

# Ownership Structure and Community Acceptance of Solar Power Plants in 'Energy Province' Groningen, NL



## Abstract

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Different forms of community ownership have shown to be beneficial to the acceptance of renewable energy installations. For solar power plants (SPPs), the reasons for this have not been researched thus far. This study compares attitudes of Groningen residents living near private SPPs and members of energy cooperations that operate an SPP. In doing so, it aims to gain deeper understanding of the relevant factors behind acceptance, as well as whether and how conducive cooperative solar energy is. By two rounds of surveys in Groningen ( $n=118$ ), this study compares the two ownership forms with regards to how they experience procedural justice and distributive justice (fairness of process & fairness of costs and benefits), the impacts that SPPs have on their environment, how they experience place attachment, and how accepting they are of the local SPP. Ordinal logistic regression analysis showed that on all abovementioned factors excluding place attachment (and connected items), cooperative SPPs elicit more positive experiences. Additionally, the study shows that for Groningen, attachment and dependence to/on the living environment were not reliable predictors for acceptance. Concluding, the results indicate that policymakers and developers both for cooperative and private SPPs should prioritize procedural and distributive justice, as well as that stimulating cooperative ownership can enhance citizen's experiences of justice and acceptance.

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# 1. Introduction

Legislation like the 2015 Paris Agreement exemplifies the determination of governmental bodies worldwide to combat the potentially destructive effects of climate change (UN, 2015). One implication of this is the switch from carbon-based energy systems towards renewable sources. The Netherlands is no exception: the 2019 climate agreement (*Klimaatpakket*) contains an updated ministerial subsidy platform targeting potential entrepreneurs in the renewable energy sector, and businesses in general that are making an effort to reduce their carbon emission (Rijksoverheid, 2019). In the solar energy sector the platform has yielded immediate result: 2.357 megawatts (MW) of installed capacity was installed nation-wide in 2020, as opposed to 1.420 MW in 2019, and even less in the years prior (RVO, 2020). The large majority of achievement comes in the form of solar power plants (SPPs), which in the Netherlands typically take the form of large fields of ground-mounted solar panels in the countryside (Hansen, 2021).

Renewable energy (RE) generally is widely supported in the Netherlands, although SPPs have been subject to a considerable amount of public scrutiny, more so if the installations are within visible range of residences (Hansen, 2021). The field of renewable energy acceptance is growing as RE is becoming more prevalent worldwide. Multiple physical factors i.e., visual impacts, ecosystem impacts, project scale influence acceptance by local residents, but also organisational factors such as project transparency and the fair distribution of benefits are important for approval (Roddis, et al., 2020).

Community ownership has been shown to mitigate the resistance towards renewable energy developments in rural landscapes on multiple occasions (Devine-Wright, 2005; Warren & McFadyen, 2010). Community ownership is associated with higher perception of energy justice since the operation is managed by and for local people, and depend on the participation of residents to exist (Walker & Devine-Wright, 2008). Energy justice can be loosely defined as the fairness of the planning process and the fairness of the distribution of benefits and costs, and is an important driver of acceptance by local residents (Walker & Baxter, 2017).

Cooperative solar projects are annually increasing in number the Netherlands, with 2021 yielding a total of 927 local projects (Schwenke, 2022). As community energy (of which cooperative SPPs is a form) are resulting in higher levels of acceptance among residents may pose as one worthwhile pursuit to change in a country that is as small, yet densely populated as the Netherlands.

## 1.2. Research Relevance

The relevance of utility scale solar parks lies in the contributions they make to the effort to decarbonise the Dutch energy sector. Policy papers Dutch climate agreement aim towards carbon neutrality by the milestone years 2030 and 2050. For the Netherlands, solar energy was estimated to become an essential part of the renewable energy mix by 2030; around 14,5 gigawatts (GW) of capacity, of the in total 18 GW of land-bound energy capacity. (Rijksoverheid, 2019). By 2022 this prospect has already become reality however; the installed total solar capacity in the Netherlands is estimated at 19 GW (CBS, 2023). The relevance of solar energy for the Dutch energy provision is established, but especially the utility-scale installations (or SPPs) often leave a lot to wish for in terms of placement, size, or other perceived impacts.

Public perception and community acceptance of solar installations is increasingly subject to research (Hanger, et al., 2016; Roddis, et al., 2020). In the broader field of RE-policy research, it still occupies a niche position however. Wind turbines are generally the more studied form of renewable energy (Devine-Wright, 2005; Öttinger, et al., 2014; Baxter, et al., 2020; Hogan, et al., 2022) and although there are similarities in the planning processes, there are also enough differences between the physical characteristics that research into SPPs exclusively is justifiable. This study therefore will look at the factors behind community acceptance of SPPs. At the time of writing no comparable scientific research into the relationship between ownership forms and community acceptance of SPPs has been made.

### **1.3. Research Aim**

In order to add to the knowledge for integrative RE planning and to fill the research gap between local ownership of SPPs and SPP acceptance, the aim of this research is to investigate the attitudes of local inhabitants towards SPPs in the landscape surrounding their community. By a broad survey design respondents living within the vicinity of SPPs in Groningen indicate their opinions and whether they are participating in an SPP themselves. Statistical analysis is used to specifically discover whether there are relations between community acceptance and community ownership of SPPs.

In order to guide the abovementioned aim, the following questions were formulated:

*RQ: To what extent is cooperative ownership a factor for the community acceptance of solar power plants, among local residents in Groningen?*

*SQ1. What are the relevant factors that form community acceptance of solar power plants for residents of Groningen?*

*SQ2. How do factors that form community acceptance differ amongst ownership structures of solar power plants?*

### **1.4. Structure of the Paper**

Chapter 2 contains important concepts related to the acceptance of SPPs, an explanation of cooperative ownership, as well as the conceptual framework and hypotheses. Chapter 3 contains the methodology; choices made in the data collection process, the data analysis, as well as ethical considerations. Chapter 4 contains the results of the quantitative research as well as statistical correlations between variables. Chapter 5 contains the discussion of the results, limitations and the conclusion which will propose what the results of this paper can contribute to SPP planning policy and how further research might look like.

## 2. Theoretical Framework

Renewable energy (RE) is an important driver of landscape change. The ensuing friction and effects on public perception, have been the subject of several researches (Devine-Wright, 2011; Walker & Baxter, 2017). Solar Power Plants (SPPs) research has also seen an increase in interest in recent years (Carlisle, et al., 2016; Roddis, et al., 2020). Support for solar energy is typically high in general, but the visual impacts, combined with the lack of buffering distance, tends to affect local attitudes negatively (Carlisle, et al., 2016).

