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What shapes community acceptance of large-scale solar farms? A case study of the UK's first 'nationally significant' solar farm

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A R T I C L E I N F O

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A B S T R A C T

New renewable energy infrastructure is essential to deliver net zero policies in response to climate change, but a lack of community acceptance is a potential barrier. It is therefore important to understand what shapes community acceptance and identify policy responses. This paper presents a case study of community acceptance of a large-scale solar farm in the UK, the first to be classified as 'nationally significant' infrastructure. In doing so, it provides the first empirical study of community acceptance of a large-scale solar farm in a developed country context, building on existing studies which use hypothetical approaches such as choice experiments, or surveys which measure general attitudes rather than responses to specific developments. The paper uses mixed methods (quantitative content analysis of online comments on the planning proposal; qualitative semi-structured interviews with local residents and key stakeholders; and participant observation) to identify determinants shaping community acceptance of large-scale solar farms. We discover 28 determinants which we group into eight categories: aesthetic, environmental, economic, project details, temporal, social, construction and process. We argue that these findings help to reveal broader issues underlying community acceptance of solar farms and other renewable energy infrastructure: 'green-on-green' tensions; issues of scale and place attachment; policy, process and justice. We also contribute a novel understanding of community acceptance as 'relational', by which we mean it is informed by the deployment of other energy technologies and the wider energy policy landscape, not just the specific project. We conclude with recommendations for how policymakers can respond to the issues identified by this article.

1. Introduction

Large-scale solar farms are increasingly being built around the world to generate renewable energy. These are ground-mounted arrays of solar photovoltaic (PV) panels which convert sunlight into electricity, sometimes called solar parks or solar fields. Whilst having advantages in terms of meeting rising energy demand and decarbonising electricity supplies (Sharma, 2011), some solar farm developments have provoked strong negative public reactions. However, the reasons underlying this have not been well explored in academic literature. This paper explores the issues surrounding public acceptance of a large-scale solar farm project in the United Kingdom (UK). It is the first solar farm to be classified as a Nationally Significant Infrastructure Project (NSIP), which is the way the planning system in England and Wales deals with major infrastructure that fulfils a national need (Rydin et al., 2018). This is a timely topic of research as a growing number of large-scale solar farms are being proposed, driven by low carbon transition policies to meet net zero emissions targets in response to climate change.

We draw upon the influential framework by Wüstenhagen et al. (2007) which distinguishes between three dimensions of social acceptance: socio-political, community and market. Socio-political acceptance refers to general support for a technology or policy from the public, policymakers or other actors; community acceptance refers to responses to specific infrastructure projects or proposals by local publics

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or wider ‘communities of relevance’ (Batel, 2018); market acceptance refers to the process of market adoption of technologies or innovations by consumers (e.g. the public) or investors. Whilst each are enacted and shaped by various actors, we focus on the role of the public as a key stakeholder across multiple dimensions of social acceptance (Walker, 1995; Boudet, 2019). Though each dimension is fundamental in the implementation of energy innovations (Wolsink, 2018), we focus on community acceptance as a particularly important consideration at the deployment stage because government officials and companies must negotiate with local people (and broader communities of interest) through planning processes (Carley et al., 2020). Without community acceptance, it may not be possible to roll-out an innovation, despite acceptance in the socio-political and market realms. In some cases, this can have wider ramifications such as in the case of onshore wind in the UK, for which government subsidies were removed as a result of local backlash (Cowell, 2017). Thus, community acceptance is commonly recognised as a critical factor in the successful implementation of renewable energy policies (Devine-Wright, 2009).

To date, there has been limited research on what shapes community acceptance of large-scale solar farms. This is important because their high land-take and potential conflict with other land uses gives rise to a unique set of environmental, social and economic issues (Jones et al., 2015), which are not necessarily directly comparable to more frequently studied technologies such as onshore wind. Against this backdrop, this paper asks the following research questions: *What are the key determinants shaping community acceptance of large-scale solar farms? What does this reveal about broader issues underlying community acceptance of renewable energy infrastructure? How can these issues be better addressed by policymakers?* The paper is structured as follows. In the following section, we review existing academic literature on community acceptance of solar farms and outline our research gap. We then introduce our case study and the mixed (quantitative and qualitative) methods used to address our research questions. Next, we present our results and discuss the broader significance of our findings. In the final section, we offer key academic and policy conclusions and suggest directions for further research.

2. Literature review

Solar farms as conceived in this paper are distinguished from Concentrated Solar Power (CSP) plants which use mirrors to direct sunlight onto a small area to generate thermal energy. They are also distinguished from PV installations on rooftops or on water i.e. ‘floating’ solar farms. Existing solar farms range from small arrays with an output less than 1 MW to ‘mega-projects’ covering thousands of hectares with an output of 2000 MW; the largest projects are in China, India and Mexico in semi-arid and desert landscapes (Wolfe, 2019). They are also increasingly developed in densely populated areas such as in Europe, on agricultural and brownfield land. To date, however, research has overlooked public responses to solar farms in these settings.

Yenneti and Day (2015) and Yenneti et al. (2016) focus on the case study of Charanka Solar Park in Gujarat, India: one of the largest solar farms in the world. Through stakeholder interviews, they find that some local residents have been dispossessed of resources in the land acquisition process for the project, threatening livelihoods and exacerbating vulnerabilities. Nkoana (2018) identifies corruption and inadequate consultation in the planning process surrounding two solar parks in Limpopo, South Africa, thereby “leaving room for powerful stakeholders to thrive over vulnerable community members” (p34). Issues surrounding livelihoods, access to land, community consultation and fair process thus appear likely to shape community acceptance of solar farms, though it is unclear whether this is specific to developing countries with higher levels of subsistence living and with weaker institutional governance. However, similar issues have been identified in developed countries in relation to other types of energy infrastructure such as oil and gas in Canada (Garvie and Shaw, 2014), onshore wind farms in Australia (Gross, 2007) and marine renewable energy in Ireland (Reilly et al., 2016).

