The interrelationships between renewable energy infrastructure and tourism: A thematic literature review

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Abstract:
Increasing demand for renewable energy and rapid tourism growth point to the need for a better overview of the factors affecting the compatibility of renewable energy infrastructure (REI) with tourism. This study aims to systematically review existing research on the interrelationships between REI and tourism, to identify their type and character and the factors affecting them, and to critically discuss planning and policy implications. Analysis of 61 original articles published in international peer-reviewed journals revealed opportunities for synergic relationships, but also showed REI can negatively impact tourist experience, leading to reduced tourism demand and economic loss. Three groups of factors shaping the interrelationships between REI and tourism were identified: (1) factors related to REI, (2) locational factors, and (3) factors related to tourism stakeholders. These factors should be considered while planning REI developments to ensure sustainable coexistence with tourism, but their role highly depends on the context surrounding each REI project. The findings highlight the importance of tourism stakeholder inclusion through participatory approaches in the early stages of renewable energy planning to ensure the identification and potential preservation of resources crucial for tourism.

Keywords: Renewable energy infrastructure; tourism; interrelationships; land use conflicts

1 Introduction

With increasing adoption of renewable energy (IRENA, 2024) and a rapid tourism recovery worldwide after the COVID-19 pandemic (UNWTO, 2024), encounters between renewable energy infrastructure (REI) and tourism are becoming more likely. This stresses the need for a better understanding of the interrelationships between REI and tourism, which are complex and multilayered. Tourism needs energy for its operations and is a significant contributor to energy demand and global warming. Excluding forcing effects, tourism's greenhouse gas (GHG) emissions account for around 8% of global emissions (Lenzen et al., 2018; Liu et al., 2023). The majority of emissions are transport-related and are expected to keep increasing (UNWTO, 2019). Thus, tourism relies on renewable energy sources for reducing its carbon footprint (Beer et al., 2018; Zolfani et al., 2015).

Both tourism and renewable energy play an important role in achieving the UN Sustainable Development Goals (SDGs) (UN General Assembly, 2015). Substantially increasing the share of renewable energy in the global energy mix by 2030 is one of the targets of Goal 7, focusing on ensuring access to affordable, reliable, sustainable and modern energy for all. The role of sustainable tourism is stressed in the targets for Goal 8, focusing on decent work and economic growth, Goal 12 on responsible consumption and production, and Goal 14, aiming at conservation and sustainable use of the oceans, seas and marine resources (UN General Assembly, 2015). However, as noted by UNWTO (n.d.), tourism can significantly contribute to achieving all SDGs. Synergic relationships between energy and tourism sectors can support reaching SDGs. Increased use of renewable energy sources in tourism facilities can contribute to more sustainable tourism practices (Gössling & Lund-Durlacher, 2021; Silva, 2022), while visits to power plants can positively influence public attitudes towards renewable energy (Frantál & Urbánková, 2017). However, both tourism and the harnessing of renewable energy require land or marine locations for which, in some cases, they have to compete. Hence, with increasing REI developments and rapid tourism growth land use conflicts are foreseeable, raising fundamental public policy questions related to REI and tourism. Concerns about potential impacts on tourism and recreation play an important role in shaping the degree of public support for REI, especially in regions where tourism is an important economic sector (Mordue et al., 2020; Rudolph, 2014). Consequently, while REI is sometimes proposed to strengthen tourism, stakeholder concerns related to potential impacts of such infrastructure on tourism can lead to delays, downsizing or even the rejection of renewable energy projects

(Kohsaka & Kohyama, 2022). Importantly, such concerns can also result in lower interest in investing in local renewable energy projects (Sirr et al., 2023).

Therefore, to minimize the likelihood of conflicts between renewable energy harnessing and tourism, an overview of existing knowledge on the complex interrelationships between REI and tourism and the factors shaping them is needed, which should be taken into consideration while planning REI developments. Such an overview is currently lacking. This study aims to address this research gap by systematically reviewing academic literature focusing on the topic. The literature review focuses on the types of REI that require harnessing of renewable energy resources where they are available, such as hydro, geothermal, wind, and marine power plants, since such infrastructure is more likely to complicate its compatibility with tourism (Tverijonaite et al., 2022).

The objectives of this literature review are: (1) to review existing research on the interrelationships between REI and tourism, (2) to identify the type and character of these interrelationships and the factors affecting them, and (3) to discuss implications for REI planning stemming from existing research and provide policy recommendations. The present review furthermore identifies existing research gaps and opportunities for further research.

Since the studies focusing on REI and tourism employ a wide range of methods, including qualitative, quantitative and mixed research methods, a systematic mixed studies review (Pluye & Hong, 2014) was conducted to provide a comprehensive overview and a thorough understanding of the complex and multifaceted interrelationships between REI and tourism.

2 Methods

This systematic literature review was conducted using the following seven steps, as suggested by Pluye and Hong (2014), for mixed studies review: (1) formulating review questions and objectives, (2) defining selection criteria, (3) conducting an extensive literature search, (4) identifying potentially relevant studies, (5) selecting relevant studies, (6) quality appraisal of the studies, and (7) analysing the studies and synthesising the findings.

During the first two steps of the review, the review questions and objectives were set, and these served to define the search terms, the databases, and the selection criteria. In the third step, the literature search was conducted by using two databases: Scopus and Web of Science, as they are the largest databases of peer-reviewed scientific literature.

Since English is the main language of international academic publishing, only publications in English were included in this review. The keywords used during the search were the following: TITLE-ABS-KEY(("renewable energy infrastructure" AND touris*) OR (("wind power" OR "wind turbine*" OR "wind farm*") AND touris*) OR ((hydropower OR "hydro power" OR hydroelectricity) AND touris*) OR (("geothermal energy" OR "geothermal power") AND touris*) OR (("solar panel* OR "solar power" OR "solar PV") AND touris*) OR (("wave power" OR "marine power" OR "marine energy") AND touris*)). The literature search aimed to identify the publications containing these keywords in the title, abstract or keywords.

To provide a comprehensive overview of existing research, no time frame was set for the literature search. To ensure that high quality publications are included in the literature review only original research articles published in peer-reviewed international journals were included. The data search was conducted at the end of February 2022. The initial literature search produced 745 results in total: 437 in Scopus and 308 in Web of Science. After duplicates were removed, 502 articles remained to be assessed in the next step of the review (Figure 1).

The abstracts of the articles were read, and relevant papers were selected. During the selection, 44 articles were excluded from the review since they were published in languages other than English. A further 383 articles were excluded from this review since they were not directly related to the topic.

In the fifth step, the full texts of 75 articles were reviewed. After assessing the full texts, 21 articles were furthermore excluded from the review. Additionally, the reference lists of each paper were scanned, and seven articles were identified which, after assessing their full texts, were added to this review, resulting in 61 articles evaluated in this review. During the next step, the quality of the selected 61 articles was assessed.

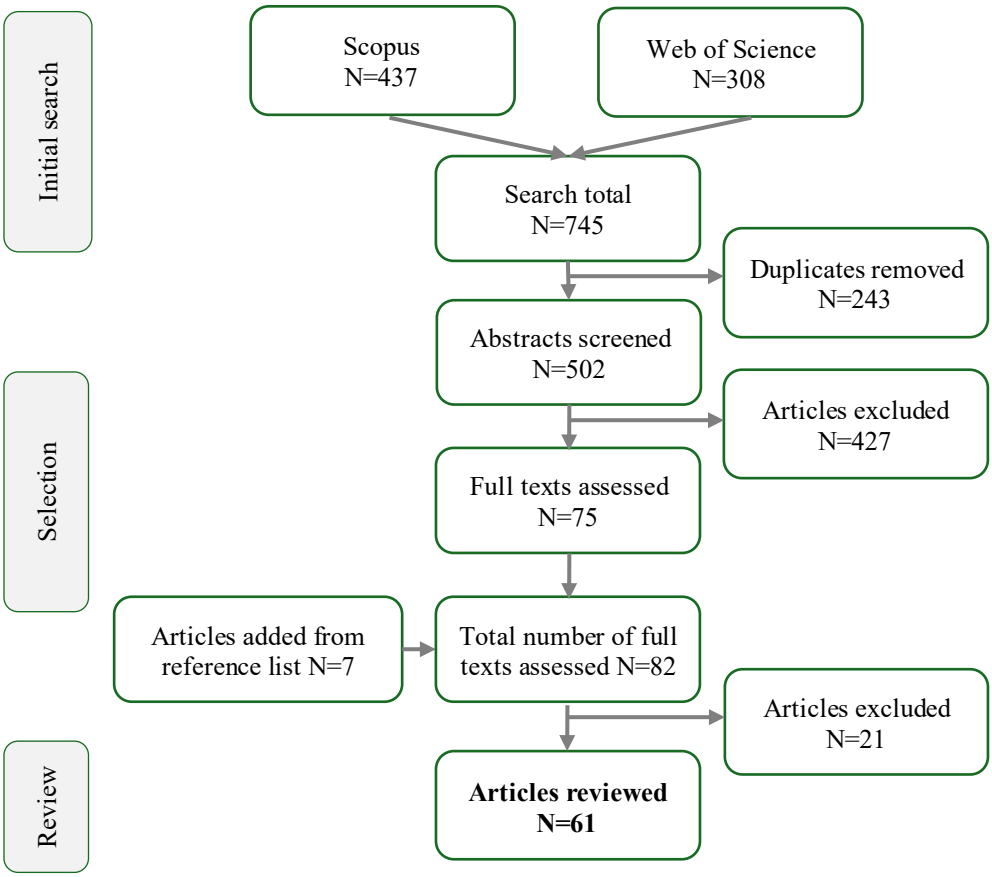

Figure 1. The steps applied in the literature review.

In the seventh step, the articles were categorised based on various factors, such as their main focus, type of discussed REI, countries and type of settings in which the research was conducted, type and character of the identified interrelationships between REI and tourism, the factors shaping them, as well as theoretical, practical, and/or management implications of the findings of analysed papers. The articles were further classified based on methods and sample used in each study. Data-based convergent synthesis design was selected for this review, meaning that all studies based on different methods were analysed by employing the same synthesis method and the findings were presented and discussed together (Hong et al., 2017). Thematic synthesis was further conducted by transforming quantitative data into themes or categories. Thematic synthesis based on grounded theory (Corbin & Strauss, 2008) was conducted in three steps: (1) coding the findings of the reviewed studies, (2) developing descriptive themes, and (3) generating analytical themes (Thomas & Harden, 2008). The findings of the review and their implications for energy planning and policy are discussed below, and suggestions for future research are made.