### 2.1. Community acceptance

Social acceptance in infrastructure studies is a concept where the welfare-decreasing aspects of a development are in balance with the welfare-increasing aspects, so that stakeholders will be at least neutral/indifferent, or maybe even supportive of a project (Cohen, et al., 2014). More concretely, Bertsch, et al. (2016, p. 467) define it as “a subjective measure of the readiness of people to accept a certain facility in their neighbourhood – regardless of rational judgement’. According to Wüstenhagen, et al. (2007), social acceptance consists of three equally important, interdependent dimensions. *Socio-political acceptance* mostly concerns the very general societal opinions on a certain energy technology, often measured at the national level. *Market acceptance* concerns the adoption of new innovations by potential consumers. The third is *community acceptance*, which concerns how RE-projects are received by local stakeholders such as residents and local authorities (Wüstenhagen, et al., 2007). Community acceptance is the dimension of focus in this paper, since it concerns local projects and the effect they have on local communities. The prominent drivers behind community acceptance in areas where RE-projects have been constructed include procedural justice/trust, distributional justice and site characteristics (Segreto, et al., 2020).

### 2.2. Place Attachment, Place Dependence and Historical context

A lack of acceptance can also stem from the existing place attachment that people experience. Place attachment, or the tie to a place, is the cognitive-emotional bond to a certain setting (Low & Altman, 1992). Experiencing attachment to a setting can range from the scale of a room to large natural areas, and has been reported to correlate with multiple psychological benefits (Scannell & Gifford, 2017). For outdoor areas, i.e. typically where SPP’s occur, relaxation and the support for activities were reported as important benefits in this study (ibid.). It is an important factor to consider as it has been demonstrated to both be positively, as well as negatively influence the acceptance of new developments (Devine-Wright & Howes, 2010; Devine-Wright, 2011). Relating to place attachment is place dependence, which translates to the benefits that locals gain from a place (Clarke, et al., 2018). Goals that people may have in life are many and vary, having a job can depend on a certain place, but also leisure activities/sports may be important aspects of life, and often depend on a specific place to be enjoyed (ibid.).

Historical context is important to consider when researching the effects of new developments. In planning, historical context means an understanding of the dynamics in social, economic, and policy have historically affected the area (Baxter, et al., 2020). It is an important concept especially for this report; Groningen is filled with historical events surrounding the exploitation of energy sources. In 1959 one of the largest global gas deposits was discovered here (EGH, 2018). Although the deposit has been an important economic motor for post-war Netherlands, this industry has brought significant downsides to the province since; man-induced earthquakes have resulted from the exploitation since 1986 (milieudefensie, date unknown). These have threatened the structural integrity of houses in the region, which have cascaded into other safety risks (OVV, 2015).

### 2.3. Justice in Renewable Energy Development

Procedural justice as a dimension is used to indicate how ‘just’ the involvement of stakeholders during a project has been carried out (Öttinger, et al., 2014). When procedural justice is deemed as valid and important in an energy project, the initiators will treat affected parties as equals in the decision-making process (ibid.). Although recognized as important, there are no legally binding instruments that enforce participation of local communities in energy projects in the Netherlands, only guidelines (Rijksoverheid, 2019). Procedural justice as a concept shares much similarity with the renowned eight-rung ladder of citizen participation-model by Arnstein (1969), where ‘non-participation’ occupies the bottom and ‘citizen power’ the top. As Gross (2007) notes, the important elements behind procedural justice are the freedom to participate, keeping stakeholders properly informed and no decision-making with a bias towards one specific party’s interest. Multiple studies have shown that the decision whether to uphold the elements of procedural justice during a process influence the trust that local communities have in commercial and governmental parties (Gross, 2007; Firestone, et al., 2020).

Distributive justice as opposed to procedural justice is concerned with the fair or equitable distribution of outcomes that result from a specific project, be they beneficial or disadvantageous (Gross, 2007). This includes ensuring that the costs and benefits of energy projects are fairly shared among different groups and that vulnerable or marginalized communities are not disproportionately impacted (Kühn, 2004). This last point harks back to historical context, since this region has been the primary source of natural gas in the Netherlands. This has contributed to the newfound welfare of the Dutch state from the middle of the 20th century onwards (Whaley, 2009). Important to note is that distributive justice doesn’t require the ‘equalizing’ risks of an energy project among communities. Rather, it’s achieved through minimizing risks of a project altogether (Kühn, 2004). Distributive justice concerns fairness of outcomes, whereas perceived impacts concern how respondents feel the outcomes of a development look like (Roddis, et al., 2018). Not necessarily having to do with justice, the impacts concern translate to the local costs that come with an RE-development (Hogan, et al., 2022). These can be aesthetic (landscape value), environmental (local ecosystems) and economic (tourism, job creation, etc.) (Roddis, et al., 2018).

## 2.4. Cooperative Ownership of Renewable Energy

Local ownership has been shown to mitigate the resistance towards wind energy developments in rural landscapes on multiple occasions (Devine-Wright, 2005; Warren & McFadyen, 2010).

Cooperative solar projects are increasing every year in the Netherlands, with 2021 seeing a total of 927 local projects (Schwenke, 2022).

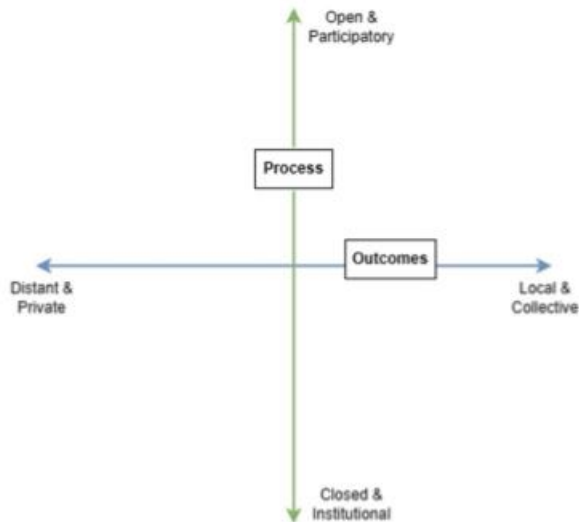


Figure 1 - Conceptual dimensions of community renewable energy developments (adapted from Walker & Devine-Wright, 2008).

*Community ownership, community-based ownership or community renewable energy (CRE)* are terms used to indicate several forms of ownership of a renewable development by a community. In the literature, interpretations of community ownership range from total ownership, to local inhabitants being given the opportunity to become financial partners of an RE development (Baxter, et al., 2020). Due to the broad definition of the concept, Walker & Devine-Wright (2008) have designed the model for conceptual dimensions of community renewable energy development. Instead of an exact definition, this model allows energy developments to be placed on a grid (fig. 1) that consists of *X*: the degree to which the *outcomes* of the project are shared locally and collectively, rather than distant and privately, and *Y*: the degree to which the *process* of building and operating are done in an open and participatory manner, rather than closed and institutional (ibid.). An 'ideal' project would be placed in the top right corner.