Another notable body of solar farm research focuses on the United States (US). For example, Carlisle et al. (2014) investigate predictors of support for large-scale solar farms in California, finding that the prospect of positive impacts, such as jobs, had a stronger effect on attitudes than potential negative impacts, such as construction traffic. Carlisle et al. (2015) explore whether attitudes vary between a national US sample and a sample in the Southwest: a key area for solar farm development. They find that support is similar across these samples: 82% nationally and 80% in the Southwest, varying slightly according to demographic characteristics. This indicates that public opinion is generally favourable and that direct experience of solar farms has a limited effect. This corresponds with research on wind energy finding that direct experience can in fact lead to increased support, suggesting an ‘Inverse NIMBY’ (Not In My Back Yard) syndrome (Warren et al., 2005). Carlisle et al. (2016) identify high support for solar farms in Southern California, though find that visual impacts and buffer distances can alter people’s attitudes.

Whilst useful in identifying broad trends in public attitudes towards solar farms and key factors influencing this (e.g. jobs, visual impacts, buffer distances), these studies are limited in that they do not focus on empirical solar farms. Thus, they are not rooted in a specific context or place, which research shows to be fundamental to community responses to energy infrastructure as a result of issues around place attachment (i.e. connection to the local area) and place identity (Devine-Wright, 2009). Studies which use hypothetical projects to explore community acceptance are limited for similar reasons. For example, Yang et al. (2017) conducted a choice experiment in South Korea in which respondents chose between imagined solar farms with differing traits. They found a greater willingness to pay for policies to reduce light pollution, habitat loss, hazardous materials and landscape destruction, the precise amount varying between these impacts (in descending order). Such studies can be influenced by hypothetical bias, in which respondents state how they think they would feel in a given situation, rather than reporting on how they actually experience it (Loomis, 2011). Thus, there remains a research gap on determinants shaping actual community responses to solar farms, which is important as public support has been found to shift when people are asked to think concretely rather than abstractly about the impacts of solar energy projects (Sütterlin and Siegrist, 2017).

Though not focusing on one empirical case, Roddis et al. (2018) provide a first attempt at understanding community acceptance of solar farms in a densely populated, developed country. They analyse planning applications for solar farms in Great Britain (GB) to identify types of project that are more or less likely to gain planning approval. They find that solar farms proposed on the highest quality agricultural land are on average five times less likely to be approved than those on non-agricultural land. This reflects planning guidance to protect the ‘best and most versatile agricultural land’ (NPPF, 2012) but may also reflect community opposition to solar farms perceived to conflict with traditional land uses such as farming. This has parallels with existing research on high voltage power lines finding that the ‘fit’ of energy infrastructure with the landscape shapes community responses (Devine-Wright and Batel, 2013), and indeed may be even more pronounced for solar farms given their higher land-take.

Roddis et al. (2018) also find that solar farms are 15% more likely to be approved in more socially and economically deprived areas, raising issues of distributive justice (i.e. the distribution of costs and benefits across society) and procedural justice (i.e. fair and representative decision-making processes) of renewable energy (Heffron and McCauley, 2017). Perceived injustices can in turn have an effect on public perceptions of energy infrastructure (Tabi and Wüstenhagen 2017), highlighting the importance of attending to justice issues when considering public acceptance. Indeed, issues of justice are identified as important for community acceptance of other energy infrastructure such as onshore wind (Simcock, 2016) and shale gas (Cotton, 2017). Finally, Roddis et al. (2018) find that smaller solar farms are more likely to be approved than larger ones, indicating that scale is another potentially important issue shaping community acceptance. This would support suggestions from scholars that large-scale infrastructures are more likely to face opposition from the public (Batel et al., 2013).

3. Case study and methods

3.1. Cleve Hill solar Park

Cleve Hill Solar Park (henceforth referred to as Cleve Hill) was proposed in 2018 in Kent, South East England, and received planning consent in May 2020. It is the first solar farm to be classified as an NSIP, which is how the planning regime in England and Wales deals with major infrastructure developments such as energy, transport and water projects, as established by the Planning Act 2008 (Lee et al., 2013). All onshore energy projects with a capacity above 50 MW are classified as NSIPs, as well as offshore energy projects with a capacity above 100 MW (Natarajan et al., 2018). Cleve Hill has a proposed capacity of 350 MW, making it the second largest solar farm application in GB to date and the third largest application in Europe (following Pizarro in Spain). In line with the NSIP threshold, this paper defines 'large-scale' as solar farms with capacities greater than 50 MW. In GB, there are currently around 1,000 operational solar farms and the average installed capacity is around 8 MW (Roddis et al., 2018).

The average capacity of British solar farms has been increasing in recent years, particularly following changes to the UK Government's subsidy regime in 2015/2016 which substantially lowered Feed-In Tariff rates and closed the Renewables Obligation (the main subsidy scheme at the time) to new solar PV capacity (Burke, 2015). This resulted in a marked drop in the number of planning applications in 2016 (Fig. 1). This makes public acceptance of large-scale solar farms a timely topic of research as proposals for large subsidy-free projects such as Cleve Hill come forward which rely on economies of scale to make them financially viable. Two further solar farm NSIPs have submitted planning applications since Cleve Hill: Little Crow Solar Park (150 MW) in December 2018 and Sunnica Energy Farm (500 MW) in March 2019, seemingly indicating this growing trend. Thus, Cleve Hill acts as an "instrumental" case study from which insights can be drawn into the issues surrounding community acceptance of large-scale solar farms more broadly, whilst recognising the specifics of the case (Stake, 1995).

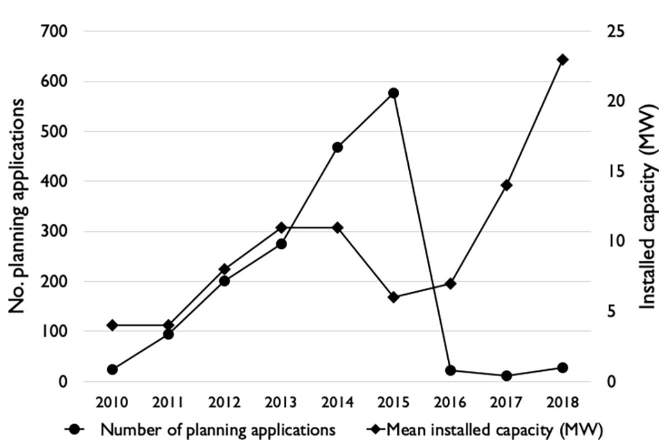

Fig. 1. Planning applications for solar farms in Great Britain (150kw+) from 2010 to 2018. Round markers show total annual number of planning applications (left Y axis); diamond markers show annual average (mean) installed capacity of installations (right Y axis). Data is from the UK Renewable Energy Planning Database (monthly extract December 2019). NB. Subsidies for solar farms were reduced by the UK Government in 2016, resulting in a fall in applications.