3 Results

3.1 An overview of the reviewed articles

The results revealed a growing interest of the academic community in the interrelationships between REI and tourism. While this topic is relatively new with only two reviewed articles published before the year 2000, the number of articles focusing on REI and tourism has been rapidly increasing. However, in 2021 fewer articles investigating the interrelationships between REI and tourism were published, which might be related to the impacts of COVID-19 pandemic on both tourism and research (Figure 2).

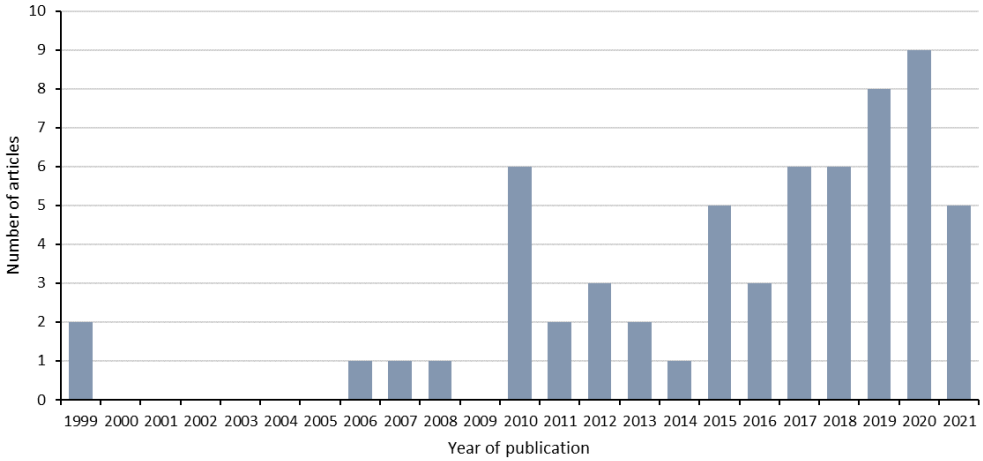

Figure 2. Number of reviewed articles by year of publication.

Geographical analysis of the distribution of the study areas showed that existing research is concentrated geographically in specific regions (Figure 3). The country with the most articles on the interrelationships between REI and tourism was Iceland (17), 12 articles focused on study areas in the USA, seven in the United Kingdom, followed by Spain (4), France (3), China (3) and Czech Republic (3). Australia, Germany and Portugal were each the focus of two articles. Twelve countries were the focus of one article each. In total, 22 countries were represented in the literature. Three studies focused on multiple countries when discussing REI and tourism. Notably, very limited research was undertaken in less developed countries.

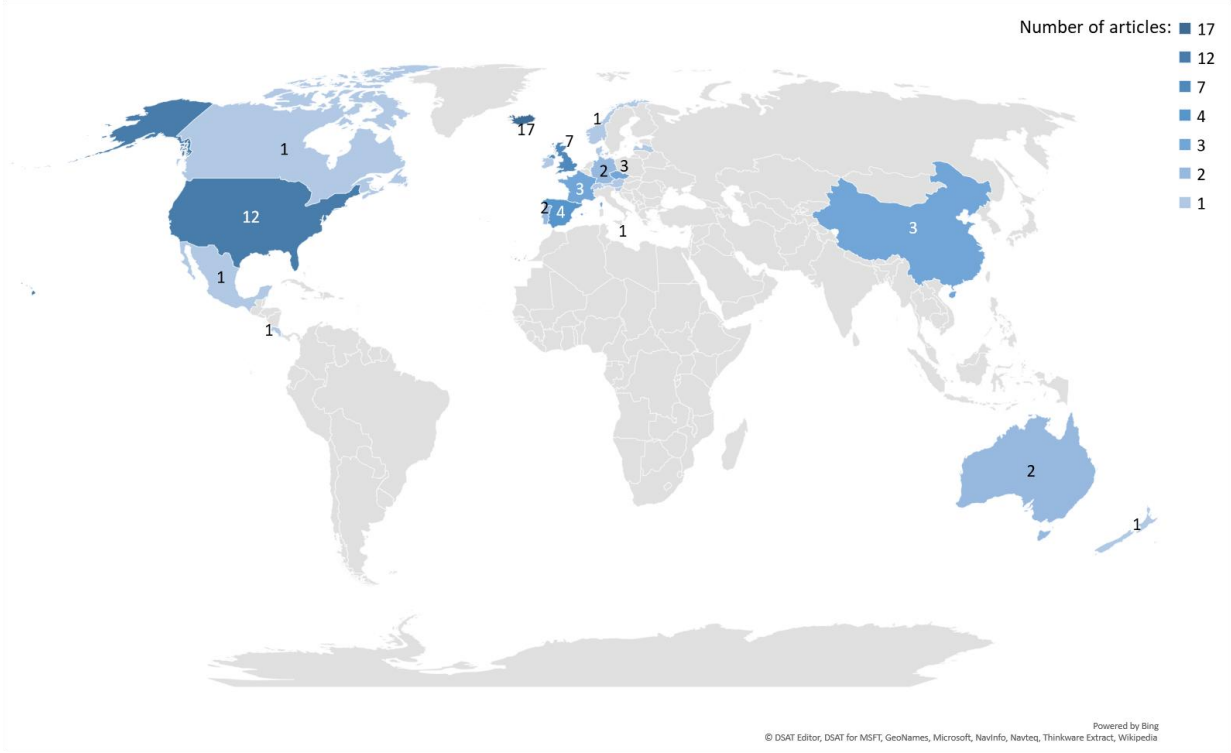

Figure 3. Geographical distribution of the study areas selected in the reviewed articles.

The reviewed research was published in 36 journals. Eighteen articles were published in journals with the main emphasis on energy, 17 were published in tourism journals, nine in policy or management journals, and 17 in journals focusing on other topics, such as sustainability, geography, or economics (Table 1). Based on their scope, some of the journals fall into several categories and were categorized according to their primary focus.

Table 1. Academic journals which published articles focusing on the interrelationships between REI and tourism 1999-2021. Category "other journals" comprises journals which published only one article.

Journal focus	Journal title	No. of articles
Energy	*Renewable Energy*	4
	Energy Policy	4
	Energy Research and Social Science	3
	Resource and Energy Economics	3
	Other Journals	4
Tourism	*Journal of Sustainable Tourism*	3
	Journal of Outdoor Recreation and Tourism	2
	Current Issues in Tourism	2
	Scandinavian Journal of Hospitality and Tourism	2
	Journal of Heritage Tourism	2
	Other Journals	6
Policy/management	*Land Use Policy*	3
	Marine Policy	2
	Ocean and Coastal Management	2
	Other Journals	2
Other	*Sustainability*	4
	Moravian Geographical Reports	2
	Impact Assessment and Project Appraisal	2
	Other Journals	9
	Total:	61

Regarding the type of REI, onshore wind turbines have received the most attention and were discussed in 23 of the reviewed articles (Figure 4). Of these, 10 articles discussed proposed or hypothetical wind turbines, nine articles focused on existing wind turbines and four included both existing and proposed or hypothetical onshore wind turbines. The number of articles discussing offshore wind turbines was slightly lower (20), hydropower plants were the focus of 16 articles, geothermal power plants were discussed in 10 articles, while solar power infrastructure was the focus of four articles. The articles discussing tidal, wave and ocean currents power infrastructure focused on proposed/hypothetical infrastructure, and two articles discussed proposed/hypothetical biomass power plants. Two articles examined proposed/ hypothetical REI and its interrelationships with tourism without specifying the type of

infrastructure. Out of the 61 reviewed articles, 13 focused on several types of REI, with six papers discussing hydropower and geothermal power plants and tourism, two onshore wind turbines and solar power infrastructure, and one onshore wind farm, coal mine and nuclear power plant.

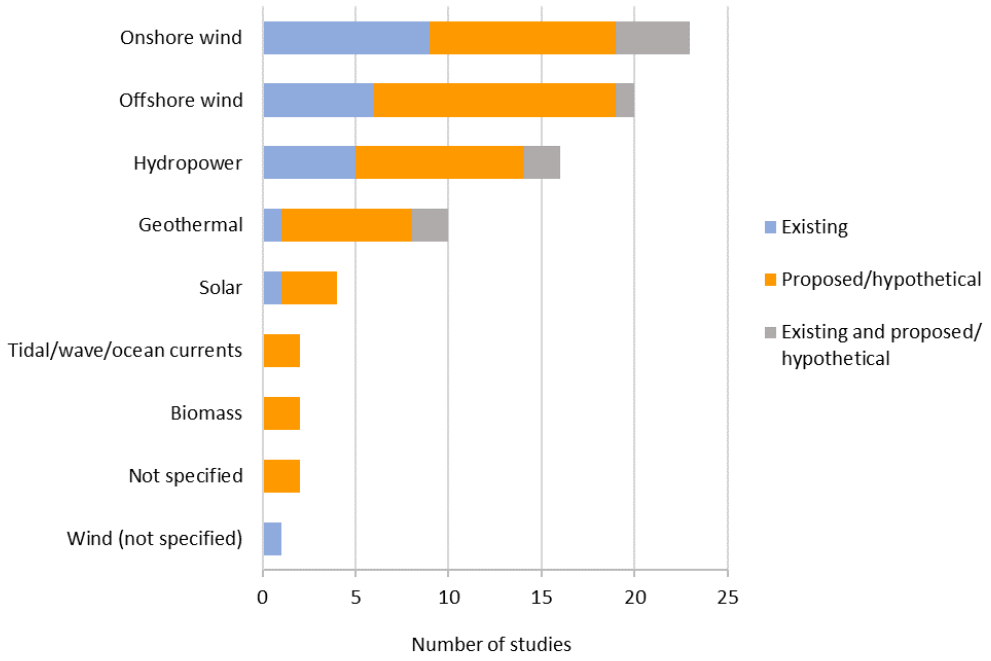

Figure 4. Type of REI discussed in the reviewed articles.

The majority of the reviewed articles (55) were based on empirical data. Most articles (41) used primary data, five used secondary data, and nine used both (Table 2). Eight empirical studies used qualitative data, 29 used quantitative data and 18 used mixed data.

Table 2. Data used in the reviewed articles.

