Citizen and consumer preferences for non-market environmental impacts of wind and solar energy farms

Master Thesis Jori Corbié

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Citizen and consumer preferences for non-market environmental impacts of wind and solar energy farms

By

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In partial fulfillment of the requirements for the degree of

Master of Science

In Systems Engineering, Policy Analysis and Management

at the Delft University of Technology

To be defended in public on 24-08-2017

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Project duration	September 2016 – August 2017	
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Preface

The main goal of this thesis is to gain insights into how individuals in their role as a citizen and as a consumer make trade-offs between non-market environmental impacts of wind and solar energy farms, by designing stated choice experiments. The study is conducted on behalf of the Delft University of Technology, in collaboration with Decisio BV. This master thesis concludes my master program Systems Engineering, Policy Analysis and Management at the Technology, Policy and Management faculty of the Delft University of Technology.

I would like to seize this opportunity to express my gratitude to everyone who helped me during my master thesis. First of all, I would like to thank my graduation committee for their feedback and guidance. Niek, I would like to thank you for introducing me to your research on citizen preferences; it has inspired me and it was exactly what I was looking for. Furthermore, thank you for your dedicated supervision from beginning to end. You were always willing to answer my question when I came knocking on the door or motivate me to do more, or rather, do less. I would like to thank you, Niels, for giving me the opportunity conduct my research and intern at Decisio BV. I thoroughly enjoyed my time in Amsterdam (despite commuting) and learned a lot along the way. Also, making me a part of the team from day one. I don't think many interns can say they joined on a very serious business trip in their first week. Furthermore, Emile, thank you for squeezing me into your busy schedule every so often to provide me with practical feedback and suggestions to keep me moving forward. Also, thank you Caspar for your insightful ideas and feedback during the meetings.

Second, I would like to thank all colleagues at Decisio BV for providing such a welcoming and open workspace. Thank you for taking so much interest in my research and me, you have all made me feel welcome from day one and I'll fondly remember the lively lunch discussions and 'team building' events.

A special thanks goes out to my family, who have supported me and helped me get to where I am now. Mom, don't worry, study time is over, so it is time to be a serious citizen and start working .. soon. After travelling.

Last, I would like to thank you, Kim, for supporting me every step of the way. I truly could not have done it without you.

Jori Corbié
Delft
August 2017

Executive Summary

This report discusses the way individuals in their role as citizens or consumers make trade-offs between (non-market) environmental impacts of wind and solar energy farms. Literature identifies two paradigms that attempt to value non-market environmental impacts. The status-quo concerns a range of consumer sovereignty based valuation methods and techniques. Besides this, recent scientific contributions demonstrate empirical efforts for a citizen based valuation approach. The latter observes substantial differences between the citizen and consumer preferences for government financed road transport projects. It is unknown what differences there are between citizen and consumer preferences for government financed renewable energy farms. To that end this study generate empirical insights in the differences between citizen and consumer preferences for non-market environmental impacts of wind and solar energy farms, by designing discrete choice experiments. The experiments generate insight in the relative importance of the different environmental impacts and addresses if this may change policy recommendations from environmental valuation studies.

The report starts off with reviewing stated preference literature on an individual's different roles also referred to as the citizen-consumer duality. The review deduces that the fundamental difference between citizen and consumer is their preference for public or private budget spending. Consistent with this finding, the literature study defines a citizen as an individual who reveals preferences in a political setting on the allocation of (previously collected) tax money by the government. A consumer is an individual who reveals preferences on spending their personal budget in a market setting.

Next the report continues to demarcate the scope of this review and works towards a conceptual framework that entices the selected and quantified factors within the research context that will be incorporated in the experiment. A literature review yields a list of relevant non-market environmental impacts, categorized in technical and institutional characteristics of wind and solar energy farms. As a result, three experiments are defined: a citizen experiment that includes technological non-market environmental impacts, a similar consumer experiment and a citizen experiment that includes both technological and institutional characteristics. The list of relevant factors was attested for their societal relevance and measurability in several expert discussion session, which led to the factor selection. Next, the attributes were quantified by determining their unit of measurement and feasible attribute level ranges. This was input for the survey design. After extensive pretesting, three main surveys were designed. Table 1 highlights the attributes, attribute levels and ranges of all attributes.