Cleve Hill is a joint venture between two private companies, Hive Energy Limited and Wirsol Energy Limited. The development includes around 1 million solar PV panels along with a battery storage facility, covering a total area of around 1000 acres (Arcus Consulting, 2017). The land is currently used for arable farming and is classified as 'moderate quality', with an Agricultural Land Classification of 3b (Arcus Consulting, 2017). The land is reclaimed saltmarsh, lending the name Graveney Marshes to the area. The site is bordered to the north by the Swale channel; to the east by a main road and substation infrastructure; to the south by dispersed residential properties; and to the west by the Faversham Creek tidal estuary (Fig. 2). There are a number of designated habitats and nature reserves close to the site though not directly overlapping with it, including a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and Ramsar wetland site. It is adjacent to or overlapping a number of public footpaths such as the Saxon Shore Way. The site is low lying and prone to flooding. Unlike other British solar farms which are south-facing, the panels are proposed in a novel east-west design to maximise their number and thus electricity generating potential.

The Cleve Hill project is located in the Swale Local Authority District (LAD) on the north coast of Kent, near the rural village of Graveney (population ~500) and the historic market town of Faversham (population ~19,000) (ONS, 2016). The Swale is a popular tourist and retirement destination with a higher percentage of retired people than the English average (15.1% vs 13.7%) (ONS, 2016). It is a relatively deprived district, ranked 69 out of 317 LADs (IMD, 2019), though there is substantial diversity in terms of affluence within the LAD. There is no community ownership or community benefit scheme attached to the development.

Cleve Hill's proposal sparked substantial debate within the local community about the pros and cons of solar farms, leading to the formation of a local opposition group 'Save Graveney Marshes'. It therefore makes an interesting case study as community acceptance has become a significant issue surrounding the project. All documentation for NSIPs is publicly available online, making these types of projects good case studies in terms of data availability. As an NSIP, Cleve Hill is also a useful case study to explore issues surrounding scale and governance as the planning process is managed centrally by a government body, The Planning Inspectorate, thereby introducing a possible tension between local impacts and national need (as well as the wider global climate benefits of renewable energy).

3.2. Methods

To address our research questions, we used both quantitative and qualitative methods. Quantitatively, we carried out content analysis of online comments written by members of the public in response to the Cleve Hill planning proposal ($n = 816$). These were obtained from the 'Relevant Representations' section of the National Infrastructure Planning website. Qualitatively, we conducted semi-structured interviews with members of the public living near the proposed site and other key stakeholders i.e. planning officials and campaigners ($n = 12$). We also carried out participant observation at three public hearings and an official site inspection held by The Planning Inspectorate. Our observations allowed us to gain deeper insights into the local context, thus helping to interpret the online comments and interviews.

Online comments (or 'representations') were submitted between December 2018 and January 2019. Statutory and non-statutory authorities and businesses were also able to submit representations; however, we focus on comments made by members of the public to directly address our research questions. Only one comment is allowed per person, though it is allowable to make a comment on someone else's behalf if specified. The Planning Inspectorate requests that comments focus on the aspects of an application a person agrees and/or disagrees with and their reasons why. They ask not to receive comments on issues surrounding compulsory acquisition of land or rights over land, or the

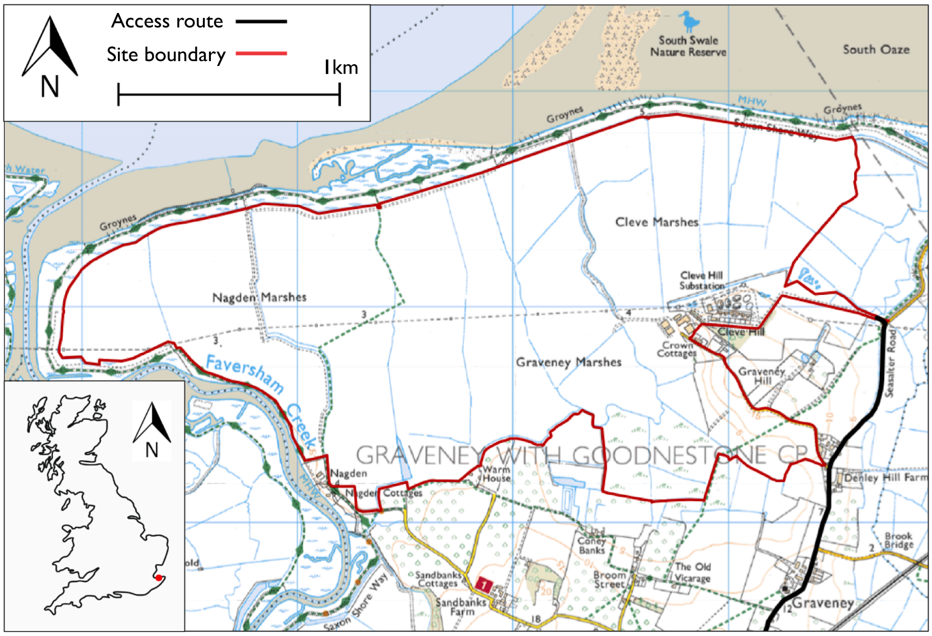

Fig. 2. Map of Cleve Hill Solar Park site. Insert shows approximate location in Great Britain (red dot). Image adapted from Scoping Report (Arcus Consulting, 2017), reproduced from Ordnance Survey digital map data. Crown copyright and database rights 2017 Ordnance Survey. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

merits of a policy set out in a National Policy Statement (which underpin the NSIP regime). There is no word limit though they do request that comments focus on key points and do not allow attachments. This may mean that not all determinants shaping community acceptance are captured in this dataset as people may exclude certain concerns, prioritise the issues they raise or tailor their comments towards what they think will have most traction in the formal planning process.