Data	N	%	Data	N	%
Primary	41	75	Quantitative	29	55
Secondary	5	9	Qualitative	8	15
Both	9	16	Mixed	18	31
Total:	55	100	Total:	55	100

Among the 41 studies that used primary data, the most prevalent data collection method were questionnaire surveys (used in 38 studies), followed by interviews (16) (Table 3). Focus group discussion and participant observation were each employed in three studies. Other primary data

collection methods included diaries (2), field surveys (2) and experiments (2). Twelve studies used multiple data collection methods.

Table 3. Primary data collection methods

Primary data collection methods	N
Questionnaire survey	38
Interview	16
Focus group	3
Participant observation	3
Diary	2
Field survey	2
Experiment	2
Total:	66

3.2 The interrelationships between renewable energy infrastructure and tourism

Thematic analysis and synthesis of the articles revealed several emerging themes related to REI and tourism: (1) tourism stakeholders' attitudes toward REI, their perceived impacts, and potential changes in behaviour due to construction of REI; (2) economic impacts of REI on tourism; (3) REI as a tourist attraction; (4) factors affecting the interrelationships between REI and tourism; and (5) tourism-related REI planning. The themes are further detailed in the remainder of this section.

3.2.1 Tourism stakeholder attitudes toward REI, perceived impacts, and behaviour

The findings of the reviewed articles focusing on tourism stakeholders, which in this literature review include tourists, tourism operators, and residents as recreationists and stakeholders affected by tourism and energy development in the area, point to the heterogeneity of their attitudes and to multiplicity of factors affecting them (Frantál & Kunc, 2011; Landry et al., 2012; Navratil et al., 2019; Parsons et al., 2020; Voltaire & Koutchade, 2020). However, in line with the attitudes of the general public, tourism stakeholders tend to be more positive toward renewable energy and related infrastructure in general, but less supportive of specific REI projects (Brudermann et al., 2019; de Sousa & Kastenholz, 2015; Ólafsdóttir & Sæþórsdóttir, 2019). The negative attitudes of tourism stakeholders toward REI are often

related to perceived or potential negative impacts of REI on tourism. Visual impacts of REI on the surrounding landscape have been shown in numerous studies (de Sousa & Kastenholz, 2015; Mordue et al., 2020; Ólafsdóttir & Sæþórsdóttir, 2019; Parsons et al., 2020; Silva & Delicado, 2017; Sæþórsdóttir et al., 2021) to be among the main concerns of tourism stakeholders. Such impacts, some studies suggest (Sæþórsdóttir & Saarinen, 2016b; Sæþórsdóttir et al., 2021), are likely to lead to changes in the image and character of tourist destinations, reduced quality of the tourist experience and lower tourism demand. Concerns about visual impacts are especially prominent in studies focusing on wind energy infrastructure due to its high visibility (Brudermann et al., 2019; de Sousa & Kastenholz, 2015). With regard to the negative impacts of offshore wind turbines on tourism, Rudolph (2014) identified several storylines used by wind farm opponents including: visual disruption, disruption of local character and identity, disturbance of coastal recreational activities, and environmental impacts.

However, visual impacts are not always perceived negatively. Offshore wind turbines off Block Island, USA, were mostly perceived positively by tourism stakeholders (Smythe et al., 2020; Smythe et al., 2021; Trandafir et al., 2020). Thus, the visibility of REI does not always equal perceived negative visual impacts. In areas where REI is regarded as compatible with the surrounding environment, it can be seen as a positive addition despite its high visibility (Frantál et al., 2017).

Visitor attitudes toward REI are likely to lead to changes in their behaviour. The construction of REI can result in avoidance or reduced use of surrounding areas for tourism and recreation (Parsons et al., 2020; Sæþórsdóttir et al., 2018; Voltaire & Koutchade, 2020), but such infrastructure can also become a tourist attraction (Frantál & Kunc, 2011; Lilley et al., 2010; Liu et al., 2019; Smith et al., 2018; Smythe et al., 2020). In some studies, no or very little change was observed in tourism demand due to the construction of REI (de Sousa & Kastenholz, 2015; Frantál & Kunc, 2011; Silva & Delicado, 2017; Warren & McFadyen, 2010). Notably, changes in visitation of areas affected by REI are not necessarily linear and can vary over time (Teigland, 1999).

REI construction is likely to affect the behaviour not only of tourists but also of tourism operators. In rural UK, 33% of tourism-related businesses surveyed by Mordue et al. (2020) stated that the existing or future onshore wind farm developments are likely to affect their business investment decisions. Tourism service providers operating in Iceland stated that they

would avoid onshore wind farms during their tours should they be constructed (Sæþórsdóttir et al., 2021).

3.2.2. Economic impacts of REI on tourism

In line with the observed heterogeneity of tourism stakeholders in attitude studies, research investigating the economic impacts of REI on tourism showed diverging results. However, most studies pointed to negative impacts on tourism demand and consequent economic losses. A study by Broekel and Alfken (2015), investigating impacts of onshore wind turbines on tourism demand in Germany, revealed that wind turbines in inland municipalities lead to lower accommodation occupancy rates. A 1% increase in the installed wind turbine capacity within 10 km from a municipality centroid results in 0.01% reduction in the occupancy rate of guest beds. The study also showed that coastal municipalities containing wind turbines experience lower occupancy rates, but in nearby municipalities, tourist demand increases, which can be due to displacement effect (Broekel & Alfken, 2015). Similarly, Riddington et al. (2010) estimated a total economic tourism loss due to implementation of onshore wind farms in Scotland to reach between 1.89% and 5.77% at area level. However, since most tourists are likely to relocate to other areas in Scotland containing fewer wind farms, the maximum estimated economic impact at the national level is likely to be less than 0.1% of the estimated employment in tourism (Riddington et al., 2010). Nevertheless, the results of Carr-Harris and Lang (2019), which used a hedonic valuation framework, contradict previously discussed findings. They estimated that during the peak months of July and August the construction of an offshore wind farm led to an increase in the number of reserved nights by seven nights/month and 19% increase in occupancy rates, resulting in $3490 revenue increase in AirBnb properties located on Block Island in USA. During other months no significant differences with control areas were observed.

Studies that combined the travel cost method with contingent behaviour and other methods mostly indicate economic losses due to construction of REI. Research conducted in Catalonia, Spain (Voltaire & Koutchade, 2020; Voltaire et al., 2017) revealed that most beach users viewed the construction of offshore wind turbines as unfavourable. None of the beach users reported intended increased beach use if wind turbines were constructed, while around 34% stated they would visit the beach less or not visit at all (Voltaire & Koutchade, 2020; Voltaire et al., 2017). The trip loss was higher in the scenario of a high number of wind turbines close to the shore and lower when a low number of turbines further away from the shore was

discussed. The authors, however, highlighted that almost 90% of beach users who predicted reduced beach visitation due to the construction of offshore wind turbines stated that they would visit other beaches in Catalonia not affected by wind energy development.

Veidemane and Nikodemus (2015) estimated that in 2012 construction of an offshore wind farm could lead to a 600,000 euro average annual loss in revenues equal to 20% of the local municipal budget of Pavilosta, Latvia, depending on the location of the wind farm. Voke et al. (2013) investigated potential economic impacts of tidal and wave energy infrastructure around St. David's, UK, and concluded that avoidance of the area due to implementation of marine energy development would be very low. Consequently, travel cost loss due to tourists not returning to the area after the development of marine energy infrastructure was estimated to reach £2784 and willingness to pay (WTP) £81, suggesting minor changes in the value of the area to visitors (Voke et al., 2013). Landry et al. (2012) conducted a survey among the households in North Carolina's Outer Banks region in USA and projected the future consumer surplus for beach trips under current conditions to be around $1068 per year, which would be reduced to $1051 if offshore wind turbines would be constructed, thus, the loss in consumer surplus is not statistically significant. In contrast, Hanley and Nevin (1999) found that the net percentage of visitors who would be less likely to visit an area if a biomass scheme was constructed reached 14.5%, for small-scale hydropower project it reached 9.3%, and just 1.4% for onshore wind turbines.

Reviewed contingent valuation studies assessing nonmarket costs related to construction of REI also revealed divergent results. In response to being asked about activities with or without views of the existing wind farm offshore of Block Island, USA, 32.7% of tourists were indifferent, 5.7% always preferred activities with the view of wind turbines, while 19.4% preferred undertaking activities without the view of the wind turbines (Trandafir et al., 2020). The preferences of the remaining 42.2% of the respondents were shaped by the activity. However, average WTP was positive among all activities, with highest WTP for sightseeing, followed by fishing, boating, visiting beach and the lowest for birding/whale watching with views of the wind turbines. This suggests that the construction of the wind farm improved tourist welfare (Trandafir et al., 2020). Furthermore, prior knowledge about the wind farm led to higher WTP by around 34 USD on average for enjoying the beach with the view of wind turbines (Trandafir et al., 2020). However, another American study, focusing on tourist preferences for hotel rooms with and without views of an onshore wind turbine, revealed that only 12.3% of the participants offered higher bids for hotel rooms with views of the wind

turbine. In contrast, the WTP of other participants was higher for the rooms without wind turbine views (Fooks et al., 2017).

In a study conducted by Westerberg et al. (2015) on the beaches of Languedoc Roussillon in France, respondents required a 140 euro per week on average compensation for staying at a tourist resort with a wind farm located 5 km from the shore. Interestingly, in the same destination (Westerberg et al., 2013, 2015), coherent environmental policies and recreational activities related to a wind farm were shown to outweigh the visual nuisance caused by the wind farm located at distances of 5, 8 or 12 km. Similarly, in a study by Vega and Alpízar (2011) construction of a hydropower project would decrease water flow in the river which would cause reduction in visitor welfare (Marginal willingness to pay (MWTP)=3.17 USD). However, this reduction could be compensated by road improvements (MWTP=2.20 USD, pools (MWTP=2.81 USD) and huts (MWTP=0.81 USD) at the tourist centre (Vega & Alpízar, 2011). Schallenberg-Rodriguez and Inchausti-Sintes (2021) also showed that the positive economic impacts in terms of gross value added (GVA) of a floating wind farm to be constructed in a tourism region are likely to be lower and the employment demand is likely to be higher compared to more industrialised regions due to sectorial redistribution of resources in favour of services.