In total 572 respondents completed the three online surveys. An analysis of descriptive results generated insight into the respondents' choice behavior and perception of the survey. The relative majority of respondents indicated that noise was the most important attribute in their decision. Furthermore, on average 60% of the respondents of the citizen experiments opted for a solar energy farm over a wind energy farm. Furthermore, a substantial amount of respondents were so-called non-traders (citizen experiment: 37.9%, consumer experiment 28.9%, citizen participation experiment 31.4%) indicating potentially small attribute ranges or a significant unobserved preference.

Three multinomial logit models report citizen and consumer preferences for the main attributes. Citizens derive significant utility for non-market environmental impacts noise hinder, solar visual hinder, wind visual hinder and solar recreational land-use. Furthermore, citizens derive significant utility for the two community participations levels that entail the provision that the community has binding decision-making power. The current status-quo 'consultation' (without binding decision) is no significant improvement from no participation. On the other hand, consumers are significantly influenced by noise, solar visibility, solar agricultural land-use and solar recreational land-use. The consumer model estimates conveys that respondents do not elicit statistical significant higher or lower marginal WTP from noise, solar visibility, agricultural land-use and recreational land-use.

Table 1: Attributes, attribute levels and ranges for all experiments

Attribute	Alternative 1: Wind energy farm	Alternative 2: Solar energy farms	Status quo: Planned Wind energy farm
Visibility number of residents with visual hinder	0 residents 100 residents 200 residents 300 residents	0 residents 100 residents 200 residents 300 residents	300 households
Noise	0 residents 100 residents 200 residents 300 residents	N/A	150 households
Agricultural land use	10 hectares 20 hectares 30 hectares 40 hectares	50 hectares 100 hectares 150 hectares 200 hectares	40 hectares
Recreational land-use	5 hectares 10 hectares 15 hectares 20 hectares	50 hectares 100 hectares 150 hectares 200 hectares	20 hectares
Tax Payment	€5 €25 €45 €65	€5 €25 €45 €65	N/A
Level of community participation	No participation Consultation Cooperation Decision-making	No participation Consultation Cooperation Decision-making	

The estimation conveys that there are differences between the trade-offs an individual in their role as citizen or consumer makes between (non-market) environmental impacts of wind and solar energy farms. One difference is that a citizen significantly cares for the visual hinder of wind energy farms, but the consumer does not. Contrarily, consumers significantly care for the agricultural land-use of solar energy farms, but the citizen does not. Furthermore, consumers attribute a higher statistically significant utility to solar recreational land-use than citizens, but attribute statistically significant less utility to solar visual hinder than citizens. Interestingly, citizens do not attribute significantly more utility to noise hinder than consumers.

Furthermore, the study finds that the differences between citizen and consumer preferences may lead to different policy recommendations for renewable energy technology alternatives. Furthermore, it is posited that the conceptual difference between citizen and consumers implies that different environmental valuation frameworks are required. A citizen utility evaluation framework assesses a project alternative's 'citizen utility per tax budget' whereas the consumer welfare estimation framework measures a project's alternative welfare in monetary terms. Furthermore, the analysis concludes that a citizen utility framework cannot be incorporated in environmental valuation studies like the social cost-benefit analysis. Citizen utility frameworks assess project alternatives with consistent tax money allocation, whereas current environmental valuation studies assume consistent electricity production across alternatives.

The study recommends to increase the research efforts to gain more insights in the tradeoffs citizens make for renewable energy technologies. It is suggested to vary in alternatives and attributes and include interaction effects with socio-economic factors and non-linearity. Furthermore, more complex logit models such as Mixed

Logit or Latent-Class Analysis can be used to get insight into the heterogeneity of preferences. Besides this, future research could explore how citizen preferences can be used in current environmental evaluation studies for renewable energy project alternatives.

Besides this, policy-makers are recommended to alleviate the position of (non-market) environmental impacts from renewable energy technologies in the current decision-making process. The study posits directions for increased research to support policy-makers to design policies to reduce the noise hinder, visual hinder and land-use of renewable energy technologies. Furthermore, it is recommended to experiment with increased levels of community participation for current designated wind energy farms. Mind that the *binding* nature of community decisions should be lawfully embedded or ensured to gain the community's trust.