To identify determinants which are captured by this dataset, we drew upon the conceptual framework by Roddis et al. (2018) on community acceptance of onshore wind and solar farms. This is the only community acceptance framework the authors are aware of which focuses explicitly on solar farms. We followed an 'abductive' research approach whereby a conceptual framework is applied with a view to modifying it and thus developing new theory (Bryman, 2012). We therefore used the Roddis et al. (2018) framework as the basis for developing a coding scheme, adding new codes where we identified determinants not captured by the original framework. As recommended by White and Marsh (2006), where the coding scheme was modified during the coding process it was then re-applied to the data already coded to ensure consistency. We used the data analysis software Nvivo to carry out the coding process.

To select interviewees, a purposive sampling approach was taken whereby key stakeholder groups were identified and targeted (Palinkas et al., 2015). Interviewees can be categorised into four groups: active residents (who actively engaged with the planning process for Cleve Hill e.g. by submitting online comments and/or attending public hearings); passive residents (who did not engage with planning process for Cleve Hill); campaigners (who were actively involved in the campaign against Cleve Hill); and planning officials (who were professionally involved in the planning process for Cleve Hill). Questions were tailored for each of these groups, however specific topics were asked about consistently to improve comparability e.g. general views on solar farms as a way of generating electricity, specific views on Cleve Hill, relationship with the Cleve Hill site, participation in the Cleve Hill planning process. Interviews followed a semi-structured format to allow flexibility. Interviewees were recruited in a variety of ways: social media; information sheets placed in public spaces; the lead researcher's attendance at public hearings for the Cleve Hill planning proposal; and snowball sampling.

As far as possible, individuals were sampled from different demographic groups (namely gender and age) as well as differing levels of engagement with the planning process to provide a diversity of perspectives and experiences (Table 1). This was informed by the insight that attitudes to solar farms vary across social groups (Carlisle et al., 2015). The interviews took place either in person or by phone, lasting between 30 minutes and an hour. They were held within a four-week period between July and August 2019, coinciding with the examination stage for Cleve Hill. We conducted fieldwork at this time because it enabled an understanding of how the NSIP planning process shaped people's perspectives, as well as the proposal itself. It also meant that awareness of the proposal was high amongst the local community (public consultation having commenced in 2017). The content analysis

Table 1
Interviewee details including stakeholder type, participation in the Cleve Hill Solar Park planning process and demographic information (gender and age).

Interviewee	Stakeholder type	Participation	Demographics
1	Active resident	Online comment	Female, 40–60
2	Active resident	Online comment	Male, 40–60
3	Active resident	Online comment	Male, 40–60
4	Active resident	Online comment and public hearings	Male, 60+
5	Passive resident	None	Female, 40–60
6	Passive resident	None	Female, 40–60
7	Passive resident	None	Male, 20–40
8	Passive resident	None	Female, 20–40
9	Campaigner	Online comment, public hearings and campaigning	Male, 60+
10	Campaigner	Online comment, public hearings and campaigning	Female, 40–60
11	Planning official	Decision maker	Male, 20–40
12	Planning official	Decision maker	Male, 40–60

was carried out prior to the fieldwork to familiarise the research team with the case and key public concerns. We did not find it necessary to further modify the coding scheme subsequent to the fieldwork.

A mixed method multi-strategy approach allowed breadth and depth of analysis, which has been shown to bring greater understanding of a phenomenon than by using individual approaches (Bryman, 2006). We followed a triangulation mixed methods design (Creswell and Plano Clark, 2007), whereby complimentary yet distinctly different data was gathered and then integrated for interpretation of the research phenomenon (Almalki, 2016). Importantly, the interviews enabled us to capture perspectives of individuals who had not responded to the online consultation, and the participant observation enabled us to contextualise our analysis.

There are limitations to our methods which are important to acknowledge. Firstly, there is likely to be bias in the sample of respondents who submitted online comments. Research shows that people who feel strongly against a proposed project are more likely to engage with the planning process than those who feel support, qualified support or indifference (Bell et al., 2005). Therefore, our analysis of determinants is likely to be skewed towards those who feel strongly against Cleve Hill. Secondly, our analysis is limited to the specific time period in which our data were collected i.e. the planning stage. Research shows that community acceptance of energy infrastructure varies across time stages of the project, usually dipping during the planning stage and rising again following construction (Wilson and Dyke, 2016). Thirdly, the number of interviewees is relatively small due to resource constraints ($n = 12$). However, we feel the interview data provides an important balance to the online comments because people may have limited or tailored their online comments for the purpose of the planning process and/or formulated them to gain greater political legitimacy and avoid being dismissed as self-interested 'NIMBYs' (van der Horst, 2007). Additionally, the interviews help to reveal perspectives of community members who did not directly engage with the Cleve Hill planning process and which would therefore otherwise be overlooked.

4. Results and discussion

Our content analysis showed that 98% of online comments ($n = 803$) were opposed to the Cleve Hill proposal and 2% were in favour ($n = 13$). This does not necessarily mean that 98% of the community is opposed, rather this corresponds with other research finding that people who feel strongly against a proposal are often most likely to engage with planning processes (Bell et al., 2005). Across the 816 comments, we identified 28 codes (i.e. determinants) which collectively recurred a total of 3776 times. Eighteen of these were identified by our analysis; ten were from the original framework by Roddis et al. (2018). We classified these codes into eight categories: aesthetic, environmental, economic, project details, temporal, social, construction and process. The first five of these categories are from Roddis et al. (2018); the latter three were identified by our analysis thus adding to the original framework. We did not identify determinants in the demographic, political or geographical categories of the original framework as this data is either not collected or made available by The Planning Inspectorate. The breakdown of codes within each category is shown in Fig. 3 and the breakdown of all codes is shown in Fig. 4. Our full coding scheme is shown in Fig. 5 and a more detailed description of what each code refers to is provided in Table S1 in Supporting Information.