3.2.3. REI as a tourist attraction

Many of the reviewed studies point to the potential of REI to become a tourist attraction. In some cases, the attracting effect can be stronger than the avoidance (e.g. Lilley et al., 2010). Studies have identified various motivational factors for tourist engagement in visiting REI. Such factors include eco-image, modern design, uniqueness and novelty of REI (Beer et al., 2018; Smythe et al., 2020). Interest in science and energy related issues, willingness to gain new knowledge, environmental consciousness, excitement, opportunities for socialization, having fun, and spending time away from more usual tourist places have all been identified as motivating factors to visit REI sites (Frantál & Urbánková, 2017; Liu et al., 2019; Liu et al., 2016; Pavlakovič et al., 2021).

Among the various types of REI, Beer et al. (2018) suggested that geothermal power plants and wind farms tend to have highest potential for becoming tourist attractions. However, Pavlakovič et al. (2021) noted that people are more interested in visiting geothermal wells during spa visits, geothermal food production in greenhouses, educational visitor centres and trails, with interest in visiting geothermal power plants being lower.

Studies emphasised the importance of providing quality visitor services and information on REI for it to successfully function as a tourist attraction (Smythe et al., 2020). Beer et al. (2018) noted that visits to REI combined with tourism services could promote renewable energy and increase social acceptance of such infrastructure. This is supported by Frantál and Urbánková (2017), who showed that 27% of visitors who attended a kite festival under the wind turbines changed their attitudes toward wind energy more positively while the attitudes of 2% became more negative. Pavlakovič et al. (2021) also emphasised the educational potential of geothermal tourism attractions. However, they noted the danger of "preaching to the converted" since interest in geothermal tourism positively correlates with attitudes toward geothermal energy. According to Pavlakovič et al. (2021), addressing the less positive attitudes toward geothermal energy is more likely to be effective in venues showcasing the direct use of geothermal energy e.g. for food production or balneology.

In some cases, REI can unintentionally provide better opportunities for tourism activities. For instance, artificial reefs created around offshore wind turbines may attract fish sought by recreational anglers (Smythe et al., 2020; Smythe et al., 2021). After constructing the dams and reservoirs for Blanda Hydropower Plant in northern Iceland the downstream water of the glacial river became transparent, which created better conditions for salmon fishing (Sæþórsdóttir & Hall, 2018). The water released from a geothermal power plant created one of Iceland´s most famous tourist attractions, thermal baths called the Blue Lagoon (Beer et al., 2018). Old hydropower plant infrastructure in the Encantats and Neouvielle massifs in the Pyrenees contribute to tourism development in the surrounding natural areas due to improved access and are also industrial heritage attractions (Rodriguez, 2012). Older wind farms containing wind turbines of various models and ages can also be successfully transitioned into tourist attractions (Szumilas-Kowalczyk et al., 2020).

In terms of visitor profiles, some studies showed that REI is mainly visited by domestic tourists, usually during day trips (Frantál & Urbánková, 2017), and the majority of visitors are likely to take only one trip to the REI site (de Sousa & Kastenholz, 2015; Parsons et al., 2020). This seems, as pointed out by de Sousa and Kastenholz (2015), to be especially the case for wind turbines since they are rather standardised structures which look similar in most countries and many international visitors can visit them in their home countries, while during international trips people may seek more unique experiences. Silva and Delicado (2017) suggested that wind farms are more likely to become tourist attractions in more industrialised areas containing little

or no cultural or natural heritage, where such infrastructure can be seen as symbol of green energy and progress.

3.2.4. Factors affecting the interrelationships between REI and tourism

The review identified a range of factors affecting the attitudes of tourism stakeholders toward REI, and the character, scale and severity of the impacts of REI on tourism. These factors are divided into three main categories: (1) factors related to REI, (2) locational factors, and (3) factors related to tourism stakeholders. The factors belonging to each category are described below.

1) Factors related to renewable energy infrastructure

Different types of REI have been shown to differently impact tourism. However, the variety of methods and settings selected in the reviewed studies makes the results difficult to compare. Navratil et al. (2019), investigating visitor preferences toward different types of renewable energy in 'green' hotels in Czech Republic, found that the most preferred were solar panels on the rooftops, followed by wind turbines, heat pumps, green tariff energy and anaerobic digestion plants, with the lowest acceptance being of solar panels on the ground. Similarly, Dalton et al. (2008) found that tourists were most positive towards solar panels on roof and on balconies of tourist accommodation, while wind energy conversion systems received somewhat lower support.

Regarding tourism stakeholder perceptions of REI in natural areas, in an Icelandic study by Sæþórsdóttir and Hall (2018), tourists were most positive toward geothermal power plants, followed by hydropower plants and most negative toward wind turbines. Another study by Sæþórsdóttir and Hall (2019) focusing on tourism operators in Iceland revealed that they were most positive toward wind turbines, followed by geothermal power plants and most negative toward hydropower plants, especially where they would affect salmon rivers or destroy wilderness areas. With regard to REI offshore, Voke et al. (2013) showed that devices used for wave energy harnessing and other infrastructure located on the surface of the water had a much stronger negative impact on visitors' enjoyment compared to underwater devices such as tidal stream turbines.

The design of REI is also an important factor since it affects the visibility of such infrastructure and its impacts on the surrounding landscape. Most of the studies investigating how the design of REI affects perceptions and attitudes of tourism stakeholders focus on wind farms, while

studies looking into the preferences regarding the design of other types of REI are currently lacking. Regarding onshore wind turbines, a study by Sæþórsdóttir et al. (2018) showed that when the wind turbines were few, tourists preferred smaller wind turbines over higher, but they preferred a smaller number of higher wind turbines in case of a wind farm. Frantál and Kunc (2011), found that around 60% of tourists preferred several smaller wind farms (3 to 5 wind turbines) while only 10% of tourists preferred one large wind farm containing 80-100 wind turbines. In Riddington et al. (2010), however, the majority of participants preferred fewer but larger wind farms. Good design of REI can not only decrease negative impacts of such infrastructure on tourism but also transform REI into a tourist attraction as is the case for several award-winning design hydropower plants in Nordland County in Norway (Beer et al., 2018).

Landscape changes related to renewable energy harnessing are caused not only by REI, but also by accompanying infrastructure such as transmission lines and roads. The reviewed studies showed that tourism stakeholders are especially negative toward transmission lines in natural open landscapes since they are highly visible and impact large areas (Sæþórsdóttir & Hall, 2018; Sæþórsdóttir & Hall, 2019; Teigland, 1999). While construction of roads for power plants often results in better access of natural areas and thereby facilitates tourism development (Rodriguez, 2012), Teigland (1999) stressed that they do not necessarily lead to increased interest in nature experience but, especially in more environmentally sensitive areas, can lead to negative impacts on tourism and recreation. This is supported by Sæþórsdóttir (2010), who showed that tourist attitudes toward built-up asphalted roads in the Icelandic Central Highlands were rather negative. Construction of roads can also lead to other developments, such as accommodation, food services, and/or petrol stations, which may further contribute to changes in image of the area (Teigland, 1999).

The reviewed studies showed that the meanings assigned to REI by the tourism stakeholders shape their attitudes. If REI is perceived as a symbol of green energy which benefits the environment, stakeholders are more likely to view such infrastructure positively (Frantál et al., 2017; Parsons et al., 2020; Smythe et al., 2021). This is reiterated by Lilley et al. (2010) who reported that 73.6% of tourists would visit the same beach if it contained a wind farm located 10 km offshore, while the proportion of tourists who would visit the same beach containing a coal power plant located 10 km inland from the beach would be lower (61.1%).

Reviewed articles focusing on the implementation of REI in tourist accommodation revealed practical concerns related to REI. In an Australian study by Dalton et al. (2007), a majority of

tourism operators were interested in installing REI in their accommodations. However, most of them questioned the ability of REI to provide sufficient power to run a resort containing more than 10 rooms and the reliability of renewable energy supply. The proportion of tourism operators doubting the economic viability of renewable energy supply was much lower among operators who have REI in their accommodation, indicative of the need for consumer education (Dalton et al., 2007).

Several studies also showed that tourism stakeholders tend to perceive existing REI more positively compared to proposed or hypothetical REI (Brudermann et al., 2019; Sæþórsdóttir & Hall, 2018; Sæþórsdóttir et al., 2018). Various explanations have been put forward. Some studies revealed that existing REI has created better opportunities for tourism and recreational activities (e.g. Smythe et al., 2021). Brudermann et al. (2019) proposed that the higher acceptance of existing REI compared to the hypothetical reflects the phenomenon of status quo bias whereby people tend to prefer the current situation over change. Areas containing REI might also be visited by different types of tourists who are less sensitive to landscape changes brought by such infrastructure. Sæþórsdóttir and Hall (2018) found that in the area where a hydropower plant has been constructed the proportion of visitors with more purist wilderness attitudes was lower than in more natural areas.

2) Locational factors

The location of REI plays an important role in shaping tourism stakeholder attitudes toward REI and its impacts on tourism. One of the factors related to the location of REI is the level of development of the area surrounding the REI and its perceived naturalness. Various studies conducted in natural areas of Iceland (Burns & Haraldsdóttir, 2019; Sæþórsdóttir, 2010; Sæþórsdóttir & Saarinen, 2016b; Tverijonaite et al., 2019) showed that most tourists prefer to protect them from REI developments, since such developments would lower the perceived wilderness quality. In line with that, tourists perceive onshore wind turbines as more suitable in agricultural areas than in wilderness areas (Frantál & Kunc, 2011; Sæþórsdóttir & Ólafsdóttir, 2020; Sæþórsdóttir et al., 2018). With regard to offshore wind turbines, research conducted in eight beaches in Catalonia, Spain (Voltaire & Koutchade, 2020; Voltaire et al., 2017), revealed that people would be more likely to decrease their beach visitation if wind turbines would be built near natural area beaches compared to more urbanised ones. Thus, developed areas are perceived by tourism stakeholders as more suitable for REI developments, while relatively natural areas and areas containing natural or cultural heritage are perceived as

rather unsuitable (de Sousa & Kastenholz, 2015; Sæþórsdóttir & Saarinen, 2016b; Sæþórsdóttir et al., 2021).