## 2.5. Conceptual Model

The concepts that will be used in the questionnaire (chapter 3) consist of roughly three parts; the perception of respondents have of characteristics of the SPP (top), the indicated personal binding that respondents have with the landscape (bottom), and the perception/acceptance that respondents express with regards to SPPs in their vicinity. The concept of interest here is the ownership form, what effect it has on perception/acceptance, although possible effects on other concepts are also possible. For example, going by the literature it's completely logical to assume that ownership form has influence on the experienced procedural justice (hence the 2<sup>nd</sup> green arrow).

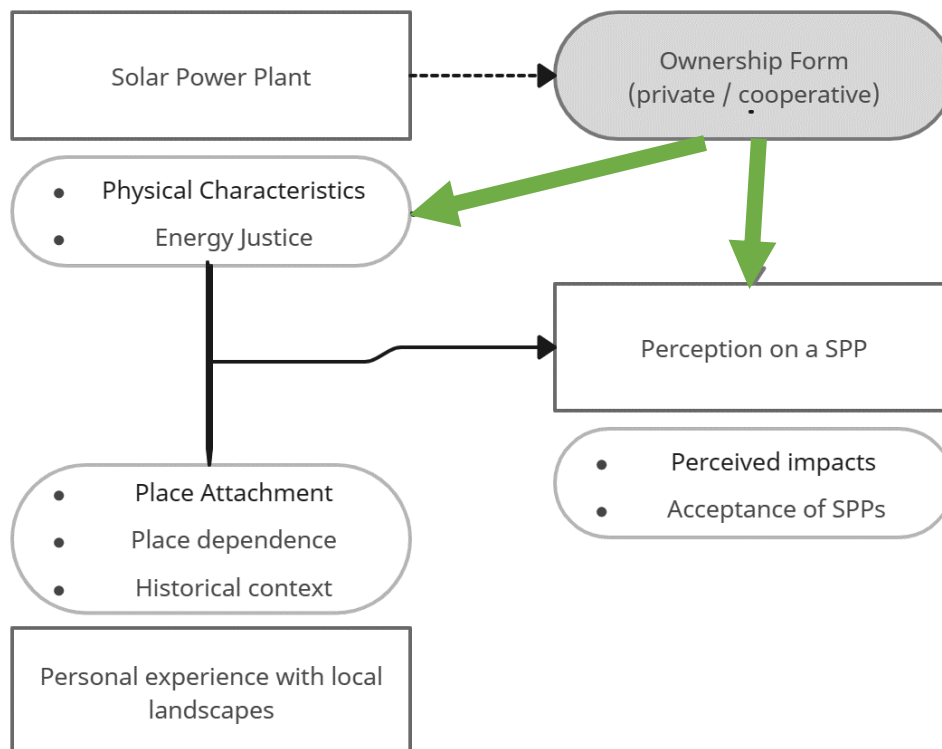


Figure 2 - Conceptual model showing SPP characteristics (top) as well as respondents experiences (bottom). Of interest for this research is the effect of the ownership form (represented by green arrows).

## 2.7. Hypotheses

1. There is no significant difference between cooperatively owned SPPs and privately owned SPPs in terms of local residents' perceived procedural and distributive justice and perceived impacts of the SPPs.
2. There is no significant difference between cooperatively owned SPPs and privately owned SPPs in terms of local residents' reported acceptance of the SPPs.
3. There is no association between the characteristics of a constructed SPP (procedural and distributive justice, and perceived impacts) and community acceptance of the SPPs.
4. There is no association between the indicated place attachment, dependence and historical context and community acceptance of the SPPs.

### 3. Methodology

#### 3.1. Study Area

The area of study for this research is the province of Groningen. Groningen was chosen because of the relatively large SPPs that were (and are being) constructed in the region. In some cases these have attracted media coverage (Westerveld, 2022). Groningen was also selected due to the presumed high visibility impact of RE infrastructure. This stems from its relatively flat and even landscape surface, combined with low levels of arborescent vegetation in comparison to the rest of the Dutch provinces (Compendium v. Leefomgeving, 2002).

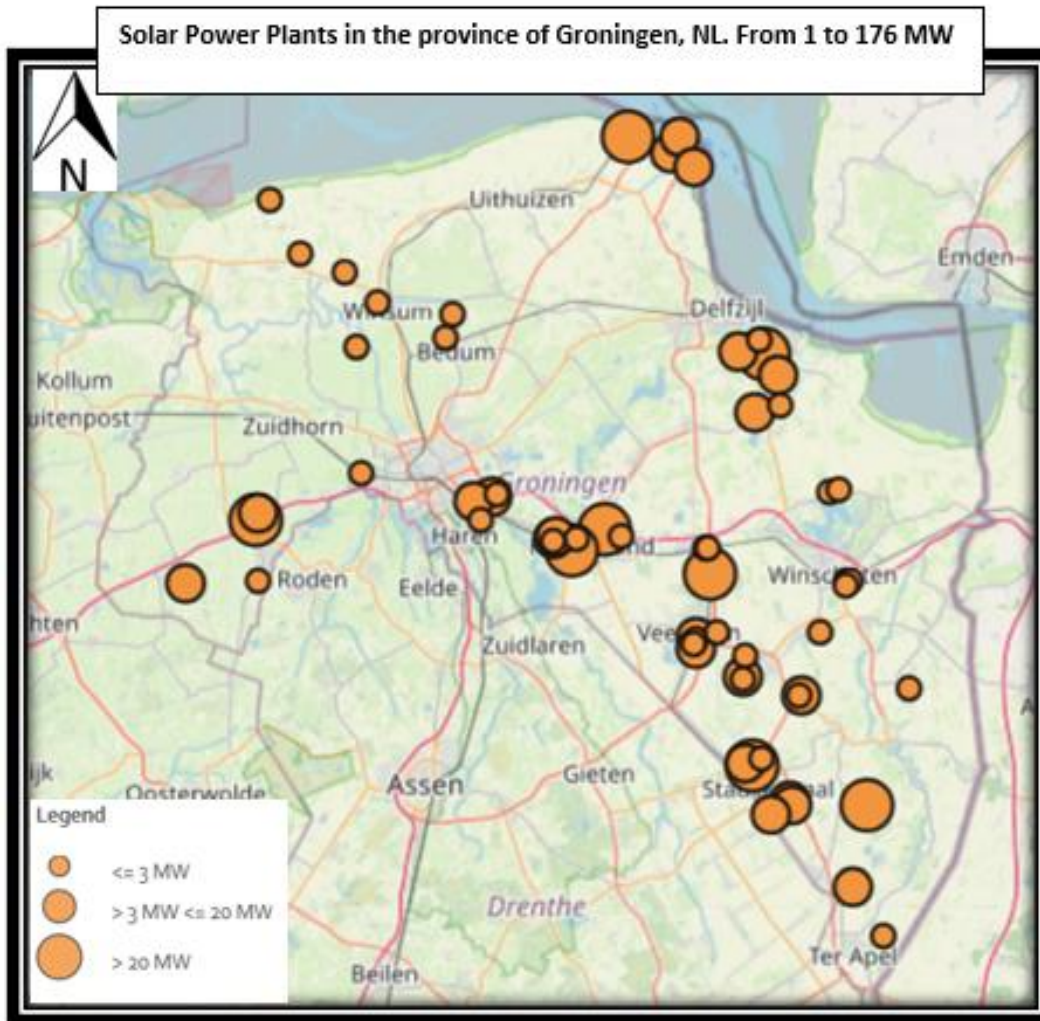


Figure 3 - Solar Power Plants in the province of Groningen, NL. From 1 to 176MW (adapted from ROM3D, 2023)

### 3.2. Recruitment Strategy

The sample of interest are the residents that reside within a range of three kilometres from an SPP. This cut-off point was chosen based on methodologies from previous RE infrastructure research, compiled in Baxter, et al. (2020).