4.1. Green-on-green tensions

Our quantitative results show that the most commonly articulated concern regarding Cleve Hill was its potential impacts on wildlife and habitats, accounting for approximately 18% of all 3776 codes. Of particular concern was its potential impacts on birds, which accounted for 51% of all codes on wildlife and habitats. This highlights the 'green-on-green' character of community acceptance of solar farms, whereby

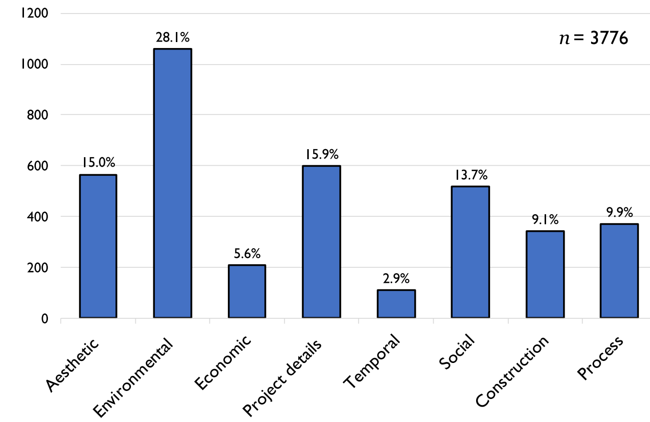

Fig. 3. Frequencies and percentages of codes (i.e. determinants of community acceptance) in each category of our coding scheme for analysing online comments from the public on the Cleve Hill Solar Park planning proposal.

measures to mitigate climate change come into conflict with other environmental priorities such as wildlife conservation (Warren et al., 2005). This tension is particularly pronounced for Cleve Hill as the site is close to several protected areas for biodiversity and hosts charismatic species such as the Marsh Harrier. Similar concerns have been identified in relation to other renewable energy infrastructure such as wind turbines (e.g. Devlin, 2005); the key difference with solar farms is that the scientific evidence on biodiversity impacts is still evolving meaning there is higher uncertainty (Randle-Boggis et al., 2020), particularly for solar farms the size of Cleve Hill and those with an east-west design. This means that *perception* of impacts is a particularly important issue in this context, as well as as *known* impacts.

Interestingly, although very few online comments were in favour of Cleve Hill, wildlife was also one of the most frequent codes in support of the project. Specifically, these comments highlighted the creation of a wildlife habitat area adjacent to the facility which was perceived very positively by those who mentioned it. Concern for wildlife was also a common theme across interviewees who supported the project. For instance, interviewee 7 commented:

> *"We have so little time to deal with climate change. Anything that has to happen, it has to happen now […] As long as you don't wipe out ecosystems, you can still walk around and still see birds, that doesn't bother me that much because psychologically you know why they're there, and they're there to make sure there still is an ecosystem."*

This indicates that biodiversity is a driver both for *and* against solar farms; some people were concerned about the immediate impacts of the infrastructure on wildlife and habitats, whilst others were concerned about the longer-term threat to wildlife posed by climate change. This highlights a temporal dimension to green-on-green conflicts which is often overlooked. It also indicates that the perception of the impacts of solar farms may vary depending on one's concern for climate change.

Other interviewees highlighted the complexity of deciding what actually counts as 'green'. As interviewee 10, a lead campaigner from 'Save Graveney Marshes', expressed:

> *"We all know that we need clean energy and we've got to do something about climate change, but we have to be mindful of the actual environment we're destroying to create that 'clean' energy. You have to look at where those solar panels are coming from, and things like transport, not just the generation of the energy. You have to look at the whole thing to decide whether it's green, and I don't think we can say that is the case here."*

This reveals a sophisticated understanding of the various sustainability metrics for energy, with direct carbon emissions only one of a number of environmental impacts that arise over the lifecycle of energy

