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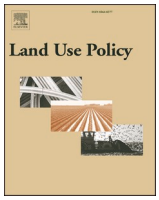

The role of community benefits in community acceptance of multifunctional solar farms in the Netherlands

Kimo van den Berg *, Barbara Tempels

Wageningen University and Research, Department of Environmental Sciences, Land Use Planning Chair Group, PO Box 47, 6700 AA Wageningen, the Netherlands

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ABSTRACT

While solar farm developments contribute to sustainable energy goals, they often face high levels of local opposition due to their expected negative impacts on the direct environment. Community benefits are a promising tool to reduce local opposition, as they have proven to do so in wind farm developments. By adding multiple functions to a solar farm, benefits for the local community - other than sustainable energy production - can be generated. However, also examples exist where community benefits have not managed to reduce levels of opposition. Therefore, this research aims to understand the role of community benefits in community acceptance of multifunctional solar farm developments through case studies in the Netherlands. The research consists of two phases: an exploratory phase through desk research mapping multifunctional solar farm developments in the Netherlands and an explanatory phase, analysing why community benefits are implemented and how they affect community acceptance, done through interviews. The results show that a key factor determining if community benefits contribute to community acceptance is the extent to which these benefits meet the experienced needs of a community. The degree to which solar farm developments succeed in meeting these needs depends on the motives and interest of developers to provide benefits, the history and context of the location and the level of community involvement. When the community feels like the benefits meet their needs, community acceptance is increased. However, when the compensation offered does not meet these needs, it negatively influences trust and thus leads to more resistance.

1. Introduction

Governments all over the world are promoting renewable energy technologies (RETs) in order to lower greenhouse gas emissions (Batel et al., 2013) and thereby reach the goals set in the 2015 Paris Climate Agreement. The national government of the Netherlands aims to have an almost fully sustainable and CO_2 neutral energy production in 2050. To achieve this, they are especially focussing on wind and solar energy, and as a result solar farms are being developed, also in rural areas. According to the Solar Trade Association's website, solar farms (also known as solar parks or solar fields) are "*the large-scale application of solar photovoltaic (PV) panels to generate green, clean electricity at scale, usually to feed into the grid.*" The number of solar farms in the Netherlands is rapidly increasing: from 22 in 2017 to more than 80 in 2018 (PBL, 2019). Nowadays, almost 100 solar farms have been developed (Kadaster, 2020). Not only the amount, but also the size of solar farms is increasing. Whereas the first solar farms had a size of about two hectares, in 2019 the average size is about 20 hectares (Kadaster, 2020).

In general, considerable support for renewable energy exists. Solar energy is the RET with the most positive image, which seems to result in a greater deployment of solar power in many countries (Nuortimo et al., 2018). While some energy projects are accepted with relative ease (Anderson et al., 2012), other projects often face strong opposition by surrounding communities (Sütterlin and Siegrist, 2017). Due to aesthetic, environmental and economic impacts of renewable energy developments on the direct environment, local residents are more critical about renewable energy technologies. As a result, they are often less supportive (Zoellner et al., 2008) and even opposition towards RETs can arise. As a consequence, projects can be delayed or even cancelled (Anderson et al., 2012). This discrepancy in public acceptance of renewable energy technologies on different scales is called the "national-local gap" (Sütterlin and Siegrist, 2017). As public acceptance of RETs plays an important role to introduce them successfully into society (Huijts et al., 2012; Nuortimo et al., 2018), much academic attention is given to this topic in scientific literature (Nuortimo et al., 2018), especially in relation to wind energy developments such as onshore wind

* Corresponding author.
E-mail addresses: kimovdberg@outlook.com (K. van den Berg), barbara.tempels@wur.nl (B. Tempels).

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farms (Aitken, 2010; Cowell et al., 2011; Devine Wright et al., 2016; Hanger et al., 2016; Walker et al., 2014). However, research focusing specifically on solar energy developments, and solar farms in particular is significantly lacking (Roddis et al., 2018).

An example of a solar farm which was accepted with relative ease is solar farm De Kwekerij (Hengelo, Gelderland, the Netherlands). This solar farm offers multiple functions: nature development, it functions as recreational area, it provides employment and it has an educational function. Several benefits have been provided for the local community (Oudes and Stremke, 2021) and the solar farm is designed with respect for the surrounding area and the local inhabitants. Remarkably, almost no opposition by citizens to the development of this solar farm arose (Veldhuis, 2021). This example shows that multifunctional solar farms can mitigate (some of) the negative impacts on the direct environment and thereby increase community acceptance of such developments. Therefore, the provision of benefits to the community through multifunctional solar farms could be considered a promising avenue for increasing community acceptance of solar farms, and thus enabling renewable energy developments on a larger scale.

Some developers already provide community benefits to compensate local communities for the possible negative impacts associated with renewable energy projects (Terwel et al., 2014) and as strategy to foster local support for renewable energy technologies and improve community acceptance (Walker et al., 2014). (Cowell et al. 2011, p.20) argue that *"it is generally thought that community benefits 'work' by improving the local social acceptability of projects. (…) However, there is limited and contradictory evidence that the provision of community benefits promotes local social acceptability, improves trust in developers, or speeds up the delivery of infrastructure development."* Therefore, (Walker et al. 2014, p.52) argue for a *"broader need to consider how community benefits will be perceived by local communities, and to take action to prevent perceptions of bribery and cynicism from emerging."*

According to Mostegl et al. (2017), financial involvement of the local community in renewable energy developments is able to significantly increase their acceptance. For that reason, many project developers and local governments offer opportunities for local communities to financially profit from a solar farm development nearby, for example through direct investing opportunities or a community fund that supports local, sustainable initiatives (e.g. "*Omgevingsfonds*" in Belgium). However, with monetary compensation, only a limited part of the population (e.g. based on zip-code) is compensated for the negative impacts of the solar park.