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List of Abbreviations

ASC	Alternative Specific Constant
BV	Private Company (Besloten Vennootschap)
CBA	Cost-Benefit Analysis
CE	Choice Experiment
CEA	Cost-Effectiveness Analysis
CV	Contingent Valuation
CVM	Contingent Valuation Method
DCE	Discrete Choice Experiment
GIS	Geographic Information System
ha	Hectares
IIA	Independence from Irrelevant Alternatives
kWh	Kilo Watt Hour
LCA	Latent Class Analysis
Lden	Level day-evening-night
ML	Mixed Logit
MNL	Multinomial Logit Models
MW	Mega Watt
N/A	Not Applicable
RP	Revealed Preference
RPL	Random Parameter Logit
RUT	Random Utility Theory
RVO	Dutch Enterprise Agency (Rijksdienst voor Ondernemend Nederland)
SCBA	Social Cost-Benefit Analysis
SCEA	Social Cost-Effectiveness Analysis
SDE+	Stimulering Duurzame Energie
Solar PV	Solar Photo Voltaic
SP	Stated Preference
TU Delft	Technical University Delft
WTA	Willingness to Accept
WTP	Willingness to Pay

1 INTRODUCTION

1 Introduction

Many characteristics of the environment are ‘valuable’ to people, but do not come with a market price. For instance, the public values clean air, while we do not buy our oxygen in a market setting. Similarly, we like to hike and bike in the outdoors yet do not price this activity, while the value of this activity perhaps differs depending on what we see around us. Such non-market environmental goods and services are often not included in a market setting and therefore have unknown economic value and are underrepresented in economic analyses (Louviere, 2003).

However, many government infrastructure investments affect non-market environmental goods and services. Therefore, the Dutch government desires insights into their impact on these non-market goods and services and has deployed a variety of environmental valuation methods and techniques to assist decision-makers and spatial planners on government infrastructure policy decisions.

This chapter provides background information on the problem and the objective of this thesis. First, the valuation of environmental goods and services is introduced. Next, the problems for eliciting citizen or consumer preferences for renewable energy technologies are discussed and the research goal and sub goals are outlined. Finally, the research structure and thesis outline is given.

1.1 Introduction to valuation of non-market goods and services

Literature identifies two paradigms that attempt to value non-market goods and services. The status-quo concerns a range of consumer sovereignty based valuation methods and techniques (Cook et al., 2016). Besides this, recent scientific contributions demonstrate empirical efforts for a citizen based valuation approach (Mouter & Chorus, 2016).

In the last decades, the consumer-based approach paradigm has seen a surge of scientific contributions in the field of environmental economics on the valuation of environmental goods and services. Ultimately, these methods aim to put environmental goods and services on the same level as market goods so that they can be assessed in equal monetary terms (Louviere et al., 2003).

Stated preference theory and methods such as the contingent valuation method (CVM) and discrete choice experiment (DCE) are the primary methods to value non-market environmental goods and services from a consumer perspective. Both methods create hypothetical markets to elicit people’s 1) willingness to pay (WTP) for an increase or decrease in the quantity or quality of the environmental non-market goods or services or 2) the amount they would be willing to accept as compensation for a decrease or increase in the quantity or quality. This way, benefits of environmental policy decisions may be estimated (Louviere et al., 2003).

The CVM has been the most frequently used non-market valuation method to estimate the benefits of environmental goods and services (Jin et al., 2006; Mitchel & Carson 1989). Respondents are asked to put a single value (specific price) on a decrease or increase of the quantity and quality of an environmental effect. However, this method is considered less suitable for situations when multiple options and attributes are considered (Stevens et al., 2000).

The DCE method is a relatively new non-market valuation method that specifically allows the analyst to identify trade-offs individuals make between attributes or alternatives. Yin et al. (2006) finds that researchers have found positive results for the use of CE in the valuation of environmental goods and services.

An abundance of stated preference literature is available on the environmental goods and services of renewable energy technologies. For instance, Mattman et al. (2016) conducts a meta-analysis on 32 CVM and CE studies on the valuation of non-market environmental goods and services of renewable energy technologies. This analysis shows that consumers are often willing to pay for improvements in goods like visibility, air quality, noise and safety.