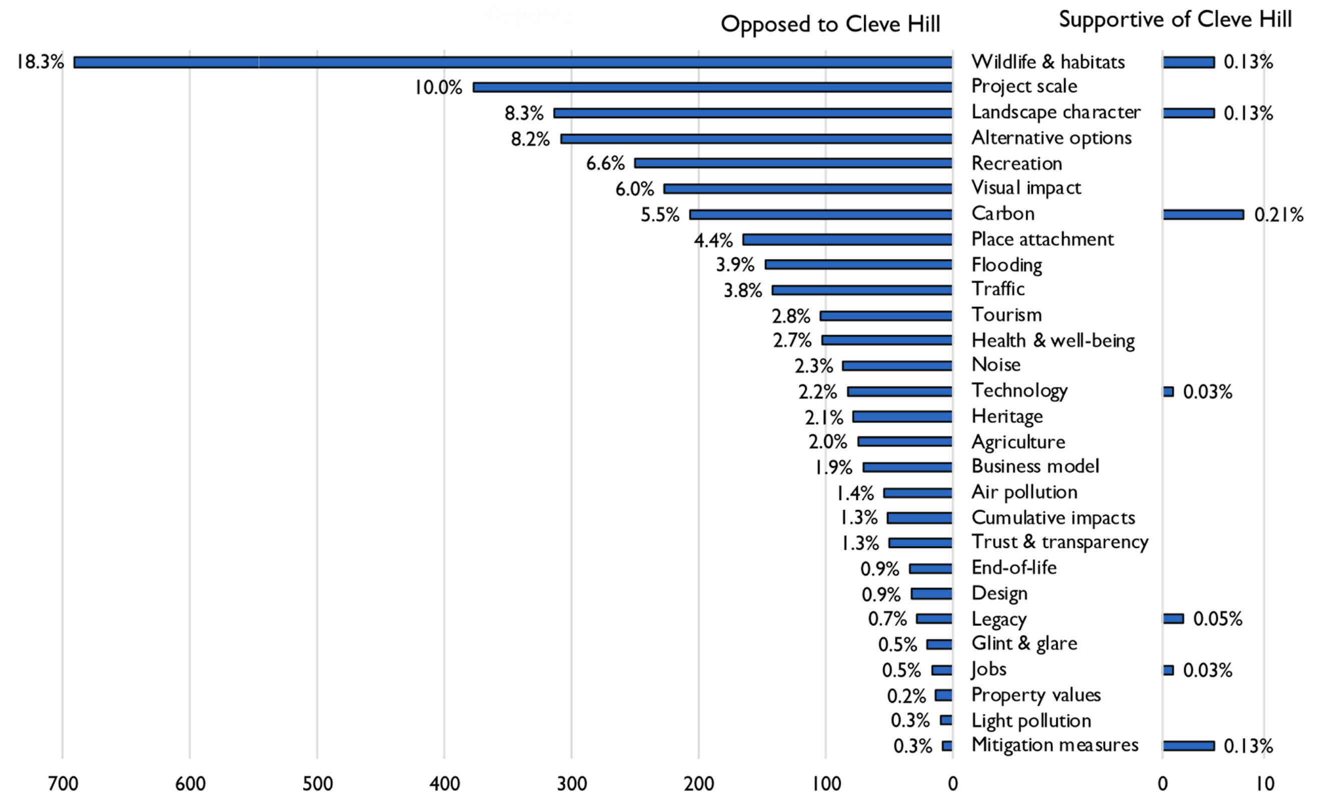

Fig. 4. Frequencies and percentages of codes (n = 3776) for each determinant (supportive and opposed) identified in our content analysis of online comments on Cleve Hill Solar Park.

projects. This demonstrates the complexity of evaluating the 'most' sustainable option when deliberating green-on-green tensions such as large-scale solar farms and other types of renewable energy, given the multiple environmental dimensions at play such as land usage, impacts on wildlife and carbon emissions.

Another interesting aspect of the Cleve Hill case study is that it is proposed on land which is prone to flooding and acts as a flood plain. This means that the panels must be raised to avoid flood water, thus adding to the project's visual impact. Climate change makes this elevation all the more necessary due to sea level rise and increased flood risk. Currently, the site's flood risk is managed by the (EA), a statutory body; however, the developer is due to take over this responsibility. The online comments and interviews reflected concern that the developer would prioritise the protection of their infrastructure rather than local residences and businesses. Others raised the point that if the EA continues to manage the site there are plans for coastal realignment whereby the land will be reverted to saltmarsh to help mitigate flooding and enhance carbon sequestration. This exemplifies a complex set of green-on-green tensions which are specific to community acceptance solar farms as opposed to other renewable energy infrastructure such as wind turbines. The amount of land required for solar farms forces consideration of how best to utilise space to meet environmental objectives including carbon reduction, carbon storage, visual amenity, flood management and wildlife conservation. In turn, these must be weighed against the societal need for energy. This accords with other scholars such as Holland et al. (2016) and Randle-Boggis et al. (2020) who argue that an ecosystem services approach to energy planning may be beneficial to evaluate these interactions, and to identify trade-offs that the public and other stakeholders are most (and least) willing to accept. In some cases, it may be that solar farms could in fact improve ecosystem service provision for example by planting wildflowers in the margins of solar farm developments (Randle-Boggis et al., 2020).

4.2. Issues of scale and place attachment

The code that appeared in the online comments most frequently after wildlife and habitats was the scale of the project, accounting for 10% of codes. This included references to the land area of the site (roughly equivalent to 750 football fields), the height of the panels (raised to 3.9 m to avoid flood water) and the generating capacity (350 MW). It was commonly described as a "*megaproject*" and comments relating to the scale were framed in a pejorative way such as "*ridiculously enormous*", "*very intrusive height and expanse*" and "*far too big for such a small area of Kent*". This raises an interesting dynamic between the relative scale of the project and the space it occupies, similar to the finding that the 'fit' of energy infrastructure in the landscape shapes community responses (Devine-Wright and Batel, 2013; Devine-Wright and Wiersma, 2020). The comparable area of the site to Faversham was also frequently highlighted by interviewees, emphasising that a project of this size was not seen to 'fit' with the local area. These findings also show the influence of the Save Graveney Marshes campaign on people's responses (Fig. 6), indicating the socially constructed nature of community acceptance i.e. people do not form their views in isolation, but also take cues from their peers and those around them (Devine-Wright, 2008).

One explanation for the negative responses to the scale of the project is that it emphasises the change in the traditional use of the landscape. Indeed, the third most frequent code was landscape character. England is a fairly settled landscape, meaning that people are accustomed to the landscape being the way that it currently is (Selman, 2010). New energy infrastructure disrupts this sense of "landscape permanence" and can trigger public opposition (Pasqualetti, 2000). This has been found to be important issue for wind energy and may be even more so for solar farms as they largely preclude the land continuing to be used for other purposes. Thus, they may come to be regarded by the public as a more fundamental change to the landscape than wind turbines. Interestingly however, although the Cleve Hill site is currently agricultural, impacts

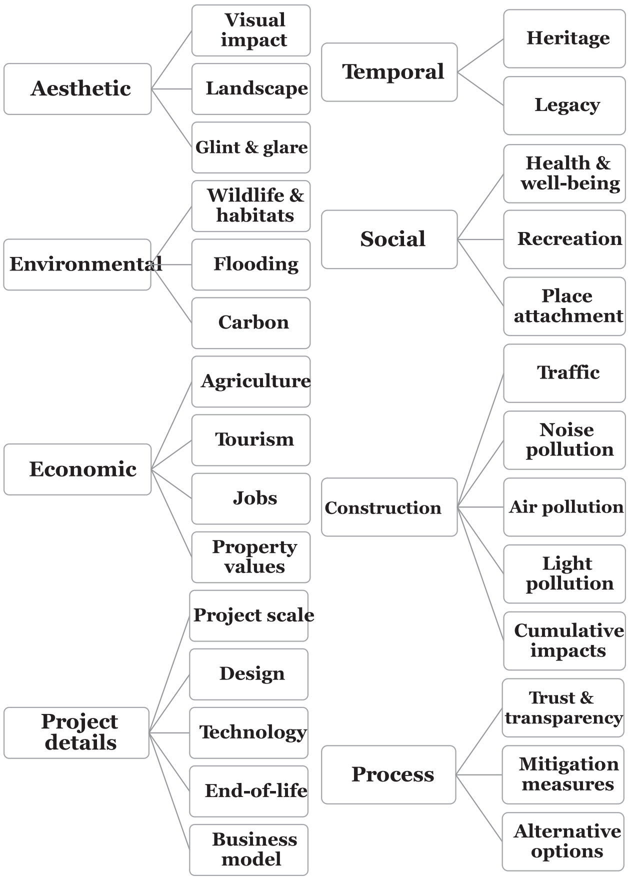

Fig. 5. Coding scheme developed in this paper for analysing online comments made by the public on the Cleve Hill Solar Park planning proposal in order to identify the determinants of community acceptance of large-scale solar farms. The aesthetic, environmental, economic, project details and temporal categories are from the conceptual framework by Roddis et al. (2018); the social, construction and process categories were added by this paper. 18 of the 28 codes (i.e. determinants) were identified in this paper; 10 are from the original framework.