Alternatively, multifunctional solar farms such as De Kwekerij are not only able to provide monetary benefits, but also mitigate impacts or even add value to the landscape itself. Compared to multifunctional solar farms, monofunctional solar farms often have great impact on the rural landscape, which is already changing significantly and rapidly due to challenges as climate change, the demand for food and water, and the transition towards renewable energy (Bishop, 2015). According to Spielhofer et al. (2021) visibility aspects of RETs have an important role in explaining local opposition. As a result, solar farm developments conflicting with landscape aesthetics often decrease social acceptance, which impedes the energy transition. Spielhofer et al. (2021) argue that visual connectedness between RETs and the surrounding landscapes is an important factor influencing the visual preference of people towards landscape changes by RETs. They found that people visually prefer landscapes that establish connections with RETs. Such connections can be visual (by shapes, colours or textures) or they can be more functional, created by specific elements or land use (Spielhofer et al., 2021). Multifunctional solar farms can create such connections by providing multiple functions contributing to other goals, such as climate change or nature development, and also visually connect better with their surroundings through these functions. In this way, multifunctional solar farms can provide a wider array of publicly accessible community benefits.

The objective of this research is to understand the relationship between community benefits and public acceptance in multifunctional solar farm developments. More specifically, it explores the role of community benefits on the local level in order to support community acceptance in the Netherlands. The research objective leads to the following research question: *What role do community benefits of multifunctional solar farms play in order to support community acceptance?* To answer this question, we have analysed (1) what types of community benefits have been or will be provided in solar farms in the Netherlands, (2) what influence community benefits have on the distribution of costs and benefits in multifunctional solar farm developments, and (3) how people perceive the provision of community benefits in multifunctional solar farms. As such, insights into the effectiveness of community benefits in planning processes for the developments of solar farms in the Netherlands are generated, leading to recommendations for the provision of community benefits in solar farms in the Netherlands. This contextual knowledge can also further advance the international discussion on a spatially and socially sustainable application of renewable energy technologies.

2. Theoretical framework

2.1. Community acceptance

Hanger et al. 2016, p.81 describe acceptance of RETs as *"a range of potential attitudes towards RET that are other than active opposition, including apathy, passive acceptance, approval, and finally active support"*. A distinction is made between different levels of acceptance taking place in different spheres (Wüstenhagen et al., 2007). The most general form is socio-political acceptance, which operates at the level of technologies, policies, key stakeholders and the general public (Sovacool and Lakshmi Ratan, 2012). Market acceptance involves the adoption of renewable energy technologies by consumers and businesses (Sovacool and Lakshmi Ratan, 2012). Local or community acceptance is the most specific level (Sovacool and Lakshmi Ratan, 2012) and it is about the acceptance of renewable energy by communities affected by the development of a technology nearby (Roddis et al., 2018). Therefore, community acceptance plays an important role in implementing RETs on the local level.

The level of community acceptance is influenced by several factors. People's attitudes towards renewable energy play a role, which is dependent on demographic, political, temporal and geographical factors (Roddis et al., 2018). In addition, community acceptance is influenced by the type and amount of negative externalities resulting from renewable energy projects, such as aesthetic, environmental and economic impacts (Hanger et al., 2016; Roddis et al., 2018). As a result of these impacts, *"rural communities often felt that they bear the risks and impacts of projects intended to produce energy for urban centres (…) and economic benefits for multinational and institutional developers"* (Shaw et al., 2015), p. 46). Cowell et al. (2011) call this issue the distributive unfairness of costs and benefits. Therefore, an important factor influencing the amount of resistance is how people perceive the distribution of costs and benefits (Shaw et al., 2015). A distinction is made by Renn et al. (1996) between an 'equitable' and 'inequitable' distribution. An 'equitable' distribution can be reached when no actors are losing compared to others; while in an 'inequitable' distribution, someone benefits more of a situation compared to others and therefore some actor is losing. Shaw et al. (2015) found that in many projects, the distribution of costs and benefits were so unfairly distributed that communities were not able to accept them, indicating the importance of the distribution of costs and benefits in community acceptance.

2.2. Community benefits

In order to mitigate an inequitable distribution, it is important to provide additional benefits to which all actors agree. Additional benefits can be provided in the form of community benefits (Terwel et al., 2014),

which are *"some form of additional, positive provisions for the area and people affected by major development"* (Cowell et al., 2011), p. 539). Developers can provide community benefits in order to manage distributional effects of renewable energy projects (Cowell et al., 2011; Yenneti and Day, 2016).

The provision of community benefits is common in the United Kingdom to increase local acceptance of wind farm developments (Walker et al., 2014). Community benefits are often provided by means of monetary benefits (fund or investments) to communities nearby a windfarm. Examples of these monetary benefits are donations to local organisations or reducing energy bills of community members nearby the development. In other countries, such as Germany, Spain or Denmark, local communities can often financially benefit from wind power developments nearby through economic incentives or by ownership or involvement in the wind farm through shares (Aitken, 2010).

According to (Claro 2007, p.190), these compensation mechanisms acknowledge inequality and can be considered *"as a way of eliminating this unfairness by transferring resources from the beneficiaries of the project to those badly affected by it"*. However, a clear spatial boundary for community is missing (Munday et al., 2011). According to Munday et al. (2011), the community is the area which is closely located to a renewable energy development and consists of people who are affected by this development.

A distinction can be made between the types of compensation to which community benefits belong: monetary compensation and public goods compensation (see Table 1) (Mansfield et al., 2002). In addition, Terwel et al. (2014) distinguish individual and collective compensation, resulting in individual or public benefits.