According to various studies conducted in Iceland (Ólafsdóttir & Sæþórsdóttir, 2019; Sæþórsdóttir & Hall, 2019), the country's image of a destination containing pristine nature and wilderness is an important selling point for the tourism industry, therefore tourism operators do not support further REI developments in wilderness areas. Such preferences are likely to be related to the meanings assigned to places and landscapes. In Michel et al. (2015), solar panels were perceived by tourists and residents more positively on industrial buildings compared to historical buildings carrying symbolic meanings and to open landscapes. Attitudes of tourists (Dalton et al., 2008; Navratil et al., 2019) and tourism operators (Dalton et al., 2007) toward REI in tourist accommodation are largely positive also because it helps reduce tourism's environmental footprint. However, meanings ascribed to certain places might differ among stakeholders and depend on various factors. Sæþórsdóttir et al. (2021) emphasised that the perception of an unspoiled natural area differs between tourism stakeholders: for some such an area can contain farms and roads, while for others it should not contain any human-made structures. Such differences might lead to divergent opinions regarding the suitability of REI in a specific location. This is supported by Sæþórsdóttir and Hall (2018), in their study the degree of naturalness of an area containing a hydropower plant was perceived differently by tourists depending on numerous factors, such as previous visits, the route tourists have taken to reach the area, mode of travel and country of origin.

The characteristics of the landscapes surrounding REI are also a critical factor in shaping tourism stakeholder attitudes. Diverse landscapes of high aesthetic quality as well as scenic areas containing tourist attractions, are viewed as less suitable for REI developments compared to more homogenous and desert-like landscapes and areas perceived as 'drive-through' areas (Sæþórsdóttir et al., 2018; Sæþórsdóttir & Ólafsson, 2010b; Sæþórsdóttir et al., 2021). In contrast, Liu and Upchurch (2020) showed that the perceived attractiveness of hypothetical wind turbines was highest in prairies and mountain regions, followed by desert areas and locations offshore.

Distance of REI from tourist attractions and activities is also of high importance for tourist experience and tourism demand (Brudermann et al., 2019; Ólafsdóttir & Sæþórsdóttir, 2019; Veidemane & Nikodemus, 2015). As revealed by the two contingent behaviour studies identified in this review (Lilley et al., 2010; Parsons et al., 2020), the nearer the hypothetical

offshore wind power infrastructure is to the shore, the higher the proportion of beachgoers reporting negative impacts of wind turbines on their experience and intention to change their trip plans. Landry et al. (2012) showed significant negative utility effect on beach visitors when offshore wind turbines would be constructed at one mile offshore, but no significant effect at further distances or in estuaries. Greater distance of offshore wind turbines from the coast may not only increase the beach visitation probability but also lead to longer stays in the area (Veidemane & Nikodemus, 2015). However, where tourism stakeholders perceive an offshore wind farm as a tourist attraction, they emphasise the importance of physical and visual access, thereby countering the commonly perceived need for placing wind turbines as far as possible offshore (Smythe et al., 2020).

With regard to placing wind turbines onshore or offshore, in a study in Latvia, Veidemane and Nikodemus (2015) found that tourists and residents were more in favour of developing a wind farm on land in the coastal areas than offshore. Similarly, in Dalton et al. (2008) 68% of tourists accepted a hypothetical wind farm on the coast compared to 40% of tourists who accepted a wind farm offshore. However, Lilley et al. (2010) criticized the simulated offshore wind turbines as 'elongated and otherwise disproportionate' in comparison with the onshore wind turbine simulation. This might therefore have contributed to more positive attitudes of tourists toward onshore wind turbines presented in the study.

Areas receiving a higher flow of tourists are usually seen as less suitable for REI developments by tourism stakeholders, while areas where local need for electricity is perceived as high are considered to be more suitable (Sæþórsdóttir et al., 2021). Furthermore, countries and regions containing areas of high heritage value, tourist attractions, and landscapes important for the tourism industry have specific challenges in developing REI. They can be partly addressed by choosing a type of REI which is less likely to impact tourism (e.g. solar PV over wind turbines), through participatory design approaches and by employing new approaches to aesthetics and landscape design (Rizzo, 2017). However, increasing tourism interest in natural areas might lead to a shift from utilisation approaches to more conservationist resource management approaches in natural areas (Sæþórsdóttir & Saarinen, 2016a).

3) Factors related to tourism stakeholders

Various tourism stakeholder characteristics have been shown to affect the interrelationships between REI and tourism. The role of previous experience of tourists with REI in shaping their attitudes has been investigated by several studies. Frantál et al. (2017) found that tourists from

more densely populated countries with numerous wind farms, such as Netherlands, Germany and United Kingdom, were more tolerant toward a proposed wind farm at the edge of the Icelandic Central Highlands. In a French study, tourists from Northern European countries which have more experience with wind turbines were more tolerant toward offshore wind turbines than domestic beach visitors (Westerberg et al., 2015). In Delaware, USA, Lilley et al. (2010) found a positive yet insignificant relationship between having seen a wind turbine previously and intention to visit a beach containing offshore wind turbines or another beach in the same state. In Veidemane and Nikodemus (2015), no strong influence was observed of having seen offshore wind farms before on attitudes toward specific wind farm proposals.

Previous experience of an area is also important. Michel et al. (2015) found that repeat visitors were more negative toward the planned solar installations, suggesting aversion to change and a preference to preserve their holiday places as they are. However, Voltaire and Koutchade (2020) showed that the more familiar people were with a beach the less likely they were to reduce their beach trip frequency if a wind farm was constructed offshore. In a study by Frantál and Kunc (2011), the attitudes of repeat visitors toward onshore wind farms were more pronounced both positively and negatively, while first-time visitors tended to be more neutral.

The distance between visitors' place of residence and a destination containing REI has also been shown to affect their attitudes. Voltaire and Koutchade (2020) showed that local tourists were less likely to reduce their beach visitation in case of construction of an offshore wind farm than tourists coming from other regions. However, in Frantál and Kunc (2011), tourists from the same region were more likely to oppose onshore wind turbines than tourists from other regions and larger cities. Similarly, in a study by Sæþórsdóttir (2010), Icelanders were more negative toward power plants in the Icelandic Central Highlands compared to foreign visitors. Tourists' country or place of origin might affect attitudes toward REI and behaviour also due to other reasons. For example, as pointed out by Liu and Upchurch (2020), visiting wind farms is believed by Chinese to bring wealth and luck. In the Czech Republic, on the other hand, corruption scandals related to on-ground solar power plants might have led to lower support among Czech tourists (Navratil et al., 2019). In Frantál and Kunc (2011), tourists coming from environmentally degraded areas were more positive toward onshore wind turbines due to their preference for clean source of energy. Studies showed divergent results regarding the influence of other demographic characteristics of tourists, such as gender, education or age on their attitudes toward REI (Frantál & Kunc, 2011; Lilley et al., 2010; Westerberg et al., 2015).

The type of activities tourists undertake affects how they perceive REI and how likely they are to change their behaviour due to construction of such infrastructure. Parsons et al. (2020) reported that tourists involved in activities on water, such as boating, swimming or surfing, are the most likely to avoid the beach after the construction of an offshore wind farm, followed by visitors undertaking beach activities, such as sunbathing or reading. Avoidance likelihood is the lowest among visitors involved in boardwalk and similar activities (Parsons et al., 2020). Likewise, Lilley et al. (2010) found that visitors surveyed on a boardwalk were more likely to come back to the beach after the construction of offshore wind turbines or to visit other beaches in the Delaware state compared to the visitors surveyed on the beach, since they were more focused on shops and restaurants instead of the seascape. Westerberg et al. (2013) revealed that while, in general, offshore wind farm disamenity costs decline with increasing distance of the wind farm from the shore, visitors coming for family and/or friends visits or cultural and historical attractions rather than a beach tend to require lower compensation.

The type of information that tourism stakeholders receive about a planned or a hypothetical renewable energy project also has been shown to shape attitudes toward REI. A study by Teisl et al. (2018) revealed that visitors who were presented with a virtual reality (VR) tool showing hypothetical floating offshore wind turbines tended to move away from 'neutral' responses to positive and negative extremes, with higher tendency to have more negative reactions toward them compared to the visitors who were presented traditional two-dimensional pictures.

With regard to different groups of stakeholders, Sæþórsdóttir and Ólafsdóttir (2020) demonstrated that tourists were more negative toward a proposed wind farm in the Icelandic Central Highlands compared to residents. The residents tended to perceive the landscape surrounding the proposed wind farm more critically, as less natural or less beautiful than tourists, while the tourists often estimated the deterioration of the landscape due to the construction of the wind farm to be more severe. In a study by Veidemane and Nikodemus (2015) in Latvia, residents were more negative than tourists toward the proposed wind farm developments, irrespective of their location. Similarly, in a study by Silva and Delicado (2017), while being appalled by the close distance between wind turbines and medieval buildings, most tourists accepted onshore wind farms existing in the area. They stated that wind farms did not interfere with their destination choice. Attitudes of residents were more divergent, with the majority opposing the wind farms. Silva and Delicado (2017) pointed out that economic benefits from wind power production and their inclusion in decision-making are important in shaping residents' attitudes toward wind farms and their perceived impacts on tourism. Such

results are also reflected in de Sousa and Kastenholz (2015) findings, which showed that while assessing the positive impacts of wind energy infrastructure on tourism, residents tended to mention benefits to their community, such as economic benefits, while tourists focused more on overall societal benefits. The attitudes of managers of large tourist accommodation also tend to be more positive toward REI implementation for their businesses than smaller ones (Dalton et al., 2007).

Various other factors related to tourism stakeholders have been shown to affect their attitudes toward REI. As Frantál and Kunc (2011) observed, visitors travelling alone or with friends were more critical toward onshore wind turbines than couples or families with children, which are likely to focus less on wind turbines and more on other destination attributes. Furthermore, as revealed by Westerberg et al. (2015), the welfare impacts experienced by the beach users in the vicinity of an offshore wind farm depended also on their environmental concerns and perceived cost-effectiveness of wind power. According to Westerberg et al. (2015, p. 175), "The results point to the fact that although we may think that we are eliciting preferences for 'objective' physical characteristics of a landscape, the elicited preferences are inherently shaped by 'political, technical, economic or ecological' implications of the object or landscape under consideration." Interestingly, Klain et al. (2018) showed that affectively-loaded impacts such as visual intrusion and effects on wildlife played a more important role in shaping the attitudes of a wide range of stakeholders toward a hypothetical offshore wind farm than impacts on tourism, which are more easily quantifiable.