Recently, a citizen-based choice experiment to assess non-market goods and services from government infrastructure projects has been developed and empirically tested by Mouter & Chorus (2016) and Mouter et al. (2016). In these experiments, the individual is moved away from being a consumer spending their after-tax income (in a market setting) to a citizen (in a political setting), where they show their preference for the allocation of previously collected tax money. Mouter & Chorus (2016, p. 317) find that "*an individual's willingness to pay from previously collected tax money for travel time gains created by a government policy, is significantly higher than their willingness to pay from their after-tax income, for time gains obtained by choosing a different route.*" This is the first empirical evidence in support of the normative claim in literature that the preferences of an individual in their role as consumer (concerning how they spend their private after-tax resources) is a poor proxy of the preferences of an individual in their role as citizen (concerning how the government should spend the public budget). Mouter & Chorus (2016) suggest that this is a first indication that the outcome of transport infrastructure appraisal studies change if the projects are evaluated from a citizen's perspective rather than a consumer's perspective.

These recent citizen-based studies focus on government *transport* infrastructure projects. However, the government finances many infrastructure project in a range of domains. For instance, the SDE+ subsidy scheme is used to finance renewable energy infrastructure projects to increase the capacity of low-carbon electricity supply. A large portion of tax-money is reserved to finance large wind energy farm projects. In fact, specific targets are set to increase the installed onshore wind energy capacity from 2950MW in 2015 to 6000 MW in 2020 (Ministry of Economic Affairs, 2016). Therefore, the government has already designated areas as building sites for these large wind energy projects. Residents in close proximity to these building sites protest against the construction plans and worry about how wind energy farms changes their living environment. For instance, a study of Elzinga & Oterdoom (2015) shows that residents mostly worry about visual hinder and noise, which are typically non-market goods. Recently, local initiatives are started to promote the building of a solar energy farm on the designated building sites (RTV1, 2017). However, residents also protest against such large renewable energy projects and worry about the visual impacts (Trouw, 2017).

Given this context, it may be interesting to study if the differences between citizen preferences and consumer preferences found by Mouter & Chorus (2016) and Mouter et al. (2016) for government transport infrastructure projects, also occurs in other domains. More specifically, it may be interesting to study if these differences occur for the valuation of non-market environmental goods and services from government financed wind and solar energy projects. Therefore, this thesis will be the first study that tries to elicit citizen preferences in this context.

1.2 Theory

This research aims to determine estimations of an individual's trade-offs between environmental goods and services of wind and solar energy farms in their role as a citizen and as a consumer. This trade-off can be expressed as a preference estimated by letting individuals choose between two different renewable energy technology projects based on non-market goods. The quantity or quality of the non-market environmental goods and services can be varied to assess how this affects the individual's choice for a renewable energy technology.

Discrete choice modelling is a method to estimate such trade-offs. McFadden (1974) asserts that choice models make the choice process from the individual explicit for specific trade-offs. While there are several underlying choice behavior, choice modelling generally based on two building blocks: Lancaster's theory of value and Random Utility Theory (RUT).

Lancaster (1966) asserted that the *utilit*y derived from a good comes from the characteristics of that good, not from consumption of the good itself. Goods normally possess multiple (shared) characteristics (attributes). Lancaster asserts that the value of a good is given by the sum of the value of the characteristics.

The second building block addresses this utility in the Random Utility Theory. The utility is an expression of an individual's preference for a good or service. The amount of utility is represented by a relative and abstract numerical value, which cannot be observed or measured by itself. Satisfaction and happiness towards a specific alternative (attribute) will be translated into a positive utility, whereas dissatisfaction will be expressed as a negative utility (McFadden, 1974).

In choice modelling, it is assumed that individuals behave in a utility maximizing way, choosing the alternative that results in the highest utility. In case of this research a respondent's choice for a renewable energy technology is based on which technology is most preferable, which is based on the trade-off of the quantity or quality levels (impacts) of the selected environmental goods and services (attributes) of the alternatives.

This study attempts to generate both citizen and consumer preferences for trade-offs between environmental impacts of wind and solar energy farms. The consumer-based approach is the prevailing method in environmental valuation studies. Section 1.1 stated that there is an abundance of literature on the consumer valuation of non-market environmental impacts of renewable energy technology. However, there is no study that empirically studies the citizen valuation of these non-market goods and services from renewable energy technologies.