Two strategies have been designed in order to recruit respondents:

- (A) Platforms like Facebook and WhatsApp, allowed for the convenient sharing of the Google Forms link. Because of the set geographical proximity boundary, the accompanying disclaimer states that respondents are required to reside within approximately three kilometers of and SPP, in order to participate. This specific range was selected after a compilation by Baxter, et al. (2020), of similar research. Sharing the Google Forms link among acquaintances was encouraged.

This recruitment strategy however proved to be not very effective at first, as the yielded response was (n=28) after several weeks. It is possible that the impersonal nature of this strategy may have made it easy for possible respondents to ignore opening or reading the questionnaire. An adequate sample (n=100) is crucial for performing parametric statistical tests, which relative to non-parametric tests can produce more meaningful results. Therefore, a second strategy was adopted later on:

- (B) Physical surveying. Areas within a three kilometer area of various Groningen SPPs were mapped out in preparation. This consisted of leaving invitation letters at residences within range, which contained QR-codes that led to the Google Forms questionnaire, but also and personally asking inhabitants in the street to fill out the questionnaire, provided that they lived within range.

### 3.3. Survey Design

See Appendix A. Because the posed research questions relate to a measurement ('To the extent...'), quantitative research was chosen (Punch, 2014, p. 3). Specifically the aimed result is a generalisation of perceptions of many respondents, therefore a form of statistical inference is necessary. Since it concerns opinions a questionnaire survey, mostly consisting out of Likert-scale oriented questions is a suitable option (McLafferty, 2010, p80). A Likert-scale orients matter of agreement (or, preference) along a scale, usually based on five, seven or eleven points (e.g.: -2= strongly disagree, -1= disagree, etc.). An uneven numbered scale is recommended to give respondents an option to express neutrality on the matter (ibid.). The platform by which the questionnaire is spread is Google Forms, an application that makes it easy to share questionnaires through media like e-mail, WhatsApp messaging, Facebook, etc. The intended result is that with this platform the survey will reach an maximum amount of people, as sharing is encouraged. Naturally, since the area of interest is in the Netherlands, the questionnaire is designed in plain, simple Dutch (McLafferty, 2010, p. 79).

### 3.4. Variables and created Variable Scales

Answer options were emphatically given numbers, so it can be argued that there are equal distances between answers, i.e. as is the case with interval data. This allows for means to be calculated and thereby also variable scales. The ordinal to interval assumption is a choice made in agreement within the increasing tendency of the peer-reviewed scholars of social sciences to make this assumption (Blaikie, 2003; Jamieson, 2004). Multiple peer-reviewed writings used in this research uphold it (Clarke, et al., 2018; Hogan, et al., 2022).

#### 3.4.1. Procedural Justice

This scale combines the two statements designed to elicit the feelings of justice and involvement of local stakeholders, in the construction of a local SPP (Ottinger, et al., 2014). The mean was calculated, which has yielded the scale *Procedural Justice*. The Cronbach's Alpha between the two statements is  $\alpha=0,823$ , suggesting good internal consistency reliability between them (Pallant, 2020, p. 105). Cronbach's Alpha is used to measure whether how closely related multiple items are that reportedly ask for similar phenomena (Tavakol & Dennick, 2011).

Table 1 – Items that were used to form the variable scale: Procedural Justice

	Procedural Justice
1.1.	I've felt that in the preparation of the local solar park, I've been encouraged to share my opinion on the subject.
1.2.	I feel that the concerns of local residents have influenced the construction of the local solar park.

#### 3.4.2. Distributive Justice

*Distributive Justice* is designed to measure how local residents perceived the fairness of the distribution of benefits of the local SPP. It originally consisted of two statements: 'The benefits of the SPP are only beneficial to a select group of investors' and 'The SPP provides economic benefits to my area' (statements 1.3. & 1.4.). Due to an insufficient internal consistency score however ( $\alpha=0,582$ ), 1.4. was omitted for the remainder of the research.

#### 3.4.3. Perceived Impacts

*Perceived Impacts* is a new variable scale created by calculating the mean of the five statements that concern impact factors. The internal consistency is satisfactory, at: ( $\alpha=0,782$ ). The answers to the last statement (2.5.) has been reversed, since this statement is worded positively instead of negatively like the other four.

Table 2 – Items that were used to form the variable scale: Perceived Impacts

	Perceived Impacts
2.1.	The solar park makes the rural landscape less attractive.
2.2.	Solar parks threaten local biodiversity: animals and vegetation.
2.3.	Solar parks negatively affect tourism in the region.
2.4.	Solar parks negatively affect local land- and housing prices.
2.5.	Solar parks bring extra job opportunities into the region.

#### 3.4.4. Place Attachment, Place Dependence and Historical Context

Although they are related, place attachment, place dependence and historical context are three separate items, and are kept separate since these are each asking for different phenomena. Also the internal consistency was very poor (lower than  $\alpha=0,2$ ).

### 3.4.5. Acceptance

The mean of statements 5.1. and 5.2. was calculated to come to the new variable scale: *Acceptance*. With an alpha score at: ( $\alpha=0,801$ ), the internal consistency is considered good.

Table 3 – Items that were used to form the variable scale: Acceptance

	Acceptance
5.1.	I think the local solar park is a positive development.
5.2.	I would support the development of more solar parks in my region.

### 3.5. Statistical Analysis

The analysis of the data is done according to two stages (section 4.2.). First, the central tendencies of the scales *procedural justice*, *distributive justice*, *perceived impacts* and *acceptance* are calculated and compared along the *ownership form*. *Place attachment* is not of value here since this is a personal characteristic of a respondent, not one that results from the SPP. The central tendencies are calculated so that differences between ownership groups can be shown at a quick glance. These differences correspond to hypotheses 3 and 4 (section 2.8.). The used central tendencies are the median and the mean. A median is an appropriate measure to use for reviewing the central tendency Likert-scale variables, it shows which is the most frequent answer per question (Hansen, 2003). Assuming equal distances means that the mean can also be used as a measure of central tendency.