3.2.5. Tourism-related REI planning

Energy planning in countries relying on nature-based tourism, where REI and tourism are likely to compete for same resources, can benefit from tools contributing to the sustainability of natural resource management. In Iceland, to solve the conflicts between energy development and other land uses, a governmental project initially called the Master Plan for Geothermal and Hydropower Development, was started under the supervision of the Ministry of the Environment. Several reviewed Icelandic studies (Sæþórsdóttir, 2012; Sæþórsdóttir & Ólafsson, 2010a, 2010b) presented the work of an expert group which used a systems approach and ranked proposed energy projects based on their impacts on tourism and recreation. For that they assessed how each proposed REI project would affect the value of the surrounding regions based on attributes falling into one of the following categories: experience, use, recreation opportunities, infrastructure and future value (Sæþórsdóttir & Ólafsson, 2010a, 2010b).

However, tourism and renewable energy development can often coexist and do not always necessarily compete for the same natural resources. Callejas-Jiménez et al. (2021) study conducted off Cozumel Island showed that biotopes with high energy densities, which are the most suitable for harvesting of marine renewables, are generally located in the areas that are of low value for tourism. In contrast, biotopes with low to intermediate energy densities are often associated with the areas containing higher coral reef cover, which are of interest to tourism and are located within protected areas. Still, as Callejas-Jiménez et al. (2021) emphasised, it is also important to investigate how such REI is likely to impact marine organisms which may not be of direct interest to tourists but are of high ecological importance.

With regard to REI planning, Mordue et al. (2020) in a study on existing and prospect wind farms in Northumberland County, UK, stated that the impacts of onshore wind farms on tourism tend to be perceived by tourism businesses as worse than their actual impacts. Therefore, the decision-making regarding the planning of REI should be conducted ensuring 'manifold justice' or equitable siting of wind installations through space and time (Mordue et al., 2020). Ingólfsdóttir and Gunnarsdóttir (2020) argued that REI might not lead to significant economic losses for tourism and therefore it should not be used as a political argument in decision-making. However, such infrastructure is likely to lead to the loss of important nature-based tourism experiences.

4 Discussion

4.1 Interrelationships between REI and tourism and factors affecting them

The results of this literature review demonstrate that REI and tourism affect each other in numerous ways. There is a growing need worldwide for renewable energy and increasing tourism is contributing to this need. The tourism industry is responsible for substantial GHG emissions and relies on REI to reduce its carbon footprint (Beer et al., 2018; Callejas-Jiménez et al., 2021; Navratil et al., 2019). Various studies have discussed REI as tourist attractions and have shown that tourism activities in sites containing REI can effectively contribute to shaping positive attitudes toward renewable energy and to raising awareness of the importance of REI for mitigating climate change and achieving SDGs (Beer et al., 2018; Frantál & Urbánková, 2017; Pavlakovič et al., 2021). REI has been shown to facilitate tourism due to improved access and by creating conditions for tourism activities (Rodriguez, 2012; Smythe et al., 2020; Smythe et al., 2021; Sæþórsdóttir & Hall, 2018). However, it can also negatively impact tourism. REI

generally transforms surrounding landscapes, which often leads to changes in the image and character of nearby tourist destinations, reduced quality of tourist experience, decreased tourism demand and consequent economic losses (Broekel & Alfken, 2015; Parsons et al., 2020; Sæþórsdóttir et al., 2018; Voltaire & Koutchade, 2020). Furthermore, high reliance of a region on tourism makes REI developments more challenging due to the need to preserve the resources essential for tourism (Rizzo, 2017) and can also affect the economic impacts of REI in terms of gross value added (Schallenberg-Rodriguez & Inchausti-Sintes, 2021).

The review revealed a range of factors affecting the interrelationships between REI and tourism, which can be divided into three main categories: 1) factors related to REI, 2) locational factors, and 3) factors related to tourism stakeholders. To the first category belong factors such as type and design of REI and its accompanying infrastructure, meanings assigned to REI and its image, practical concerns related to REI and its reliability (Figure 5). The factors related to the location of REI include the level of development of the area, its degree of naturalness, meanings ascribed to the area and its image, the level of use of the area for tourism, local demand for renewable energy, diversity and aesthetic quality of surrounding landscapes, presence of tourist attractions and opportunities for tourism activities, as well as distance between REI and tourist attractions and activities. To the third category belong factors related to tourism and its stakeholders, which, among others, include tourist motivations, expectations, and activities they are undertaking, previous experience of REI and of the area where REI is discussed, country/region tourists are coming from, other demographic characteristics, type of information tourism stakeholders receive about REI, as well as their values and views on various topics, including concerns over climate change.

The findings suggest that the interrelationships between REI and tourism are highly context-dependant. Thus, while this review provides an overview of the factors which should be taken into consideration while planning REI developments, how these factors will affect tourism depends on the context surrounding each renewable energy project.

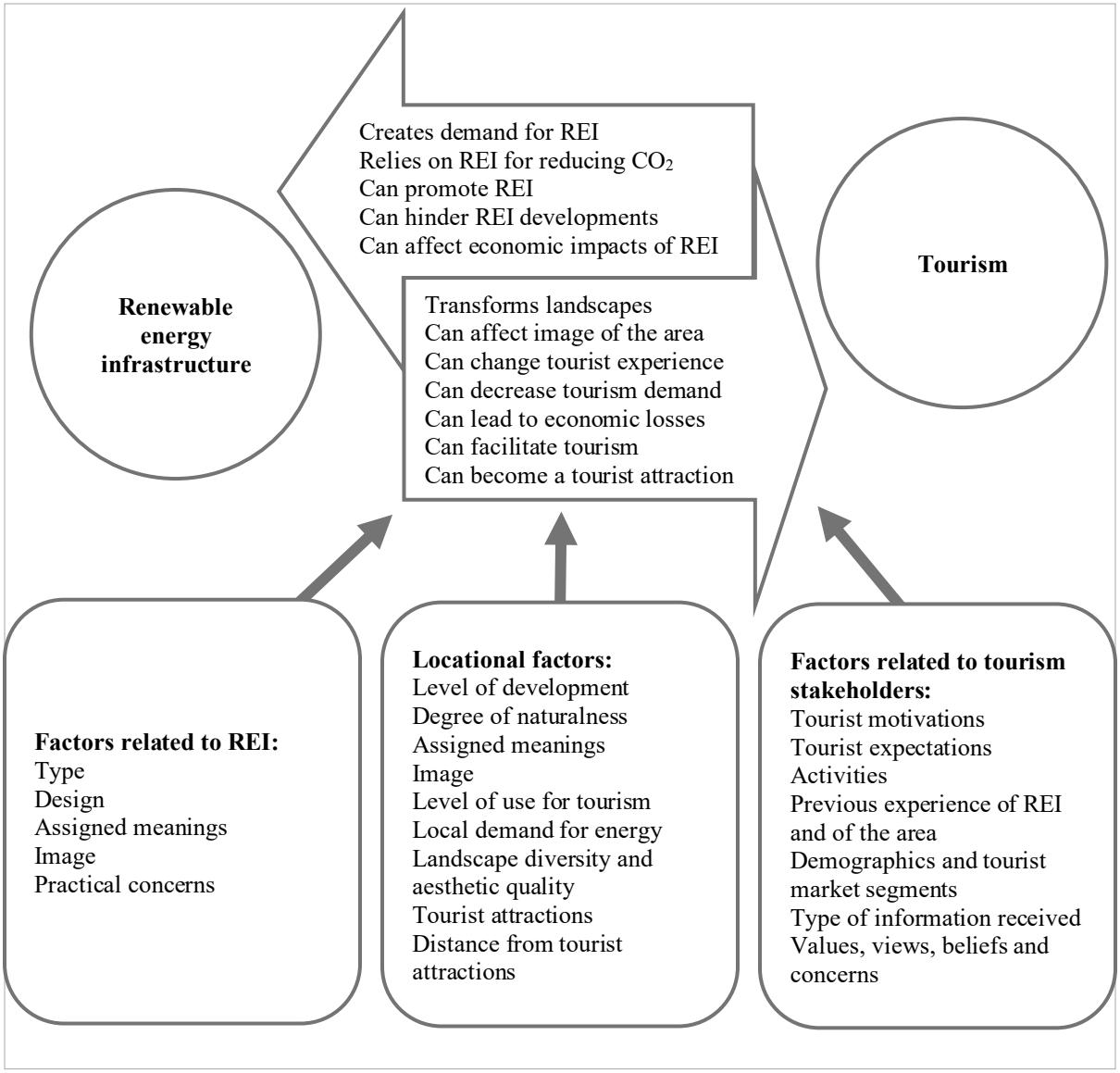

Figure 5. Interrelationships between REI and tourism and the factors affecting them.

The revealed factors partly relate to the factors identified by Devine-Wright (2008) explaining public views on renewable energy technologies, which fall into three categories: 1) personal (various socio-demographic factors), 2) social-psychological (degree of awareness, experience, environmental and political beliefs, perceived impacts, perceived fairness in development process), and 3) contextual (type and scale of REI, spatial context, and institutional structure). This reiterates the relationship between people's views on REI and its impacts on tourism. Notably, while numerous reviewed studies suggest improvements to REI planning based on their findings, this literature review revealed the lack of empirical studies investigating the effects of institutional factors identified by Devine-Wright (2008), such as REI planning strategies and policies for reducing the impacts of REI on tourism.

Other research gaps and opportunities for future research were identified. Conducting more longitudinal studies would help investigate how the attitudes of tourism stakeholders toward REI are changing in relation to rapidly developing REI technology and the increasingly pressing need to mitigate climate change. Longitudinal studies would also allow investigating tourism stakeholder attitudes before, during and after the construction of REI and provide better understanding of attitudinal changes over time. More studies conducting a systematic comparison of the impacts of different types, design and locations of REI on tourism would facilitate REI planning. While numerous studies focusing on wind turbines emphasise the importance of distance on the attitudes of tourism stakeholders and on the severity of the impacts of REI on tourism, studies estimating the spatial extent of the impacts of other types of REI on tourism are limited. The results also showed the need for a better geographical distribution of research as well as the need for comparative international studies, which would provide a more complete picture on the interrelationships between REI and tourism.