A possible approach is described in Mouter & Chorus (2016). They let individuals in a role as a citizen allocate previously collected tax money to road expansion projects. They suggest that future research may explore the transferability of these conclusions to other fields of studies to assess the citizen approach to the valuation of non-market goods and services.

So far, it is unknown how citizens may tradeoff the non-market environmental impacts from government renewable energy projects. Furthermore, it is unknown what can be done with the results from this analysis. This study tries to ameliorate these knowledge gaps by adopting the approach of Mouter & Chorus (2016) of measuring citizen preferences by letting individuals trade-off the environmental non-market goods of wind energy farms and solar energy farms.

1.3 Research Goal

The main goal of this research can be drawn from the previous. Section 1.1 shows that consumer and citizen stated preference methods can be used to trade-off non-market environmental goods from renewable energy technologies. Next, section 1.2 shows empirical results stating consumer and citizen preference may differ. However, there is yet incomplete information to design a citizen based preference stated choice experiment for environmental impacts from renewable energy technologies. Therefore, the main goal of this research is:

> *"To gain insight into how individuals in their role as a citizens and as a consumer make trade-offs between non-market environmental impacts of wind and solar energy farms, by designing stated choice experiments."*

1.4 Sub-research goals

In order to reach the main goal, a number of sub-goals are identified. The first step is to determine how the main goal of this research can be reached. Therefore, a step-by-step guideline of research phases and research methods is formulated. Hence, the first sub-goal is:

a. *To establish the required research steps and research methods*

The main goal demands the inference of data from discrete choice models from individuals in their role as a consumer and as a citizen. This means that it needs to be established what defines the concepts of consumer and citizen in stated preference literature. Therefore, the second sub-goal is:

b. *To define the concepts of consumer and citizen, based on stated preference literature.*

The main goal aims to estimate trade-offs from non-market environmental goods and services from renewable energy technologies. In order to incorporate such variables in a choice model, relevant variables have to be identified from stated preference literature. Therefore, the third sub-goal is:

c. *To select relevant factors that influence an individual's preference for a wind and solar energy farms*

Next, in order to estimate citizen and consumer preferences on non-market environmental goods and services of wind and solar energy farms, data has to be generated. This data will be generated by the design of several stated choice experiments. The fourth sub-goal is therefore:

d. To design stated choice experiments to measure citizen and consumer preferences to infer trade-offs from the non-market environmental impacts of wind and solar energy farms.

Next, the data is collected and analyzed to gain insight in the quantified survey results. Therefore, the last sub-goal is:

e. *To gather and analyze data of citizen and consumer preferences for trade-offs between non-market environmental impacts of wind and solar energy farms*

Finally, the model estimations generate citizen and consumer preferences. The results and their implications for environmental valuation of renewable energy technologies are discussed.

f. *To infer citizen and consumer preferences for trade-offs between non-market environmental impacts of wind and solar energy farms.*

1.5 Method

In this thesis several methods are used. These methods are highlighted hereafter.

Literature study: A literature study of the state of the art is conducted to determine the exact scope of this research. Two literature review are conducted. The first part aims to conceptualize the role of an individual as a *consumer and a citizen*. The second part aims to identify from the state of the art relevant environmental factors that influence an individual's preference for wind energy farms or solar energy farms.

Survey Design: A two-staged D-efficient design approach is adopted to generate three final surveys. The first stage concerns orthogonal experimental design for a pilot study to assess the understandability of the research and derive *prior* values that are used to make the final survey. Then, three D-efficient experimental designs are generated for the three surveys, two citizen-based experiments and one consumer-based experiment. Denote that the literature reviews provide the conceptual basis to design both citizen and consumer preferences, as well as relevant attributes for the choice situations.

Analysis: This research aims to interpret the data generated with the three final surveys. First, a descriptive data analysis is conducted to describe the sample characteristics, the generic choice behavior and perceived difficulty, realism and relevance of the surveys. Then, different choice models are estimated to infer citizen and consumer preferences. Multinomial logit models estimations give insights into the factors that significantly influence the preference of citizens and consumers per experiment. Moreover, differences between experiments are derived.