According to Oudes and Stremke (2021), solar farms can be considered multifunctional when additional functions beyond electricity generation are provided. They have identified three types of multifunctionality: below panels (array multifunctionality), between panels on patch area (patch multifunctionality) and adjacent to patches (adjacent multifunctionality). Multifunctional solar farms can deliver public goods through multifunctionality, if the solar farm combines functions which are accessible and generate added value for the public. For example, developing footpaths, a recreational facility or nature within a solar farm can be considered as additional functions to a solar farm beyond energy production. These combined functions lead to a multifunctional solar farm offering additional benefits to the public. However, it must be noted that not all multifunctional solar farms deliver public goods, as the additional functions in some cases might only generate added value to private parties, such as the investor(s) and/or land owner(s). Table 1 provides an overview of the different categories of community benefits.

Table 1
An overview of community benefits (based on Cowell et al. (2011) and Munday et al. (2011)) related to the type of compensation (based on Mansfield et al. (2002)).

Type of compensation	Category of community benefits	Example (s)
Monetary compensation: provision of money or monetary benefits to a community	Conventional economic benefits	Using local manufacturers and contractors Land rental income by landowners
	Flows of financial benefits to local communities	Ownership through shares Reduction of energy prices Community benefit fund
Public goods compensation: provision of public goods to a community	In-kind benefits	Developing footpaths, community centre, recreational facility
	Local services	Educational programmes
	Environmental mitigation or enhancement	Planting flowers/trees Adding natural elements

2.3. Effectiveness of community benefits

The effectiveness of community benefits in gaining community acceptance differs per type of compensation. Public goods compensation is considered as more effective than monetary compensation (Claro, 2007; Mansfield et al., 2002; Terwel et al., 2014), because "*schools and parks are usually not thought of as "bribes" in the same way as cash payments"* (Mansfield et al., 2002), p. 370). Monetary compensation can, compared to no compensation at all, perform even worse in terms of public acceptance. In the case of monetary compensation, people are less likely to believe that a developer is concerned with the public interest (Terwel et al., 2014), because people argue that (health) impacts resulting from a development cannot be compared with money or their approval cannot be bought with money (Claro, 2007). In some cases, community benefits were considered as tool to 'buy' support by the local community (Terwel et al., 2014; Walker et al., 2014) or to repair impacts (Cowell et al., 2011). As a result, people can become more suspicious about the intentions of commercial developers (Shaw et al., 2015). In other words, community benefits can even have adverse effects by increasing opposition (Terwel et al., 2014). The impact of community benefits is likely to be more positive when the community has more influence in determining the type and amount of community benefits (Terwel et al., 2014).

3. Methods

To understand the role of community benefits in multifunctional solar farm developments in the Netherlands, a systematic screening of solar farms (exploratory phase) and semi-structured interviews (explanatory phase) were conducted. This qualitative approach enables us to consider people and settings in the research as a 'whole' (Taylor et al., 2015), and therefore allows us to take contextual influences in the research into account (Hennink et al., 2020).

3.1. Exploratory phase

A systematic screening of existing and future solar farms was performed to identify multifunctional solar farms and analyse the community benefits they provide. First, existing and future multifunctional solar farms that provide community benefits were identified from the list of existing solar farms published on www.zonopkaart.nl (last accessed on 9 July 2022). This list of existing solar farms is based on data from January 2020 provided by the RVO (Netherlands Enterprise Agency) based on applications for the SDE+ scheme, a national subsidy for renewable energy production. Almost all solar farms producing more than 1 MWp make use of this scheme. Solar farms that do not use this scheme are not registered centrally, and therefore manually added by ROM3D (the initiator of www.zonopkaart.nl) based on other public sources. To the knowledge of the authors, this is the most complete list of existing solar farms available.

From this list of existing solar farms, multifunctional solar farms were identified based on their spatial layout. By analysing the space between and around the arrays on aerial photos, other functions provided in the solar farm could be identified. As such, we were able to detected patch and adjacent multifunctionality. Considering the extensive list of more than 100 existing solar farms, it was not feasible within the available resources for this research to detect array multifunctionality.

In addition, plans for future multifunctional solar farm developments were selected. This was done through an internet search by using the term "multifunctional solar farm" and any combination of those words. This search was also a cross check for existing multifunctional solar

farms. By including unbuild solar farms that are considering the provision of public goods through multifunctionality, the role of community benefits in shaping community acceptance during the development of these plans can be included in the analysis, even if some of the promised functions in the plans might eventually not be realized.

After identifying multifunctional solar farms, the provision of community benefits was then confirmed and further analysed through a desk research and document analysis using secondary sources. This provided us with more information about the particular community benefits provided by the solar farm developments. This information was analysed to classify the community benefits every solar farm development offers, following the categories defined by Cowell et al. (2011) and Munday et al. (2011): in-kind benefits, local services, environmental mitigation or enhancement, and financial benefits (see Table 1). Conventional economic benefits were not taken into account as they were considered to be outside the scope of our research, because they can be considered as individual rather than public benefits.

3.2. Explanatory phase

The relationship between community benefits and community acceptance was examined through in-depth case studies focussing on multifunctional solar farms. Out of the twelve multifunctional solar farms identified in the exploratory phase, three solar farms with varying levels of community acceptance were selected (see Fig. 1):

1. De Kwekerij (Hengelo, Gelderland). This is an existing multifunctional solar farm which is located adjacent to a residential area. Almost no opposition arose to this solar farm.
2. Zonnewoud (Zeewolde, Flevoland). This solar farm has not been developed yet and the licensing procedure for the development is still pending. To this plan, a high level of opposition arose and a petition protesting the development was signed about 1.500 times and one notice of objection is submitted to the plan.
3. Abdissenbosch (Landgraaf, Limburg). At the time of the research, the permit for this solar farm has been granted, but it was not yet developed. The level of opposition was high in the beginning of the process, but declined throughout the process. In the meantime, the solar farm has been built.

These three cases were analysed in-depth through semi-structured interviews with three categories of stakeholders per selected case: solar farm developers or initiators (business), civil servants (public) and local community groups (civil society). Per case, four stakeholders were interviewed, adding up to a total of twelve semi-structured interviews (see Table 2).