on agriculture were not identified in the interviews or content analysis as a very strong determinant of community acceptance, representing 2% of codes. Instead, the underlying concerns around the project's scale appear to be more strongly driven by place attachment, as indeed existing research has identified as important for other types of energy infrastructure.

Place attachment refers to the bonding between individuals and their environments (Scannell and Gifford, 2010). In our content analysis, 4.4% of codes explicitly expressed place attachment i.e. they expressed love or strong affection for the Cleve Hill site or wider area. However, many other codes are also intertwined with place attachment, such as landscape character (8.3%), recreation (6.6.%), visual impact (6%), and health and well-being (2.7%). Our interview data also identified place attachment. For example, interviewee 5 commented on the spiritual value of Graveney Marshes and how they were saddened by the prospect of losing a place that they frequently visited and was very special to them:

> *"I love nature. In terms of my faith, I feel close to God when I'm near nature, and we won't have that anymore. It will just be industrial."*

This demonstrates the religious or spiritual importance of the marshes to the community, another important component of place attachment. This can be described as a 'cultural ecosystem service' (Fish et al., 2016) i.e. the non-material benefits people obtain from nature, further demonstrating the value of applying an ecosystem services approach to public acceptance of renewable energy.

The issues of scale and place attachment discussed here are particularly relevant to NSIPs as they are underpinned by a policy presumption of national need (Johnstone, 2014). Both online respondents and interviewees frequently acknowledged the need for low carbon energy generation, taking into account the national scale (energy supply issues) and the global scale (tackling climate change). However, their views are deeply embedded in the local scale and concerns over the local impacts of the Cleve Hill project. Interviewee 5 described this tension as a "*battle in my head*" because they recognised the broader benefits of the project but were distressed about the loss of a highly valued place in their local area. Similarly, many online respondents stated that they supported solar technology generally because of its low carbon emissions (6% of all codes) but did not support Cleve Hill specifically, demonstrating the multi-scalar character of community acceptance of renewable energy. This supports calls to provide policymakers with more realistic measures of community acceptance to avoid misleading expectations of public responses to solar energy (Sütterlin and Siegrist, 2017). It also supports existing research (e.g. Roberts and Escobar, 2015) which finds that the public deliberate a range of complex issues when formulating their opinions on energy infrastructure, supporting a shift away from simplistic accusations of NIMBYism.

4.3. Policy, process and justice

Other key themes arising from our analysis relate to policy, process and the justice implications of these issues. The fourth most frequent code identified in the online comments (8.2%) related to alternative options i.e. the perception that other locations or technologies were more suitable for generating electricity and reducing emissions, frequently accompanied by a perception that these had not been adequately considered by decision-makers. In particular, the topic of rooftop solar was a common theme across the interviews, as well as the online comments: 32.4% of the 'alternative options' codes referred to putting solar on industrial or domestic rooftops. This indicates that community acceptance of solar farms is 'relational' rather than absolute; by this we mean it is informed by the deployment of other energy technologies and the wider energy policy landscape, not only the specific solar farm. This builds on conceptions of community acceptance as 'qualified' or 'conditional' depending on project characteristics or attitudes to the technology (Bell et al., 2005; Ellis et al., 2007).

This relationship between community acceptance of solar farms and the wider energy policy context is illustrated well by this comment from interviewee 2:

> *"I think there's a big problem in the UK with building regulations and how we use energy. In Faversham, we have around a thousand new homes being built around the town; none have solar panels on the roof or are designed with any idea that you could retrofit because of the way they're oriented. It's cheaper and easier to use a greenfield site, but it's using up an environmental space. So it's a case of I'm not against solar farms, but we need a far more grown up and integrated approach to energy in total. It's the lack of a national integrated approach that bothers me."*

Similarly, interviewee 8 expressed that their views towards Cleve Hill were intertwined with policy, referring to the UK government's subsidy cuts for rooftop solar (Kabir et al., 2018):

> *"I think it would be better if we use space where there are already structures, like if you put solar panels on top of houses then you're utilising the space much better. But if the government aren't going to support that, we haven't really got another option."*

We believe the insights offered by these results are a novel contribution to the literature, showing that community acceptance is not only conditional on the specifics of a project or views towards the specific technology in question (Ellis et al. 2007), but is also *relational* i.e. it is

Fig. 6. 'Save Graveney Marshes' campaign posters on a board overlooking the proposed site for Cleve Hill Solar Park, one reading: 'No to the solar park! As big as Faversham' and the other highlighting landscape impacts. Photograph was taken by the lead researcher in July 2019.

deeply intertwined with wider policy context and the context of which other energy technologies are currently being deployed.

In line with extant research on solar farms (e.g. Nkoana, 2018), we also find that consultation processes are a noteworthy consideration. Issues relating to 'trust and transparency' (regarding the developer and the Planning Inspectorate) accounted for 1.3% of codes. For example, online comments described a "*misleading and deceitful public consultation process*" and argued that "*the procedure followed does not offer meaningful consultation and tends therefore to create its own momentum, which is procedurally unjust*". This sentiment was echoed by interviewee 9 who described the process as "*asymmetrical warfare*" because they judged that the developers had greater resources and influence in the planning process than local people. This shows that as well as the project itself and the wider policy context, process surrounding planning for large-scale solar farms can be an important factor shaping community acceptance. This supports other research (e.g. Lee et al., 2018; Natarajan et al., 2019) which finds that participation in NSIP planning processes should be made more inclusive of the public and community stakeholders.