Ordinal regression is a test that models the effect that (an) independent variable(s), have on a single ordinal response variable (CSCU, 2020). Apart from the effect it also models the relationship (positive or negative) and through calculating the ratio odds for the estimates can show the strength of the effect as well. The first test uses ownership form as independent variable, so that its influence on dependent variables *procedural justice*, *distributive justice*, *perceived impacts* and *acceptance* might be discovered. The second part is a ordinal regression too, only here the independent variables are *acceptance*, *procedural justice*, *distributive justice*, *impact factors* and *place attachment*, *place dependence* and *historical context*. The dependent variable is *community acceptance*. This corresponds to the hypotheses 3 and 4 (section 2.8.)

### 3.6. Ethical Considerations

Anonymity and voluntariness are two key ethical principles during this questionnaire.

Anonymity means that no personal data (names, e-mail addresses, phone numbers, etc.) are required to take part in the survey. Explicitly stated at the beginning of the document, is that to take part a person must have one or more solar parks in the direct vicinity of their homes however (the cutoff point is set at +/- 3km, after Baxter, et al. (2020)). This data is only used for the statistical research and is deleted directly after the study is concluded.

Voluntariness is also explicitly mentioned in the disclaimer of the questionnaire. At any point a respondent may stop and close the window. This is also links to the principle of Autonomy (Punch, 2014, p. 43), the concept that every respondent is capable of forming their informed decision about whether or not this questionnaire is suitable. The respondent confirms that they are 18 years of age when they participate. The respondent also agrees to contribute to research where conclusions will be made by participating. If respondents wish to know more, they are encouraged to send an e-mail so that they can ask questions or receive a summary of the results.

## 4. Results

### 4.1. Summary of Demographics

The survey yielded a total response of (n=)181, of which all of the respondents lived within 3 km of an SPP (people residing further away were already averted in the survey disclaimer). Of this total sample 119 (65,7%) respondents lived within the vicinity of a private owned SPP. 62 of the respondents (34,3%) were members of an energy cooperation that operates an SPP.

The age distribution (Figure 4) per ownership form shows that large disparities between ownership forms exist in the younger age categories. The category 18-25 has not even a single recorded cooperative SPP participant. The age distribution data of energy cooperative members in Groningen as a whole is unknown, so determining whether this is a limitation to the representivity of this research is impossible. The average age category is 46-55, which is not representative for the province of Groningen, where the average age is 42.48 (Dutch average: 42.4) (Provincie Groningen, 2022; CBS, 2022).

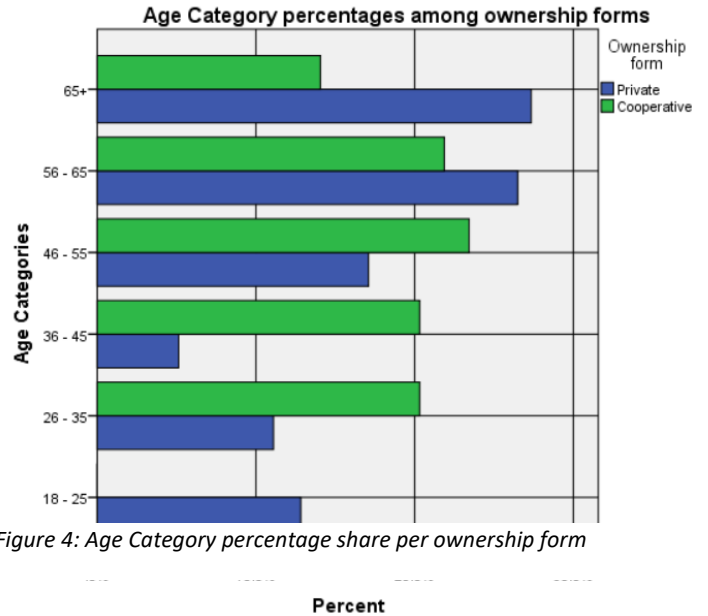


Figure 4: Age Category percentage share per ownership form

When looking at the gender distribution (figure 6) the mix for members of a cooperative SPP are slightly more unequal than the residents near private SPPs, however in both cases women are slightly overrepresented.

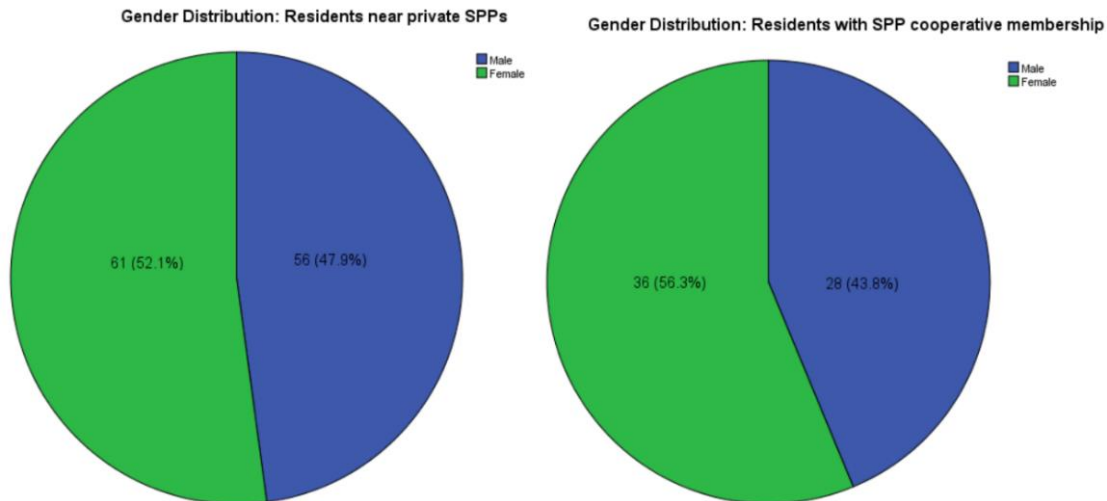


Figure 5 - Gender distribution of respondents per SPP ownership form

## 4.2. Differences between Ownership Forms

This section compares the median and mean results of *procedural justice*, *distributive justice*, *impact factors* and *SPP acceptance*, across ownership form. Place attachment is not relevant here, since it does not result from the ownership form of an SPP.

Table 4 - Comparison of the central tendency measures of the variables Procedural Justice, Distributive Justice, Perceived Impacts and Acceptance, between ownership form of SPPs.