The interviews were performed between April and June 2020 and addressed three topics: the motives of developers to provide community benefits, the influence of community benefits on the distribution of costs and benefits and the effect of the perception towards the provision of community benefits on acceptance. The interviews were conducted by telephone (due to the restrictions of COVID pandemic) and were transcribed and analysed through coding. Open coding was applied, in order to derive themes from the answers of the interviewees and thereby give meaning to the answers. This was followed by axial coding in order to find overarching and general categories within answers. Finally, selective coding was applied to link categories together in order to find relations between concepts and answers. This inductive approach allows concepts to emerge from the data analysis, which are then related to existing literature to give them meaning.

Table 2
An overview of the categories of stakeholders interviewed and the respondents per stakeholder category.

Solar farm	Public	Business	Civil society
De Kwekerij	• civil servant	• investor	• community representative • citizen
Zonnewoud	• initiator (Staatsbosbeheer)	• developer	• initiator of petition • citizen
Abdissenbosch	• civil servant	• designer • initiator of solar farm	• chairman of workgroup

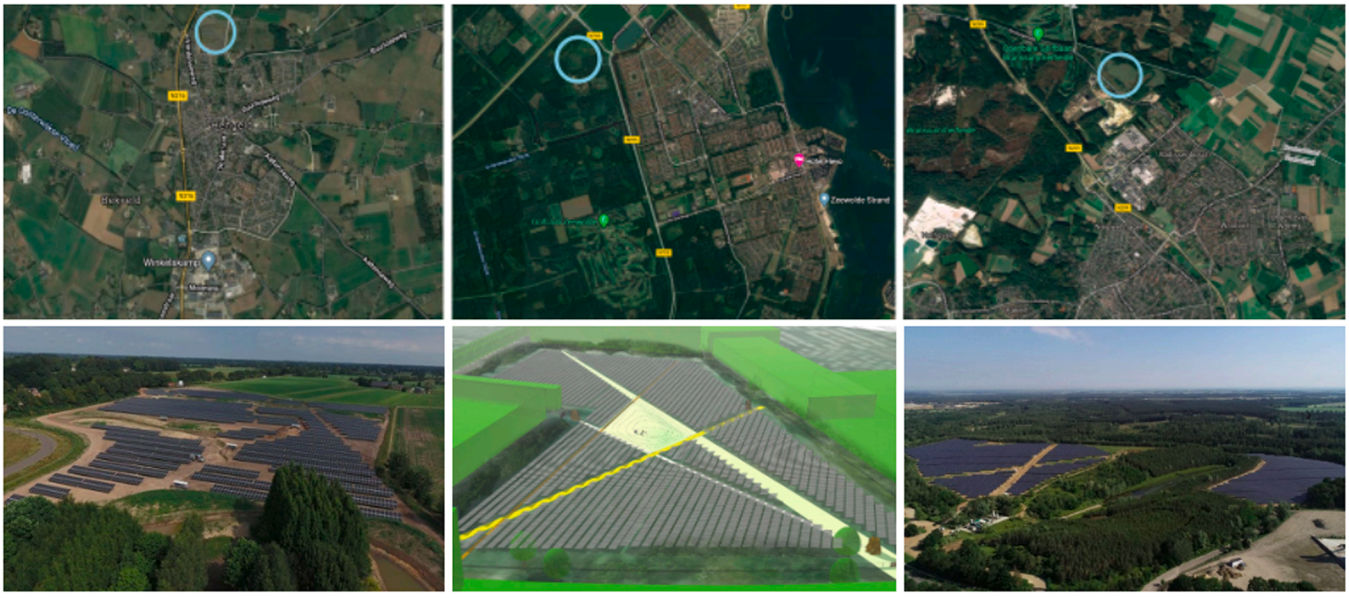

Fig. 1. Locations (top, indicated by blue circle) and photos (below) of the three cases which were selected in this research. (1) De Kwekerij (photo retrieved from https://www.vkj.nl/projecten-nieuws/solarpark-de-kwekerij-hengelo/), (2) Zonnewoud (photo retrieved from https://sunvest.nl/zonnewoud-zeewolde/), (3) Abdissenbosch (photo retrieved from https://www.bodemzorglimburg.nl/nieuws/opening_zonnepark_abdissenbosch_te_landgraaf).

4. Results

4.1. Systematic screening

Out of the 110 existing solar farms, only two were identified as multifunctional and providing community benefits: Laarberg in Beltrum and De Kwekerij in Hengelo. Both solar farms are located in the province of Gelderland and are located in a rural area. In addition, ten planned solar farm developments that provide community benefits through multiple functions were found. An overview of the types and categories of provided community benefits in two existing and ten future solar farms can be found in Fig. 2.

Community benefits related to the category "environmental mitigation or enhancement" are the most provided category of community benefits, and in particular nature development, as all twelve solar farms offer this category. Other environmental mitigation or enhancement measures include the addition of natural elements, landscape enhancement, climate adaptation strategies, contribution to ecological connection zones or an overpass for fauna and CO_2 reduction. In-kind benefits and financial benefits are the second most provided categories of community benefits in the analysed cases. Both categories were provided in ten cases. Financial benefits include financial participation through shares, obligations or crowdfunding and the reduction of energy prices for the community. In-kind benefits relate to the provision of a physical asset to the community. In the analysed cases these were the development of a recreational area in the solar farm, a visitor/information/innovation centre and charging stations for cars, devices or bicycles. The least provided category of community benefits are local services. In the analysed cases a range of services is offered, such as education, food production or social employment.

4.2. Case studies

Solar farm De Kwekerij was accepted relatively easily, although it is located adjacent to a residential area. The results show that the high acceptance rate was especially influenced by the history of its location, because the former plan was to develop a residential area on this location. In addition, a committed civil servant and the planning process played a role, because during the whole planning process, citizens were involved in the project. As a result, they were able to influence the community benefits according to their actual needs. Another important contributing factor is the large subsidy for this project provided by the province.