4.2 Implications for REI planning and policy recommendations

The findings of this literature review showed that the impacts of REI on tourism are context-specific and highly depend on tourism stakeholders' perceptions, attitudes and preferences, which are heterogeneous. This demonstrates the importance of considering the context of each REI project while planning REI development, which is supported by various researchers (Navratil et al., 2019; Smythe et al., 2020). The findings also re-emphasise the importance of including social perceptions into the planning process of REI development to minimise land use conflicts between REI developments and tourism (Minsch et al., 2012; Sovacool, 2014). This can be achieved by employing participatory processes in REI planning. Stakeholder inclusion in early stages of renewable energy planning, when selecting the most suitable locations for REI as well as type and design of REI, is likely to improve compatibility of REI with other land uses, including tourism, and result in higher social acceptance of specific renewable energy projects (Smythe et al., 2020; Stadelmann-Steffen & Dermont, 2021; Wolsink, 2007). It has also been shown (e.g., Silva & Delicado, 2017) that inclusion of local actors into REI planning processes is likely to positively affect their perceptions regarding the impacts of REI on tourism. Consideration of tourist preferences, motivations, expectations and behaviour can facilitate prediction of potential impacts of planned REI on tourist experience and consequently tourism demand. Such knowledge is essential for identification of locations, type and design for REI which would lead to higher compatibility of REI and tourism.

To improve compatibility and strengthen the synergic relationships between REI and tourism it is important to align energy and tourism policies so that they support and benefit each other (Frantál & Kunc, 2011; Liu et al., 2016). The use of renewable energy is highly important for climate change mitigation, environmental sustainability, and achieving the SDGs (Caglar, Avci, et al., 2024; Caglar, Daştan, et al., 2024). However, as stressed by the International Energy Agency (IEA, 2018), REI can have various negative environmental and social impacts, which can be reduced by following best practice. "It is therefore imperative that these potential impacts are recognised and minimised, mitigated or compensated" (IEA, 2018, p. 15). With regard to tourism, energy planning strategies should ensure that opportunities for tourism are not hindered by REI developments, and that resources important for the tourism industry are preserved. While tourism stakeholder perceptions regarding the suitability of REI in various areas are highly subjective and can be divergent, this literature review showed that REI in some places can receive significantly higher tourism stakeholder support than in others. As shown by the reviewed studies (Silva & Delicado, 2017; Hynes & Hanley, 2006; Sæþórsdóttir & Hall, 2019), scenic natural areas, wilderness areas, as well as areas containing cultural heritage tend to be of high value for tourism. Meanings assigned to such areas often relate to transformative and spiritual experiences and reconnection with nature and culture (Ingólfsdóttir & Gunnarsdóttir, 2020; Sæþórsdóttir & Saarinen, 2016b). Consequently, REI is often perceived as less suitable in such areas and less compatible with tourist expectations. To preserve the value and attractiveness of such areas for tourism, they should be protected from energy infrastructure developments. Instead, following best practices, REI should ideally be constructed in environmentally degraded or lower value areas which do not hold significant symbolic meanings for tourism stakeholders (Apostol et al., 2017; Frantál et al., 2018).

Importantly, construction of REI affects tourism in both the destination areas surrounding such infrastructure as well as in transit regions. This emphasises the importance of planning REI developments in coordination between all affected municipalities and regions (Broekel & Alfken, 2015) by taking into consideration travel routes that tourists are using and the changes REI may bring to these areas (Sæþórsdóttir & Ólafsson, 2010a, 2010b). Employing holistic approaches to energy planning is essential for sustainable REI development which aims at preservation of a wide range of recreational opportunities for visitors in regions relying on tourism (Sæþórsdóttir et al., 2021).

Furthermore, possibilities to enhance opportunities for sustainable tourism development should be explored. Incentives should be provided for integration of renewable energy sources in

tourism facilities and transportation to reduce environmental footprint of tourism activities and to support tourism development in areas with previously limited electricity supply. Education of tourism operators on the benefits of REI installations in tourism facilities and addressing their concerns related to reliability and consistency of power provision can accelerate employment of renewable energy sources and contribute to energy transition in tourism sector (Dalton et al., 2007). Synergic relationships between REI and tourism should be strengthened, where possible, by integrating tourist visits to sites containing REI. Provision of educational materials and activities in such sites can benefit both energy and tourism sectors by providing more activities to visitors while positively shaping visitor attitudes towards the use of renewable energy sources (Frantál & Urbánková, 2017; Pavlakovič et al., 2021). Moreover, providing tourism operators with sufficient resources for presenting REI to tourists and promoting it as an important contributor to sustainable development is likely to facilitate compatibility of REI and tourism (de Sousa & Kastenholz, 2015; Smythe et al., 2020).

Both, energy and tourism sectors aim to be sustainable, but if not managed appropriately both sectors can cause damage to the natural environment and negatively impact other land uses (Sæþórsdóttir & Hall, 2019). Finding a balance between the needs of local stakeholders, tourist preferences, economic benefits, and environmental aims is therefore of crucial importance for successful coexistence between REI and tourism and sustainable use of land and marine resources (Michel et al., 2015).

5 Conclusions

As shown by this literature review, the interrelationships between REI and tourism are complex and reciprocal. Yet, understanding them is critical, as both the energy and tourism sectors are rapidly growing worldwide. While in some cases REI and tourism can successfully coexist in symbiotic relationships, more often REI is likely to negatively impact tourism, especially in settings where REI is perceived as incompatible with tourism. This literature review identified three categories of factors shaping the interrelationships between REI and tourism: 1) factors related to REI, 2) locational factors, and 3) factors related to tourism stakeholders. The results furthermore demonstrated that the character of the interrelationships between REI and tourism is highly context-dependent. Thus, while the identified factors should be considered during the planning of REI development to ensure its sustainable coexistence with tourism, their role highly depends on the context surrounding REI.

While this literature review provided a needed comprehensive overview of the research focusing on the interrelationships between REI and tourism, it has several limitations, which can be addressed in the future. Its methodology followed the standard approach commonly employed in similar reviews. The search of relevant articles was based on the presence of specific keywords in the title, abstract or keywords of each article. While it allowed to keep the focus of the review on the articles directly related to its objectives, some relevant articles might have been overlooked due to the choice of keywords. Additionally, only the articles published in English were considered. Nonetheless, the findings of this literature review, the practical implications for renewable energy planning and the policy recommendations resulting from it are expected to inform decision-making related to REI planning and to positively contribute to a sustainable energy transition that safeguards resources critical for tourism.

Appendix 1. Reviewed articles

List of themes identified by the review: (1) tourism stakeholder attitudes toward REI, perceived impacts, and behaviour; (2) economic impacts of REI on tourism; (3) REI as a tourist attraction; (4) factors affecting the interrelationships between REI and tourism; and (5) tourism-related REI planning.

Nr.	Author/s (year of publication)	Journal	Country/ies	Main focus	Methods	Themes
1	Pavlakovič et al. (2021)	Sustainability	Slovenia	Interest of general public in geothermal energy tourism	Online questionnaire survey	3, 4
2	Sæþórsdóttir et. al. (2021)	Land	Iceland	Attitudes of tourism operators toward proposed wind farms, perceived key factors for selecting locations for onshore wind farms	Semi-structured interviews	1, 4
3	Schallenberg-Rodriguez & Inchausti-Sintes (2021)	Renewable and Sustainable Energy Reviews	Spain	Socio-economic impacts of a proposed floating wind farm in a region highly relying on tourism	Economic estimation	2
4	Smythe et al. (2021)	Marine Policy	USA	Recreational fishermen perceptions of the impacts of an existing offshore wind farm on their experience	Semi-structured interviews and an online survey	1, 4
5	Callejas-Jiménez et al. (2021)	Ocean and Coastal Management	Mexico	Combining marine energy harnessing with marine tourism	Field surveys and secondary data	5
6	Smythe et al. (2020)	Energy Research and Social Science	USA	Perceptions of tourism operators and recreational professionals of the effects of an existing offshore wind farm on tourism and recreation sectors	Focus groups	1, 3, 4
7	Mordue et al. (2020)	Journal of Sustainable Tourism	UK	The reasoning behind the local opposition to existing and proposed onshore wind farms in rural tourism locations	Literature review, online questionnaire survey of tourism businesses, a focus group with tourism stakeholders opposing wind farms	1, 4, 5
8	Parsons et al. (2020)	Energy Policy	USA	The effects of a large hypothetical offshore wind farm on recreational beach use	Online contingent behaviour survey among beachgoers	1, 3, 4
9	Voltaire & Koutchade (2020)	Resource and Energy Economics	Spain	Factors affecting the acceptance of hypothetical offshore wind turbines among beach users and their beach trip behaviour	On-site combined travel cost - contingent behaviour survey	1, 2, 4
10	Szumilas-Kowalczyk et al. (2020)	Renewable Energy	USA	Planning and design strategies related to decommissioning and repowering of onshore wind farms	Literature review and field surveys	3, 5

11	Ingólfsdóttir & Gunnarsdóttir (2020)	Journal of Outdoor Recreation and Tourism	Iceland	Impacts of power plants on the economic value of natural areas for tourism vs eco-centric environmental ethics approach in the planning of renewable energy development	Critical discourse analysis, review of four survey reports on tourist experiences and attitudes	1, 5
12	Liu & Upchurch (2020)	Journal of Leisure Research	China	The use of eye-tracking technology for investigating hypothetical onshore and offshore wind farms as tourist attractions	Mixed experimental design using eye-tracking technology and self-report assessments among students	1, 3
13	Sæþórsdóttir & Ólafsdóttir (2020)	Energy for Sustainable Development	Iceland	Residents' and tourists' attitudes toward a proposed onshore wind farm	On-site questionnaire survey	1, 4
14	Trandafir et al. (2020)	Journal of Ocean and Coastal Economics	USA	Tourists' preferences for the views with and without an existing offshore wind farm during their recreational activities	Stated preference survey disseminated to respondents using a Qualtrics panel	1, 2, 4
15	Ólafsdóttir & Sæþórsdóttir (2019)	Land Use Policy	Iceland	Attitudes of residents and tourism service providers toward a proposed onshore wind farm	On-site questionnaire survey of residents, semi-structured interviews with residents and tourism service providers	1, 4
16	Tverijonaite et al. (2019)	Sustainability	Iceland	Tourist attitudes toward a proposed hydropower plant	On-site questionnaire survey, semi-structured interviews, open-ended diaries, participant observation	1, 4
17	Brudermann et al. (2019)	Clean Technologies and Environmental Policy	Austria	Acceptance of existing and hypothetical onshore wind farms among tourists	On-site questionnaire survey	1, 4
18	Carr-Harris & Lang (2019)	Resource and Energy Economics	USA	The effect of existing offshore wind farm on the AirBnB vacation rental market	Analysis of the AirBnb data before and after construction of a wind farm, a difference-in-differences (DD) model using three nearby tourist destinations as controls	2
19	Navratil et al. (2019)	Renewable Energy	Czech Republic	Preferences for solar panels on rooftops/on the ground, heat pumps, anaerobic digestion plants and wind turbines in hotels among visitors in cultural and natural sights	On-site questionnaire survey	1, 4
20	Sæþórsdóttir & Hall (2019)	Sustainability	Iceland	Tourism operator perceptions of geothermal, hydro- and wind power generation and of implications of such developments on tourism	Online questionnaire survey, semi-structured interviews	1, 4, 5