<b>Survey items / variable scales</b>	Private SPPs: median	Private SPPs: mean	Coop. SPPs: median	Coop. SPPs: mean
<b>Variable scale:</b> Procedural Justice	<b>3.00</b>	<b>2.51</b>	<b>4.00</b>	<b>4.13</b>
<i>1.1. I've felt that in the preparation of the local solar park, I've been encouraged to share my opinion on the subject.</i>	3.00	2.72	4.00	4.19
<i>1.2. I feel that the concerns of local residents have influenced the construction of the local solar park.</i>	2.00	2.31	4.00	4.08
<b>Variable:</b> Distributive Justice	<b>3.00</b>	<b>2.83</b>	<b>4.00</b>	<b>4.03</b>
<i>1.3. The benefits of the SPP are only beneficial to a select group of investors' and 'The SPP provides economic benefits to my area'</i>	3.00	2.83	4.00	4.03
<b>Variable scale:</b> Perceived Impacts	<b>3.00</b>	<b>3.42</b>	<b>3.00</b>	<b>2.55</b>
<i>2.1. The solar park makes the rural landscape less attractive.</i>	4.00	4.15	3.00	3.14
<i>2.2. Solar parks threaten local biodiversity: animals and vegetation.</i>	3.00	3.42	2.00	2.25
<i>2.3. Solar parks negatively affect tourism in the region.</i>	3.00	2.94	2.00	2.06
<i>2.4. Solar parks negatively affect local land- and housing prices.</i>	3.00	3.08	2.00	2.45
<i>2.5. Solar parks bring extra job opportunities into the region.</i>	4.00	3.50	3.00	2.84
<b>Variable scale:</b> Acceptance	<b>3.00</b>	<b>2.69</b>	<b>4.00</b>	<b>3.94</b>
<i>5.1. I think the local solar park is a positive development.</i>	3.00	2.66	4.00	4.11
<i>5.2. I would support the development of more solar parks in my region.</i>	3.00	2.72	4.00	3.77

#### 4.2.1. Comparing Measures of Central Tendency

The median values in table 4 do not have values in the decimals; they correspond to the single digit answering method of the questionnaire. The table shows that residents near privately owned SPPs consistently rate their level of agreement lower than residents that take part in an energy cooperative with an SPP. *Perceived impacts* are formulated negatively, hence the reverse here.

All items of the questionnaire differ one level of agreement (i.e. one digit) between forms; only item 1.2. 'I feel that the concerns of local residents have influenced the construction of the local solar park.' exceeds this with two levels of agreement. This means that the majority of residents near a privately owned SPP disagree with this statement, whereas most of cooperative members would agree. Relevant here are the 13 out of the 20 median scores that are equal to 3.00, i.e. *neutral*. High amounts of neutral answers warrants caution, since *neutral* can represent multiple underlying considerations: indecision, lack of knowledge, etc. These considerations do not belong to the logical continuum of 'level of disagreement' of the Likert-scale (Nemoto & Beglar, 2014).

#### 4.2.2. Regression Analysis: Influences on Community Acceptance

Ordinal regression was used with the dependent variable is *Community Acceptance*, with the factors being *Procedural Justice*, *Distributive Justice*, *Perceived Impacts*, *Place Attachment*, *Place Dependence* and *Historical Context*. Table 5 gives a simplified version of the output, indicating only the values with a significant effect and whether the relationship is negative or positive (under 'estimate').

Table 5 - The questionnaire items with significant effect on Community Acceptance

Factors	Estimate	df	Sig.	Odds Ratio
P. Justice= 1,50	-4.258	1	.006	.014
P. Justice= 2,00	-3.359	1	.009	.035
P. Justice= 2,50	-3.177	1	.013	.042
P. Justice= 3,00	-2.531	1	.039	.080
P. Justice= 5,00	0	0	.	
D. Justice= 2	-2.567	1	.005	.077
D. Justice= 3	-2.029	1	.014	.131
D. Justice= 5	0	0	.	
P impacts= 2,00	2.957	1	.021	19.240
P. impacts= 2,40	3.017	1	.002	20.430
P. impacts= 2,60	2.789	1	.005	16.265
P. impacts= 4,00	0	0	.	
Historic= 2	3.499	1	.006	33.082
Historic= 3	1.995	1	.028	7.352
Historic= 4	1.757	1	.049	5.795
Historic= 5	0	0	.	



The results above suggest that it's likely that *community acceptance* scores will drop as scores of *procedural justice* drop as well. The highest score of 5 ('completely agree') is taken as the reference point (a) and as the scores for *procedural justice* drop (3 > 2.5 > 2 > etc.), it's visible that the estimates are decreasing too. The cumulative odds ratio of these estimates reveal the magnitude of the effect that a lower procedural justice score will have on community acceptance. This is calculated by taking the exponential value (e) of the estimate (Norusis, 2012). The estimate *Procedural Justice* = 1,50 for example, the exponential value is  $\exp(-4.258)$  yielding an odds ratio of .014. This number means that when *procedural justice* is rated at 1,50, the chance that a respondent will rate *community acceptance* as higher/better is .014 times as likely than when procedural justice is rated at 5,00 (a.k.a. extremely unlikely).

This reasoning applies to the other significant factors. As *Distributional Justice* drops, the score for *community acceptance* drops as well. *Perceived impacts* are formulated negatively, a lower score means lower reported perceived negative impacts. As impacts scores drop the community acceptance score rises, with the only anomaly being that the negative influence of *Impacts*= 2,00 is marginally lower than *Impacts*= 2,40. This means that this drop in perceived impacts is likely to slightly affect the community acceptance score to be higher.

Finally, *Historic context* is reported to cause a positive effect on community acceptance as the scores drop, i.e. lower perceived historical energy injustice of the province of Groningen will result in higher levels of acceptance. The far-right column displays the odds ratio's, showing the magnitude of some of the influences that these independent variables hold over community acceptance.

#### 4.2.3. Regression Analysis: Influence of Ownership

This section concerns the 3<sup>rd</sup> and 4<sup>th</sup> null hypotheses, and uses the same method. Like the first round ordinal regression has been used, the difference is that over four rounds *Ownership Form* is used as the independent variable, whereas the dependent variables for each different round are *Procedural Justice*, *Distributive Justice*, *Perceived Impacts* and *Community Acceptance*.

Table 6 - Repeated ordinal regressions show the effect that *Ownership Form* has on *Procedural Justice*, *Distributive Justice*, *Perceived Impacts* and *Community Acceptance*.

##### Distributive Justice

Factors	Estimate	df	Sig.	Odds ratio
Coop. member= No	-4.114	1	.000	.016
Coop. member= Yes	0	0	.	

##### Procedural Justice

Factors	Estimate	df	Sig.	Odds ratio
Coop. member= No	-7.200	1	.000	.000
Coop. member= Yes	0	0	.	

##### Perceived Impacts

Factors	Estimate	df	Sig.	Odds ratio
Coop. member= No	3.768	1	.000	43.293
Coop. member= Yes	0	0	.	

##### Community Acceptance

Factors	Estimate	df	Sig.	Odds ratio
Coop. member= No	-3.910	1	.000	.02
Coop. member= Yes	0	0	.	

