											1	7	sometimes	1	1	1		1	1	1	1	1	1	1	10	very often	often								

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