The plan for solar farm Zonnewoud is the result of a tender issued by the initiator, Staatsbosbeheer (the national state forest agency). This was done as national experiment and for several locations across the country to get the 'best' solar farm possible. A multifunctional solar farm contributes to the goal of Staatsbosbeheer to become more sustainable by generating sustainable energy. In addition, the solar farm can generate proceeds for nature developments and it can contribute to recreational goals in the area by adding recreational functions and thereby attract more visitors. In this case, concerns especially arose about effects on nature due to its location in a forest area. Although the submission of a petition and a notice of objection, the development was not cancelled. The level of resistance was already high from the start of the process and this remained high during the process. Despite the involvement of a sounding board, who were able to choose the design of the solar farm, the results show that participation and communication to the broader community was lacking according to some citizens.

Abdissenbosch is located on a former landfill which is used as walking area. Concerns of the development especially related to accessibility of the walking area after the development and the impacts on

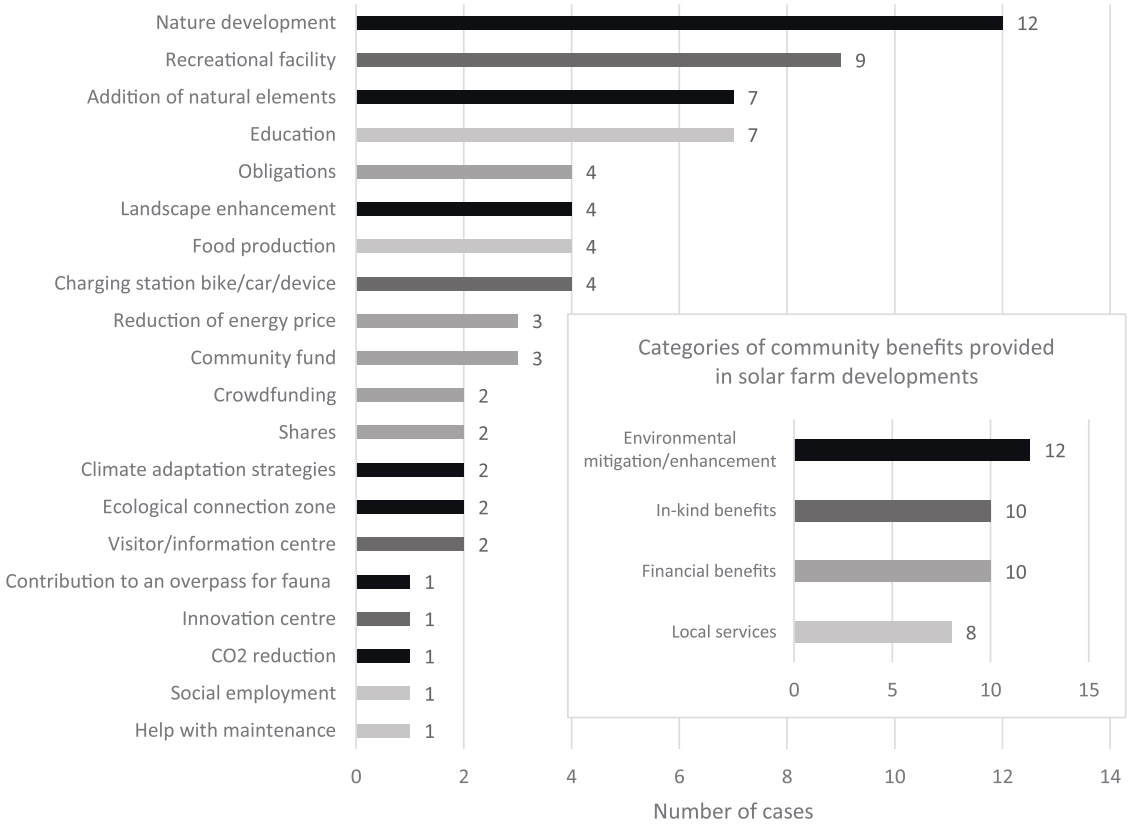

Fig. 2. Community benefits provided in the 12 analysed multifunctional solar farm developments that provide community benefits (i.e. 2 existing and 10 planned solar farm developments). The colour of the bars corresponds to the four categories of community benefits. The aggregation into these four categories of community benefits is shown on the right side.

nature in the area. Concerns disappeared, because a workgroup was set up to involve surrounding citizens in the plan for the solar farm. This workgroup had influence in the design of the solar farm and thereby on community benefits which were provided by the development of the solar farm.

4.2.1. Motives for the provision of community benefits

The reasons to provide community benefits differed per case and per stakeholder within the cases. In De Kwekerij, the multiple functions and benefits were provided because it was the ambition of the developer, but also a wish by the municipality and a committed civil servant, to make the solar farm a 'pleasure' for the community and thereby gaining more support for the development. The municipal civil servant involved in De Kwekerij argues: *"for many colleagues, the idea of a solar farm at that location was something to get used to. It was fairly unknown. I had the idea, it would be nice if there will be a solar farm with multiple functions. Because I was afraid that in those years, solar parks would go in the same direction as wind farms that also generate a lot of resistance. Thus, in this way you can achieve that a solar farm gets more support and can pursue multiple objectives"*.