21	Burns & Haraldsdóttir (2019)	Journal of Outdoor Recreation and Tourism	Iceland	Perceptions of tourists and tourism businesses of potential impacts of proposed hydropower plants	On-site visitor questionnaire survey, interviews with tourism operators	1, 4
22	Liu et al. (2019)	Tourism Review International	China	The influence of behavioural beliefs, normative beliefs, attitudes, and subjective norms on residents' intent to visit an existing onshore wind farm	Questionnaire survey	1, 3, 4
23	Beer et al. (2018)	Current Issues in Tourism	USA, Canada, UK, Iceland, Denmark	Tourism potential of existing hydro-, geothermal and offshore and onshore wind power infrastructure	Literature review and analysis of visitor numbers	3, 4, 5
24	Smith et al. (2018)	Energy Research and Social Science	USA	Social effects of an existing offshore wind farm on the tourism and recreation experience	Thematic media content analysis, ethnographic participant observation, tourism and recreation sector stakeholder focus groups	1, 4
25	Teisl et al. (2018)	Energy Policy	USA	Tourists' responses to a virtual reality and static picture rendering of proposed floating offshore wind turbines	On-site visitor survey	1, 4
26	Sæþórsdóttir et al. (2018)	International Journal of Sustainable Energy	Iceland	Tourists' attitudes toward a proposed onshore wind farm	On-site questionnaire survey	1, 4
27	Klain et al. (2018)	Ecological Economics	New Zealand	Predictive power of the psychometric risk paradigm while assessing perceived risks on ecosystem services by a hypothetical offshore wind farm among various stakeholders, including tourism	Semi-structured interviews using animated seascape visualisation of the hypothetical wind farm	1, 4
28	Sæþórsdóttir & Hall (2018)	Sustainability	Iceland	Impacts of an existing hydropower plant on tourist experience and perceptions, main variables affecting these perceptions and comparison with the areas where hydropower plants have been proposed but are not yet built.	On-site questionnaire survey	1, 4
29	Frantál & Urbánková (2017)	Current Issues in Tourism	Czech Republic	Conceptualising the interrelationships between energy and tourism, energy infrastructure as a tourist attraction (coal safari, nuclear power plant's information centre, kite festival under wind turbines)	On-site visitor questionnaire survey	1, 3, 4
30	Frantál et al. (2017)	Moravian Geographical Reports	Iceland	Factors shaping attitudes of tourists toward a proposed onshore wind farm	Field trip with observations and note-taking, mental mapping, a questionnaire survey	1, 4

31	Fooks et al. (2017)	Agricultural and Resource Economics Review	USA	Tourists' willingness to pay for hotel rooms with and without the views of an existing onshore wind turbine	Within-subject field experiment offering tourists the opportunity to purchase a lottery for a weekend stay at one of several hotels	1, 2, 4
32	Rizzo (2017)	Sustainable Cities and Society	Malta	Managing the possible conflicts between landscape protection and renewable energy implementation (offshore wind and solar PV) in a country relying on tourism	Unstructured interviews with government stakeholders, analysis of official policy documents and web material	5
33	Voltaire et al. (2017)	Marine Policy	Spain	Potential welfare impact on beach recreation demand due to construction of hypothetical offshore wind turbines	On-site visitor questionnaire survey, which included travel cost and contingent behaviour methods	1, 2, 4
34	Silva & Delicado (2017)	Moravian Geographical Reports	Portugal	Residents' and visitors' perceptions of existing onshore wind farms and their effect on destination choice	Semi-structured interviews	1, 4
35	Liu et al. (2016)	Journal of Sustainable Tourism	China	Governmental initiatives on wind farms and tourism development, domestic tourist perceptions of wind farms as a form of energy tourism	Analysis of tourist postings on google.com and baidu.com	1, 3, 4
36	Sæþórsdóttir & Saarinen (2016a)	Polar Record	Iceland	Solving conflicts related to development of tourism and renewable energy harnessing in natural areas	Review of various reports and questionnaire surveys	4, 5
37	Sæþórsdóttir & Saarinen (2016b)	Scandinavian Journal of Hospitality and Tourism	Iceland	Tourist perceptions of wilderness areas and acceptance of REI in these areas	Semi-structured interviews	1, 4
38	Westerberg et al. (2015)	Energy Research and Social Science	France	Factors affecting tourist attitudes toward the siting of hypothetical offshore wind turbines	On-site questionnaire survey, which included choice experiment	1, 2, 4
39	Veidemane & Nikodemus (2015)	Journal of Environmental Planning and Management	Latvia	Attitudes of residents and tourists toward hypothetical offshore wind turbines	Questionnaire survey, residents surveyed at home, tourists at the beach, in parking lots and at their accommodations	1, 2, 4
40	de Sousa & Kastenholz (2015)	Journal of Sustainable Tourism	Portugal	Visitors' and residents' attitudes toward existing onshore wind farms and perceptions of their impacts on tourism in a historic village	Semi-structured on-site interviews	1, 4
41	Broekel & Alfken (2015)	Energy Policy	Germany	Relation between existing onshore wind turbines and tourist accommodation occupancy rates	Analysis of data on wind turbines and tourist arrivals, available beds, accommodation facilities, and number of inhabitants for German municipalities	2, 4

42	Michel et al. (2015)	Mountain Research and Development	Switzerland	Residents' and tourists' perceptions of photovoltaic installations on avalanche barriers	Questionnaire survey of tourists in accommodation and on paths, of residents in this and neighbouring municipalities	1, 4
43	Rudolph (2014)	Scottish Geographical Journal	UK, Germany	The reasoning used by opponents of offshore wind turbines regarding tourism	Review of documents and consultation responses, interviews with experts	1, 4
44	Voke et al. (2013)	Ocean and Coastal Management	UK	Coastal users' opinion on proposed tidal and wave devices, and non-use values of a marine habitat	On-site user questionnaire survey which included the travel cost and the contingent valuation methods	1, 2, 4
45	Westerberg et al. (2013)	Tourism Management	France	Tourists' attitudes toward hypothetical offshore wind turbines at different distances, factors affecting them	On-site questionnaire survey, which included choice experiment	1, 2, 4
46	Sæþórsdóttir (2012)	Tourism Planning and Development	Iceland	Approaching land use conflicts between tourism and power plant development in natural areas	Delphi method using systems approach	4, 5
47	Rodriguez (2012)	Journal of Alpine Research	France, Spain	The relationships between hydropower landscapes and mountain tourism	Not specified	3, 5
48	Landry et al. (2012)	Resource and Energy Economics	USA	Assessing the impacts of hypothetical offshore wind turbines on local coastal tourism and recreation using stated preference nonmarket valuation methods	Combination of telephone and web survey, which included travel cost models and revealed and stated preference methods	1, 2, 4
49	Vega & Alpízar (2011)	Impact Assessment and Project Appraisal	Costa Rica	Assessing potential impacts of a hydropower plant under construction on a tourist centre due to water reduction	On-site visitor questionnaire survey, which included choice experiments	1, 2, 4
50	Frantál & Kunc (2011)	Annals of Tourism Research	Czech Republic	Impacts of an existing and a proposed wind farm on tourist experience and their tourist attraction potential	On-site visitor questionnaire survey, semi-structured interviews with tourism entrepreneurs	1, 3, 4
51	Riddington et al. (2010)	International Journal of Tourism Research	UK	Economic impacts of existing and proposed onshore wind farms on tourism	GIS model to estimate how many tourists would be exposed to the wind farms, intercept survey on likelihood to return, online survey on willingness to pay for the scenery	1, 2
52	Warren & McFadyen (2010)	Land Use Policy	UK	Residents' and tourists' perceptions of impacts of onshore wind farms on landscapes and seascapes	Questionnaire survey, semi-structured interviews	1, 4

53	Lilley et al. (2010)	Energies	USA	The effects of hypothetical offshore wind turbines on tourist behaviour and local tourism	On-site visitor questionnaire survey which included contingent behaviour method	1, 3, 4
54	Sæþórsdóttir & Ólafsson (2010a)	Journal of Heritage Tourism	Iceland	A methodological framework developed to evaluate the value of nature tourism destinations where renewable energy projects have been proposed	Defining spatial boundaries, determining scale on the score card, defining attributes, their categories, sub-categories, and relative importance, calculating scores, ranking according to value	5
55	Sæþórsdóttir & Ólafsson (2010b)	Journal of Heritage Tourism	Iceland	A methodology developed to evaluate the impacts of the proposed renewable energy projects on tourism and recreation and to rank the projects according to their impacts	Defining spatial boundaries of construction regions and impact regions, determining the effect of REI on attributes and re-evaluating the affected tourism regions, calculating the impact coefficient, ranking based on impacts	5
56	Sæþórsdóttir (2010)	Scandinavian Journal of Hospitality and Tourism	Iceland	Wilderness tourism, wilderness experiences of tourists and potential conflicts between wilderness tourism and REI	On-site visitor questionnaire survey, semi-structured interviews, diaries	1, 4
57	Dalton et al. (2008)	Renewable Energy	Australia	Tourist attitudes toward hypothetical solar PV and wind energy conversion systems in tourist accommodation	On-site questionnaire survey	1, 4
58	Dalton et al. (2007)	Renewable Energy	Australia	Tourist accommodation operators' perceptions of renewable energy sources	Questionnaire survey sent by post or by email	1, 4
59	Hynes & Hanley (2006)	Land Use Policy	Ireland	The nonmarket benefits from the preservation of natural river conditions where the development of hydropower plants is considered	On-site and online questionnaire survey among whitewater kayakers, which included travel cost method	1, 2
60	Teigland (1999)	Impact Assessment and Project Appraisal	Norway	Short- and long-term effects of hydropower and road developments on tourism and recreation	Questionnaire surveys, road surveys, interviews (longitudinal study)	1, 4
61	Hanley & Nevin (1999)	Energy Policy	UK	Estimating economic impacts of the development of onshore wind, hydro- and biomass power plants	Local economic impact study among visitors, contingent valuation study among residents	1, 2, 4

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