The table shows that a lack of cooperation membership has a negative effect on the perceived Distributive Justice, Procedural Justice and Community Acceptance. A lack of a cooperation also has a positive relation with perceiving impacts. What the model tells by this is that it's reasonable to assume that residents near a privately operated SPP will report more perceived negative experiences. Like the first round of testing, the far right column gives the odds ratio's for whether a lack of cooperation membership results in a higher score for the four dependent variables than when the respondent is a member of a cooperation.

## 5. Discussion

This paper presents a selection of empirical findings that highlight the importance of ownership form for the community acceptance of SPPs in the province of Groningen. Its aim is to add empirical knowledge to the literature that is concerned with the planning policy of renewable energy developments. In particular, the aim was to seek out whether energy cooperatives can contribute to more positive community acceptance of SPPs.

### 5.1. The Effects of Cooperative Ownership

Like earlier RE-development research (Warren & McFadyen, 2010; Hogan, et al., 2022), this report shows that there is a positive effect of cooperative ownership on perceived procedural and distributive justice, perceived impact factors associated with SPPs, and community acceptance. Especially the enhanced experience of justice shows that the dynamics of the 'ideal' community energy model by Walker & Devine-Wright (2008) apply to Groningen. Simultaneously, private owned SPPs show a severely negative effect on perceived procedural and distributive justice; the odds that residents near a private SPP rate their procedural and distributive justice higher than their cooperative counterparts are practically non-existent (.016 and .000, resp.).

#### 5.1.1. Justice

'Energy justice' includes both procedural and distributive justice and is heavily connected to the degree of stakeholder participation that is experienced (Jenkins, et al., 2016). Community ownership being beneficial to the experience of justice has been empirically confirmed before (Walker & Baxter, 2017; Hogan, et al., 2022). Since control of the project is levied onto the community, the opportunity to participate as well as the distribution of costs and benefits are enhancing the experience of justice (Walker, 2008). Additionally, since the community is embedded in the locus, more balanced decision making in siting, size, etc. is possible, minimising resistance (ibid.). A possible explanation for why residents near private SPPs are outright disagreeing with the statement whether they feel influential over the project, whereas cooperation members would agree (table 4), is this lack of control. Indeed, control/decision making has been reported as making the crucial difference for citizens to experience participation (Amy, 1987). More literature has substantiated this claim; in Scotland for example, a naming contest for wind turbines was shown to enhance identification with the local development (Warren & McFadyen, 2010).

Magnani & Osti (2016) found that in the EU renewable energy developments are generally conducted with economic motivations in mind, therefore concerns like participation are of secondary interest. Although Dutch government directives insist on the stakeholder participation (Rijksoverheid, 2019), local communities are often left placated instead of included in the decision making process, Groningen being no exception (Arnstein, 1969; Ekker, 2021; Koster, 2021). Placation may be a possible explanation for why residents near private SPPs experience such poor distributive justice. Community benefit funds are often attached to the construction of new SPPs, but these are still a fraction of the total benefits associated with a renewable energy project (McHarg, 2016). Furthermore, some concerns/values that residents harbour cannot be overwon by monetary compensation; actually fair procedures can be necessary (Leer Jorgensen, et al., 2020). Developers therefore must be cautious not to 'bribe' into justifying new RE developments (McHarg, 2016). It is however hard to specifically identify what causes low distributive justice for private SPPs in Groningen, this would warrant a more qualitative, in-depth research.

### 5.1.2. Impacts

Private SPPs also strongly influence perceived impacts of a local SPP; private SPPs are 43.293 times as likely to elicit higher perceived impacts than its cooperative counterparts. Earlier research has shown that worrying about possible impacts that a RE-development might have is consistent with a deficit in energy justice, similar to Groningen (Mills, et al., 2019). They found that local residents in Michigan who experienced low procedural justice consistently were more worried about aesthetics and property values, a concern that was growing after several years. This dynamic could suggest that an experience with an energy justice deficit in the initial stages of the project could cause broader discontent over time, instead of getting used to and/or starting to accept SPPs.

Of all impacts, landscape quality and the lack of job opportunities are the most important drivers of them. Aesthetically speaking this is no shock as private SPPs in Groningen are enormous by Dutch standards, while cooperatives typically exploit smaller SPPs (~5,000 solar panels, or 1.5 hectare). Meanwhile, the landscape of Groningen is relatively flat and lacking in vegetation compared to the rest of the Netherlands (Compendium vdL, 2002). Interestingly, cooperation members were 'neutral' towards SPPs as threats to the attractiveness of the landscape, rather than disagreeing. Therefore, for Groningen the aesthetic risks of SPPs are not completely eliminated by community ownership forms.

### 5.2. Community Acceptance

For acceptance, the median and mean responses of residents near privately owned SPPs rate consistently lower than of their cooperative counterparts. This relationship was shown to be statistically significant with an odds ratio of .02, meaning that residents near private SPPs are .02 times as likely to rate community acceptance higher than their cooperative counterparts. A similar result was reproduced in the work of Hogan, et al. (2022), where cooperative wind turbine installations in Scotland too warranted significantly higher levels of support than private ones.

A peculiar phenomenon however is that place attachment and dependence had no significant impact on acceptance. High place attachment has shown to lead to discontent when new developments are built (Devine-Wright & Howes, 2010; Stedman, 2002), as well as place dependence (Clarke, et al., 2018). An explanation for this lack of effect might be that the survey did not research a specific case. When researching for a specific case the place attachment that locals experience might be researched beforehand, whereas the general approach of this survey may have included areas that already elicit low levels of place attachment. A future study with a more qualitative approach might be able to discover how place attachment and dependence is experienced across SPP sites in Groningen and the residents in the vicinity.

This report shows that for Groningen *Historical Context* significantly effected community acceptance in a negative manner. The more that respondents agreed with the notion that Groningen has facilitated enough energy industry historically, the more community acceptance suffers. This phenomena can possibly be explained by the history of negative effects associated with the natural gas exploitation, which started to result in man-induced earthquakes in 1986. The heaviest earthquake in 2012 (3,6 on the Richter scale) brought the safety issue to the national stage and prompted reparations for affected homeowners (Van den Berg, 2017). Residents may feel that they have been disadvantaged by energy development in the past, which could translate to a lack of acceptance for SPPs.

#### 5.4. Limitations to this Study

Some criticism can be applied to the methodology of this study. The first and most obvious, is that it compares two things that are not necessarily similar. In terms of physical dimensions, private and cooperative SPPs in Groningen are shown to vary immensely; some private SPPs reach up to 120 hectares (Schröder, 2020), while cooperative SPPs are typically in the single digits in terms of hectares. Within a category like private SPPs there are also steep differences in size. Additionally, ownership forms are not rigid, many SPPs exist that have partial private and partial cooperative ownership, choosing to include SPPs with any form of cooperative ownership as *cooperative* was out of necessity in order to make a dichotomous comparison. A case study with one 100% private and one 100% cooperative SPP would have been more precise.