In contrast to providing benefits out of interest for the community, in Zonnewoud and Abdissenbosch, they were provided to comply to criteria set by the government. In order to get the permit for the development of the solar farm on both locations, the provincial government set criteria in order to compensate for the impact on nature in the area. The initiator of Zonnewoud, Staatsbosbeheer, argues, *"…the former provincial chief who said, I want this to be a solar park with a recreational function. I don't care if it produces less electricity, but it should be a recreational park. Well, we also achieved that by saying, we are going to award it to a party that makes a recreationally good design, so to that party a lot of points were awarded."* As a result, the initiator issued a tender as national experiment for a multifunctional solar farm and included the criterion to add a recreational function to it. This tender was the reason for the developer to add multiple functions and community benefits in the solar farm development. According to him, *"we would never have won if we had completely filled the solar farm with solar panels. Thus for me, it is not about how to deal with it, but it is more of a requirement."* This indicates that developers do not only provide community benefits out of interest for the community, but also as way to win the tender. This indicates that community benefits are not only provided for public interest, but also out of self-interest of the developers.

In Abdissenbosch, additional criteria were also set by the municipal and provincial government. According to a civil servant involved in Abdissenbosch, *"the initiator had to demonstrate towards the province and the municipality in which way nature is being compensated"*. The designer of the solar farm argues *"we had to be able to show the province that the function nature could remain at that location. And you can only do that by ensuring that the quality does not deteriorate and preferably actually improves."* However, additional community benefits beyond nature development were provided by the developer. *"When it comes to education or walking structures, these are all extras. The province did not make those demands. The province simply stated that certain areas and certain plants and animal species should be given space and the initiator must then demonstrate how he will do this and how he will maintain that in the coming years."* Another clear reason to provide community benefits came from the workgroup. They wanted to get something in return for losing their current walking area: *"we understand that the municipality wants it, but we would like to get something in return. And actually wanting something in return, that had something to do with contributing to the design of the site. That is one. And on the other hand, it had something to do with, yes, some kind of compensation for losing that walking area."* From this perspective, community benefits were provided as tool to compensate the local community for this development.

Other frequently mentioned reasons to provide multiple functions is to attract more visitors to the area by improving the quality of the area and by offering something special. According to the initiator of the solar farm, Staatsbosbeheer, Zonnewoud for example can be considered as *"a location in or near the forest where visitors are drawn to in a different way with the result that people visit the forest more often."* In addition, technical reasons, such as the connection capacity to the power grid plays a role. Due to the limited capacity of the power grid on some locations, only a limited amount of solar panels can be developed in the solar farm. As a result, space for other functions became available.

4.2.2. Distribution of costs and benefits

During the interviews participants were asked how the provision of community benefits influenced the distribution of costs and benefits in the different solar farm cases. Although some concerns about negative influences on the surroundings by glare, noise, visual disturbance and negative effects on nature existed, in two analysed cases De Kwekerij and Abdissenbosch, the community mostly saw benefits stemming from the solar farm nearby their house. A local citizen living in front of De Kwekerij argues, *"well, I literally look out over the park. I am happy that there is a park and that there are no houses there. The park also provides me an unobstructed view. Do you understand? The park is there, but because of this we look over the park and we have an unobstructed view."* In addition a community representative agrees to that, *"yes, I actually do not see any negative effects. Except for how it will be in twenty-five years, then it will be over, but yes, that is still so far, because it has already been established that the municipality can say that we will take over that land, we want, well imagine, the housing development must increase, then they can still build there. At least that is not possible for the coming twenty-five years."* Both perspectives from the citizen and the community representative show that the solar farm is considered the least impactful landscape change, compared to housing development. As a result, this positively contribute to acceptance of this solar farm. In addition, people appreciated the nature development and recreational aspects, such as walking paths and benches, in the solar farm. According to a community representative, *"so it is just very nicely designed and there is a lot of wildlife and a lot of greenery, yes, what more do you want?"* Due to the development of the solar farm, they got a new recreational park in return: *"they have developed beautiful routes and what does us all good, is that many people use the park."*

In Abdissenbosch, benefits especially relate to the design of the solar farm. The designer of the solar farm, especially sees benefits for nature development, *"well, I think so, because certainly from the story of that nature function, look there will be solar panels, but the space between those panels will be so large that it also offers benefits for nature and certainly if we can ensure that, the surface was now just a bit of a dry grassy area, if we can offer a plus there, then I think it certainly can outweigh it [negative effects]."* As a result of the design, the civil servant does not see any negative effects, *"at this time we see no potential negative effects. All parties involved and who were involved in the development of this solar farm are satisfied with the developed plan"*. Another advantage of the solar farm on this location, is that it generates a financial contribution to the aftercare of the former landfill site.

In contradiction to the former cases, in Zonnewoud, the benefits were not able to outweigh the disbenefits. Citizens especially saw negative effects on nature. One citizen who initiated a petition to this solar farm argues, *"the municipality's argument that one has an objective with regard to the generation of clean energy should at the same time not lead to a serious attack on nature."* In addition, he argues *"it is recommended not to sacrifice the forest in this area, but to let it function within the framework of forest and nature. One must therefore miss forest and nature for 25 years."* Another citizen is also concerned about the loss of nature, *"but I am much more concerned, my concern is much more about the ease by which we sacrifice land and nature for this growing energy issue that cannot even be supported by the electricity grid."* Interestingly, the area is not a designated nature area or protected nature reserve and the initiator of the solar farm, Staatsbosbeheer, states that the natural values in the area were already limited. As a result, this location was chosen for the development. In contrast to the citizens, he sees benefits of the solar farm development, because *"with the proceeds of this solar farm,*

Staatsbosbeheer can do a lot of good things for nature in other places, while we would otherwise not have the resources." However, this also shows that some benefits generated by this solar farm can also flow to other areas and communities than the direct environment and the local community itself.