Other online comments highlighted the privatised business model and lack of community benefits for Cleve Hill (1.9% of codes), commenting there was "*no benefit whatsoever for the local people*". This sentiment also arose in the interview data, for example interviewee 6:

> *"I don't know where the power from this development is going to go, it would be good if it was consumed locally. Where is the profit going? Where is the power going? The people of this area will be looking at the solar panels, but will they have any benefit from it? I think some money should come off the energy bills of the local people."*

This reveals a perception of unfair distribution of costs and benefits i.e. a distributional injustice, as well as the procedural injustice noted in the previous paragraph (Walker, 2009). Another 'cost' is the risk of fire from the battery storage which is a relatively untested technology, accounting for 2.2% of codes (coded under 'technology'). This indicates that unjust distribution of costs, risks and benefits does influence community acceptance, supporting existing research which finds that perceptions of injustice shape responses to renewable energy infrastructure (Tabi and Wüstenhagen, 2017). It also adds to calls on the need for a holistic 'just transition' which takes into account the full range of impacts, risks and benefits arising from the transition to a low carbon society (Heffron and McCauley, 2018).

5. Conclusions and recommendations

This paper contributes the first empirical study of community acceptance of a large-scale solar farm in a densely populated, developed country context. The key contributions are as follows. Through content analysis of 816 online planning responses, supplemented with 12 qualitative interviews and participant observation, we build on the conceptual framework established by Roddis et al. (2018) to describe the key categories of determinants shaping community acceptance of large-scale solar farms: aesthetic, environmental, economic, project details, temporal, social, construction, and process. The latter three categories are identified in this paper and are thus a new contribution towards the existing framework. We also identify 28 determinants of community acceptance within these eight overarching categories, of which 18 are original contributions. Further research could test other frameworks for comparison (e.g. Harper et al., 2019) and draw upon different data sources such as social media content, given there are limitations to using planning responses as a measure of community acceptance and our relatively small interview sample size. This type of research could also be repeated at a different stage of the Cleve Hill project's lifespan, as our results focus on the planning stage before the project is actually built.

Another contribution is to highlight the 'green-on-green' character of community acceptance of solar farms. The most frequent concern raised about Cleve Hill in the online consultation was its potential impacts on wildlife and habitats. Whilst there is scientific uncertainty regarding impacts of solar farms on wildlife, particularly in relation to solar farms the size of Cleve Hill and those with an east-west design, it is clear that the *potential* conflict was a major determinant of community (non) acceptance. This indicates that research on the impacts of solar farms on wildlife should be prioritised by policymakers in order to enhance the evidence base and increase certainty. This article also raises many issues about how land is best used to achieve different policy goals including energy generation, wildlife habitat, agriculture, carbon storage and flood mitigation. In the context of low carbon transitions, policymakers may need to more strategically plan how land is going to be used in order to balance these competing goals, potentially drawing upon an ecosystem services approach as suggested by other scholars to identify synergies and trade-offs. This may involve prioritising rooftop PV installations or solar farms on brownfield sites to avoid the green-on-green tensions identified in this paper. Despite the UK government's previous policy attempts to encourage developments in these locations (Cowell and Devine-Wright, 2018), lack of subsidies appears to be driving large-scale proposals such as Cleve Hill, perhaps due to the need for economies of scale for viability.

This links closely to another key contribution of this article which is to highlight issues of scale and place attachment as important to community acceptance of solar farms. The scale of the Cleve Hill project was the second most frequent concern identified in the online comments. This connects to many other frequently raised concerns such as landscape character, visual impacts and recreation, all of which are intertwined with place attachment. Issues of scale are particularly important for solar NSIPs because they are designed to fulfill a national need and have global benefits for the climate, but their impacts are experienced locally. Policymakers could address these multi-scalar issues by limiting the area of land that can be used for any one energy development, or by implementing a minimum MW output/per unit of land area. Alternatively, the total area of land used for energy production could be capped through spatially explicit strategic planning.

Finally, we highlight the role of policy and process in shaping community acceptance of solar farms. We find that people's broader views on energy policy feed into their views on specific infrastructure projects such as Cleve Hill, which we describe as a 'relational' understanding of community acceptance. This builds on conceptions of community acceptance as 'conditional' or 'qualified' depending on project characteristics or attitudes to that technology (e.g. Bell et al., 2005; Ellis et al., 2007). This highlights the need for joined-up energy strategy to meet climate goals which takes account of public acceptance across the whole energy system, not just isolated aspects of it. We also show that consultation processes are an important factor, emphasising the need for developers and The Planning Inspectorate to reconsider their approach to consulting local people and find ways to make this more inclusive. Another policy approach would be to make more use of community benefit funds to compensate host communities for the impacts of solar farms. This would help to more equally distribute the costs and benefits of renewable energy and has the potential to improve perceptions of justice, though should not be regarded as a 'silver bullet' for community acceptance (Cass et al., 2010).

Whilst our results are inevitably tied to the Cleve Hill case study, they may provide insights into how communities may respond to other large-scale solar farms. This is particularly topical given the increasing average capacity of solar farms in GB, as well as the rising number of solar farm mega-projects around the world. It may also help to understand acceptance of other renewable energy infrastructure, which is important in the context of climate crisis and policy targets to reach net zero emissions. A key difference between our results and other studies is that potential negative impacts were much more prominent than positive impacts such as jobs, in contrast to Carlisle et al. (2014) who found the opposite. In our analysis, the issue of employment featured in only 0.5% of codes. This is perhaps an indication of the difference between research elicited from participants in relation to hypothetical solar farms versus the concerns of communities when faced with the reality of a proposed project. Whilst this may reflect bias in the people who responded to the consultation and the topics which tend to arise through invited consultation in planning processes, it also emphasises the importance of triangulating results from hypothetical studies with empirical data on community acceptance (ideally via multiple methods) to provide policymakers with better evidence to make decisions about the ongoing transition to renewable energy.

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.solener.2020.08.065.

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