Secondly the sampling methods are not accurate. The first sampling method, via social media, called for respondents that lived within 3 kilometres to respond. It relied on online groups (Facebook and the network of energy cooperatives) to fill in the questionnaires. A possible danger with engaging online groups could be that people with strong opinions are more willing to voice them, resulting in a skewed sample. This however generated far too few responses, therefore the second strategy consisted of scoping out specific areas within 3 kilometres of SPPs and delivering letters with links to the questionnaires to residences in the area. This second method is also not without critique however, as it relied on personal insight as to which areas to choose, even though effort was made to make the selection as random as possible.

Other aspects that might have skewed the results is the lack of cooperation members in the younger categories, with no members in the 18-25 category. It is possible however that cooperation membership is not a priority for these groups, as they typically are only starting to enter the housing market. Still, this skewedness might warrant more attention to respondent sampling for future research.

The Likert scale also has proven to have some downsides. This was five points and categorical, which means that several controversial assumptions had to be made in order to come to more meaningful statistical possibilities, such as the combining into scales (section 3.4.) This manoeuvre allowed for more meaningful statistics, but it is not without controversy. This mistake might be avoided in future research by using interval scales (1 to 10 for example) so that no conversion/combining into scales will be a necessary extra step.

## 6. Conclusion

This report has demonstrated that cooperative ownership of SPPs has a positive effect on the acceptance of SPPs. Conversely, the analysis has shown that a lack of experienced energy justice, as well as perceived impacts that an SPP might bring are detrimental to acceptance. When looking at ownership structure, residents near private SPPs experience all of these factors significantly more negatively than their cooperative counterparts. For the parties that are responsible for the planning (local government) as well as the funding and construction (corporate entities) this report recommends to integrate the participation of local stakeholders as a leading goal of development. Aside from contributing to local democracy, less objections due to a more inclusive decision making process has shown to speed up acquiring permissions as well.

The research question *'To what extent is cooperative ownership a factor for the community acceptance of solar power plants, among local residents in Groningen?'* can carefully start to be answered. First, it leads to agreement that there are forms of procedural and distributive justice present. Second, it shows concerns for impacts are low, although aesthetics remains dubious. Third, acceptance is perceived positively. Both residents near private as well as cooperative SPPs show agreement that procedural and distributive justice and impacts that come with an SPP are very important for the acceptance. Many earlier findings have supported the connection between community energy and more procedural and distributive justice. Therefore for enhancing the experience of these dimensions of justice, this study can recommend community energy as a viable way of expanding the capacity for solar energy in Groningen, especially since these are already positively experienced by cooperation members.

Furthermore, a surprising result is that place attachment and place dependence are not reliable predictors for acceptance of SPPs. Although earlier reports have shown that place attachment might lead to protective behaviour opposite of new developments (Clarke, et al., 2018), in Groningen there is no such dynamic.

A more uniform and randomised sampling method may be necessary for further research in order to come to more representative results. Aside from this, a case-oriented approach may give more precise results as to what drives community acceptance, but then again, the aim of this research was finding this dynamic for Groningen in general. Still, the fact that cooperative SPPs are beneficial to the experience of justice and acceptance, combined with the fact that the number of cooperative SPPs is still growing in the province, gives a positive outlook for the future.

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## A.1. Questionnaire (translated from Dutch)

### Questionnaire: Solar Parks in the landscape of Groningen

Dear reader, respondent,

Thank you for taking the time to fill in this list of questions! My name is Durk van der Laan and I'm a student of Social Geography and Planning. For my final thesis I am researching the spatial integration of solar parks in the more rural regions of Groningen. With this questionnaire I am hoping to receive your opinions as a resident of Groningen, on the approach of planning solar parks is currently taking place.

**Important: Did you receive this questionnaire but do you not live in Groningen? Then you can close this questionnaire.**

The list of questions will first briefly ask about some of your data and the relationship that you might have with solar parks. The questions can be answered with a scale that contains five point, of level of agreement:

1 = completely disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = completely agree, 6 = does not apply.

Privacy statemen:

Your participation is completely anonymous: the answers that you fill in are shown to no-one except for myself. There will follow some broad questions that concern your data, but these do not concern exact data that can in any way be retraced to you as an individual. Do therefore do not fill in additional data that is not asked for.

Your answers will be deleted the moment the research has concluded.

Please realise that this questionnaire is filled in completely on a voluntary basis; at any point you are able to close the window.

With participating you confirm that:

- You are 18 or older
- Your answers may be processed for my final thesis

## Your data

1. Choose your age category:

18 - 25

26 - 35

36 - 45

46 - 55

56 - 65

65+

2. With which gender do you identify?

*Man*

*Woman*

*I won't tell*

*Other: ....*

3. Do you live within +/- 3 kilometre range of a solar park? (Make an estimate here).

*Yes*

*No*

4. Are you a member of an energy cooperation that (partly) owns a solar park?

*Yes, I'm a member of an energy cooperation that (partly) owns the solar park in my vicinity.*

*Yes, I'm a member of an energy cooperation, but this does not own the solar park in my vicinity.*

*No, I'm not a member of an energy cooperation.*

## Your opinions about solar parks in the landscape of Groningen

### Part 1

- 1.1. *I've felt that in the preparation of the local solar park, I've been encouraged to share my opinion on the subject.*
- 1.2. *I feel that the concerns of local residents have influenced the construction of the local solar park.*
- 1.3. *The benefits of the SPP are only beneficial to a select group of investors' and 'The SPP provides economic benefits to my area*

### Part 2: Risks

- 2.1. *The solar park makes the rural landscape less attractive.*
- 2.2. *Solar parks threaten local biodiversity: animals and vegetation.*
- 2.3. *Solar parks negatively affect tourism in the region.*
- 2.4. *Solar parks negatively affect local land- and housing prices.*
- 2.5. *Solar parks bring extra job opportunities into the region.*

### Part 3: Personal relationship with the landscape of Groningen

- 3.1. *I'm personally attached to the rural landscape of Groningen.*
- 3.2. *My daily activities (living, sports, leisure, etc.) largely take place within the landscape of Groningen.*
- 3.3. *The Landscape of Groningen is (considering its history) unfairly exploited with energy generation.*

### Part 4: Your approval of solar parks

- 5.1. *I think the local solar park is a positive development.*
- 5.2. *I would support the development of more solar parks in my region.*

## End of the questionnaire

If you want to address personal questions/critiques to me, or if you want to receive a summary of my research afterwards, e-mail to:

[D.van.der.Laan@student.rug.nl](mailto:D.van.der.Laan@student.rug.nl)

Sharing the questionnaire is always appreciated! The link with which you have received this questionnaire can be conveniently copied and shared via whatsapp/e-mail/facebook/etc.

This is the end of this page and also the questionnaire. Your responses have been received, you can now click on 'Send' and close this screen. Many thanks!