4.2.3. Perception towards the provision of community benefits

The provision of community benefits can be perceived by some as positive contribution to a development, while others might be more critical about the intentions of the developer. As was the case in the perceptions towards the distribution of costs and benefits, the perceptions towards the provision of community benefits in the case De Kwekerij and Abdissenbosch are especially positive, while the perceptions in the case of Zonnewoud are more negative. In both cases, all stakeholders consider the provision of community benefits as positive. Citizens especially consider the provision of community benefits as positive addition to the community and as added value for the surrounding area, because it leads to an improvement of the area. As a result, their acceptance rate increase. One citizen living nearby De Kwekerij argues, *"I like the fact that I can recreate there and that in a beautiful way, that the solar farm has been laid out and that beautiful nature has been created around it or actually in the park, that it is beautifully laid out, which I can enjoy. I think this increases my acceptance compared to a park with a fence around it, where I had to walk around it."* In addition, the civil servant involved in the development argues, *"I see that when you can add multiple functions to such a park, the support and the willingness to participate will increase. That has its advantages."*

Due to the offered benefits, the opposition to Abdissenbosch also declined, because it took away concerns of citizens. According to a civil servant, *"and the biggest concern was, yes, does the whole story not damage the current nature that is present there? And that is absolutely not the case, because the whole plan only gets better. So that is actually why everyone agreed with the plan, both the province and the workgroup"*. In addition, it was mentioned that the willingness to participate in the planning process grew due to the positive contribution the offered benefits have for the area. Another positive contribution was made to get permission for the development by the province and municipality. According to the initiator of the solar farm, *"without the added value offered through the development of the solar farm, the project would not be accepted by the province and municipality."* As a result of the benefits, the plans complied to the additional criteria set by these governments.

In contrast to the positive perceptions in De Kwekerij and Abdissenbosch, in the case of Zonnewoud, citizens were more critical about the intentions of the developer. This negative perception arose, because both citizens consider the suggested benefits, especially the addition of a recreational function to the solar farm, as unnecessary. Instead of contributing to community acceptance of the solar farm, the addition of different functions and benefits increased the opposition of some citizens, because they thought the benefits were only offered with no other aim than generating support for the project by the community. A citizen argued: "*in my opinion, the added value devised by the developer is only intended to make the plan saleable. In such cases, you only have to hire a consultancy firm that comes up with something in the direction you want. That is how it works unfortunately.*" As a result, her perception towards the multifunctional solar farm development became even more negative: "*the more multifunctional tasks or things we attach to this, the worse I actually find it."*

5. Discussion

This research identified the motives and interests of different parties to provide community benefits. In all three case studies, the municipal or provincial government played a role in demanding to provide community benefits through multifunctionality. For public institutions to safeguard the public interest in solar farm developments by requiring multifunctional solar farms through criteria of a tender, permit procedures or direct collaboration with developers. Sometimes these requirements were complemented with additional community benefits voluntarily proposed by the developer or demanded by the community. Some developers also had intrinsic motives and voluntarily provided community benefits, because it was their ambition to give the community something in return for the development or to decrease the level of opposition to solar farm developments. Because lowering opposition is often one of the main reasons to provide community benefits, it is important to secure the public interest in the provision of community benefits. In the analysed cases, the public interest is assured in two ways: by active opposition of the community and by criteria set by the government. Both ways led to the provision of community benefits by the developer. This raises the question how the public interest can best be safeguarded and who should do this. By relying on communities, there is a risk that some groups will not have a voice because they don't have the resources, capacities or information to do so, or governments, where too rigid regulations might hamper innovation.

However, the question is whether the provision of community benefits in the cases has led to a more equal distribution of costs and benefits. An equitable distribution of costs and benefits only happens when the compensation offered to the community outweighs the negative effects of the development. According to the community in the case of Zonnewoud, the compensation did not adequately outweigh negative impacts. However, the city council accepted the solar farm (with a minor majority), despite the opposition and petition to the solar farm. In the two other cases, De Kwekerij and Abdissenbosch, compensation was adequate according to the community, the developer and government and as a result, the community benefits led to a higher level of community acceptance.

The results demonstrate that a fair and open decision making process fosters trust in the stakeholders and gives citizens the opportunity to discuss the type and amount of community benefits. However, when the level of involvement is low and therefore, the community was not able to influence the type of community benefits, these benefits did not meet the needs of the community. In the case of solar farm Zonnewoud, citizens considered the provided benefits in the solar farm (recreational functions) as unnecessary. As a result, the perception of some citizens towards the provision of these benefits became negative, according to them the benefits were only offered with no other aim than generating support for the project. The negative perception towards the provision of community benefits might be the result of the lack of participation to shape community benefits according to the needs of the community. However, in this case the people were also concerned about other impacts on the landscape generated by the introduction of recreational elements in the landscape, leading to noise nuisance, litter, more visitors and thereby disturbing the quiet environment of the nature area.

In this case, community benefits were not able to increase community acceptance and even adverse effects arose. In other words, community benefits can indeed compensate the affected community for the impacts resulting from an renewable energy development (Terwel et al., 2014), but only if the community feels like they meet the needs of the community. This shows the importance of community involvement and a fair and open planning process in the process of shaping community benefits. However, it should be taken into account that a community lacks a clear spatial boundary (Munday et al., 2011). Therefore, a community is very heterogeneous and plural. As a result, the people belonging to a community do not feel the same and perceptions and acceptance of a development might be different for each individual within a community.

In this research, three cases were analysed. It should be taken into account that each case took place in different contexts. Therefore, the level of acceptance differed per case and was influenced by the particular circumstances in all three cases. For example, an extra subsidy for solar farm De Kwekerij and a committed civil servant. In addition, the former or future land use played a role. In De Kwekerij, a solar farm was developed instead of housing development. Compared to housing

development, a solar farm was the least impactful landscape change. In Abdissenbosch, the solar farm has been developed on a former landfill. The proceeds generated by the solar farm are used as financial contribution to the after care of this former landfill site. Both situations are thus dependent on location and land use and were contributing factors in the level of acceptance. In Zonnewoud, a tender approach was applied by Staatsbosbeheer for the development of the solar farm. These contextual and location dependent factors played an important role in shaping the perceptions of the provision of community benefits and in the end the level of acceptance. However, these specific circumstances in each case have implications for the generalizability of our findings.

The findings from these three Dutch case studies may have implications for the provision of community benefits and acceptance rate of solar farm developments in other countries. Spatial planning in the Netherlands has a long and rich history because it is a densely populated country combined with a compact surface, leading to scarce space and competing land uses. As a result, solar farm developments will be more likely to take place nearby communities in the Netherlands. This single country case study research has led to contextual knowledge that can further advance the discussion in acceptance and application of renewable energy technologies. Whereas in many countries such as the UK, Germany, Spain and Denmark, the provision of community benefits for wind energy is common in the form of monetary benefits (Aitken, 2010; Walker et al., 2014), this research has shown the wider application of different categories of community benefits and its influence on local acceptance of solar farm developments in the Netherlands and the influence on the local acceptance. This application of community benefits can also be taken into account in solar farm developments in other countries, although different contexts, cultures and planning process.

Based on a case study in Morocco, Hanger et al. (2016) argue that the level of community acceptance is high when solar farm developments contribute to a positive environmental impact or when the development at least do not lead to any negative impacts on the environment. This is in line with the findings of this research. Another important factor contributing factor Hanger et al. (2016) found in developing countries is the expectation of socio-economic benefits generated for the community (job generation and reduction of electricity prices) by the solar farm development. In our analysed cases socio-economic impacts did play a minor role. However, it shows that the provided benefits by the solar farm development, although different context, cultures and planning process, should meet the actual needs of the community in order to be effective and support community acceptance.

This research presented a systematic mapping of the community benefits multifunctional solar farms provide. It focused on patch and adjacent multifunctionality by analyzing the uncovered space between and around the arrays of solar farms on aerial photos. Due to the extensive list of more than 100 existing solar farms, it was not feasible within the available resources for this research to detect array multifunctionality. In addition, the aerial photos did not always clearly show multifunctionality (e.g. trees had not been planted in the solar farm). As a result, in some cases, we were not able to detect multifunctionality. Furthermore, some existing solar farms in the Netherlands might be missing in the data used in this research. Considering these methodological limitations, the systematic screening can therefore be seen as conservative estimation of the types of community benefits provided by multifunctional solar parks in the Netherlands.

This research focused on different categories of provided community benefits through multifunctional solar farms. However, the in-depth case studies did not distinguish between the types of community benefits. An interesting direction for future research is to analyse which category and/or type of community benefits is most effective in increasing community acceptance. For example, are in-kind benefits more effective in supporting community acceptance compared to other categories of community benefits? This helps to understand whether another type of community benefit could have led to other outcomes in the case of Zonnewoud and thereby, could prevent the adverse effects of community benefits provision on community acceptance.

6. Conclusion

While the generation of renewable energy is widely supported, solar farms often generate local resistance due to expected impacts on the surrounding environment. Multifunctional solar farms can offer added value to the local community through community benefits and thereby, reduce opposition. Therefore, this research explored the role of community benefits in community acceptance of multifunctional solar farm developments in the Netherlands. It analysed which community benefits are provided in multifunctional solar parks, the motives to provide community benefits by developers, how community benefits influence the distribution of costs and benefits in such developments and the perception of communities towards the provision of community benefits. This was analysed in two phases: desk research and systematic screening were used to map the use of community benefits in existing and planned solar farms (exploratory phase), and three case studies were analysed in-depth through interviews (explanatory phase).

Out of 110 existing solar farms, only two were identified as multifunctional solar farm. Among planned solar farms, ten multifunctional solar farms were identified. This indicates that multifunctional solar farms are gaining popularity. This is due the 2019 national Climate Agreement, which mentions multifunctionality as one of the leading spatial principles of the renewable energy transition. The most provided category of community benefits in the analysed solar farms are environmental mitigation, while local services are the least provided category of community benefits.

The case studies show that community acceptance of solar farm developments increases when the offered community benefits outweigh the (perceived) negative externalities of the development. The research identified three factors that influence the effectivity of community benefits in increasing community acceptance of solar farm developments: (1) the developer's motives and interest to provide community benefits, (2) the history and context of the location determining the expected negative externalities, (3) the level of community involvement to influence the precise community benefits provided. These factors, among others, determine to what extent the offered community benefits meet the actual needs of the community, and thus to what extent they outweigh the negative externalities that prompt opposition. In other words, community benefits only have a positive effect on community acceptance if they manage to meet the actual needs of the local community. Securing that the benefits meet these needs was done through the involvement of citizens in the decision making process. In the case where the compensation offered did not meet the needs, it negatively influenced trust and even lead to more resistance.

This leads to the question of how this alignment of community needs and provided benefits can be achieved. The results of the systematic mapping of multifunctional solar farms shows that leaving the provision of community benefits to the developers will lead to a low application. Therefore, as shown in this research, public guidance is beneficial for the provision of community benefits. However, although some cases might succeed without government interventions, public authorities can ensure the provision of community benefits by developers and thereby a fairer distribution of costs and benefits in solar farm developments.

Multifunctional solar farms are a promising model to achieve this fairer distribution of costs and benefits. While monetary compensation could also reduce resistance, only a few people would profit in this case, while multifunctional solar farms provide added value that is publicly accessible and contributes to both the physical landscape and society as a whole. Providing community benefits is a more equitable situation compared to not offering any compensation to a community. In the latter, the community is the one who 'loses' compared to the developer and investor. However, when community benefits are offered to the community, they also gain some form of 'benefits' resulting from the development. According to Renn et al., 1996, in an 'equitable'

distribution no actors lose compared to others. In such a situation, costs and benefits should be fairly distributed between actors. It could be argued that in the case of the provision of community benefits through multifunctional solar farms, the actors have more equal access to costs and benefits, because communities get something in return for the possible impacts resulting from the development.

Data availability

The authors do not have permission to share data.

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