Conclusions: The aim of the conclusion is to assess if the main goal of this research is reached, by discussing the different sub-goals. The discussion reflects on the model assumptions and estimations. Finally, recommendations for future research are provided.

1.6 Scope

This section briefly describes the scope of the research. The first sub-research goal aims to delineate the research steps and research methods that are required to reach the main objective.

Figure 1. Thesis scope: citizens and consumers choosing between wind or solar energy parks

Sub-research goal b and c are focused on defining the scope of this research based. First, a literature review on the state of the art on the so-called citizen-consumer duality works towards a definition of these two concepts. A citizen is defined as an individual who reveals preferences in a political setting on the allocation of (previously collected) tax money by the government. A consumer is defined as an individual who reveals preferences on spending their personal budget in a market setting. Second a conceptual framework is to demarcate the context and select relevant environmental impacts. The research assesses factors that influence the preference of an individual (citizen or consumer) for a wind and solar energy farm. These two options are chosen for a reason. The Dutch government has introduced long-term tax-money financing schemes for wind energy farms to push the transition to a low-carbon energy supply. Solar energy farms are the most likely alternative. However, the Netherlands is a densely populated country and therefore, construction sites of renewable energy farms are always within the living environment of residents. Therefore, this study primarily looks at non-market environmental impacts that may influence an individual's preference. The selected state choice preference method is discrete choice experiments. With this method, one pilot survey and three final surveys are designed. The data acquired from these surveys is estimated with Multinomial Logit models. Denote that this is the first research that aims to estimate citizen and consumer preferences in this context. Therefore, the study focuses only on estimating the main effects (attributes) and omits the use of more complex logit models, like the Mixed Logit model or Latent Class Analysis. The model estimation analysis specifically focuses on interpreting and comparing the empirical results. Finally, the empirical insights into the differences of the preferences of citizen and consumers for trade-off of the environmental impacts wind and solar energy farms may fuel the scientific citizen-consumer duality debate. Furthermore, it may inform policy-makers on sustainable energy policies to reduce the environmental impacts of (built and) planned wind and solar energy farms.

1.7 Scientific and social contributions

The increased understanding gained from this research, can be used for multiple purposes. It can be of purely academic value as this is the first studies that generates empirical insights into the differences between citizens and consumers trading off environmental impacts of wind and solar energy farms. This may fuel the ongoing citizen-consumer duality discussion and inspire new research to elicit citizen preferences for government financed projects.

Furthermore, this research is relevant for politicians and policy-makers who deal with the spatial planning of renewable energy technologies. First insights into the relative importance of non-market environmental technological characteristics from a citizen perspective may spike a discussion on the dominance of current financial evaluation frameworks, like the social cost-benefit analysis (SCBA). Furthermore, the consumer-based choice experiments increases understanding of possible willingness to pay for non-market technology characteristics. This may result in insights for possible policy measures that reduce the environmental impacts from wind and solar energy farms.

1.8 Thesis outline

Figure 2 shows an outline of this thesis. In chapter 1 the problem and objective of this research were distinguished. Chapter 2 identifies and elaborates on the required research steps and research methods to reach the main goal of this study. This leads to a step-by-step research approach overview and an increased understanding of the main research method; choice modelling. Chapter 3 reviews literature on the use of the concepts citizen and consumer in stated preference literature. This chapter concludes with a selected definition of these concepts. Chapter 4 works towards a conceptual framework that links the precise field of study (implementation of wind energy and/or solar energy farms within the living environment) with an overview of the selected factors that may influence an individual's decision for a wind or solar energy farm. Chapter 5 elaborates on the design of the citizen and consumer (input from chapter 3) stated preference surveys for choices between wind energy and solar energy farms (input from chapter 4) . An in-depth analysis of the required design choices for the pilot and final surveys are outlined in this chapter. Chapter 6 presents the analysis of the descriptive results, which gives insight into the sample characteristics and choice behavior. Chapter 7 outlines the model estimations of the citizen, consumer and citizen participation surveys. MNL model estimations of main effects are interpreted, compared and discussed. Chapter 8 explores the implications of the differences in citizen and consumer preferences for environmental valuation. It is assessed if these differences may lead to other policy recommendations. Finally, Chapter 9 reflects on the process to reach the research main goal through the research sub goals. Furthermore, limitations of this study and recommendations are discussed.

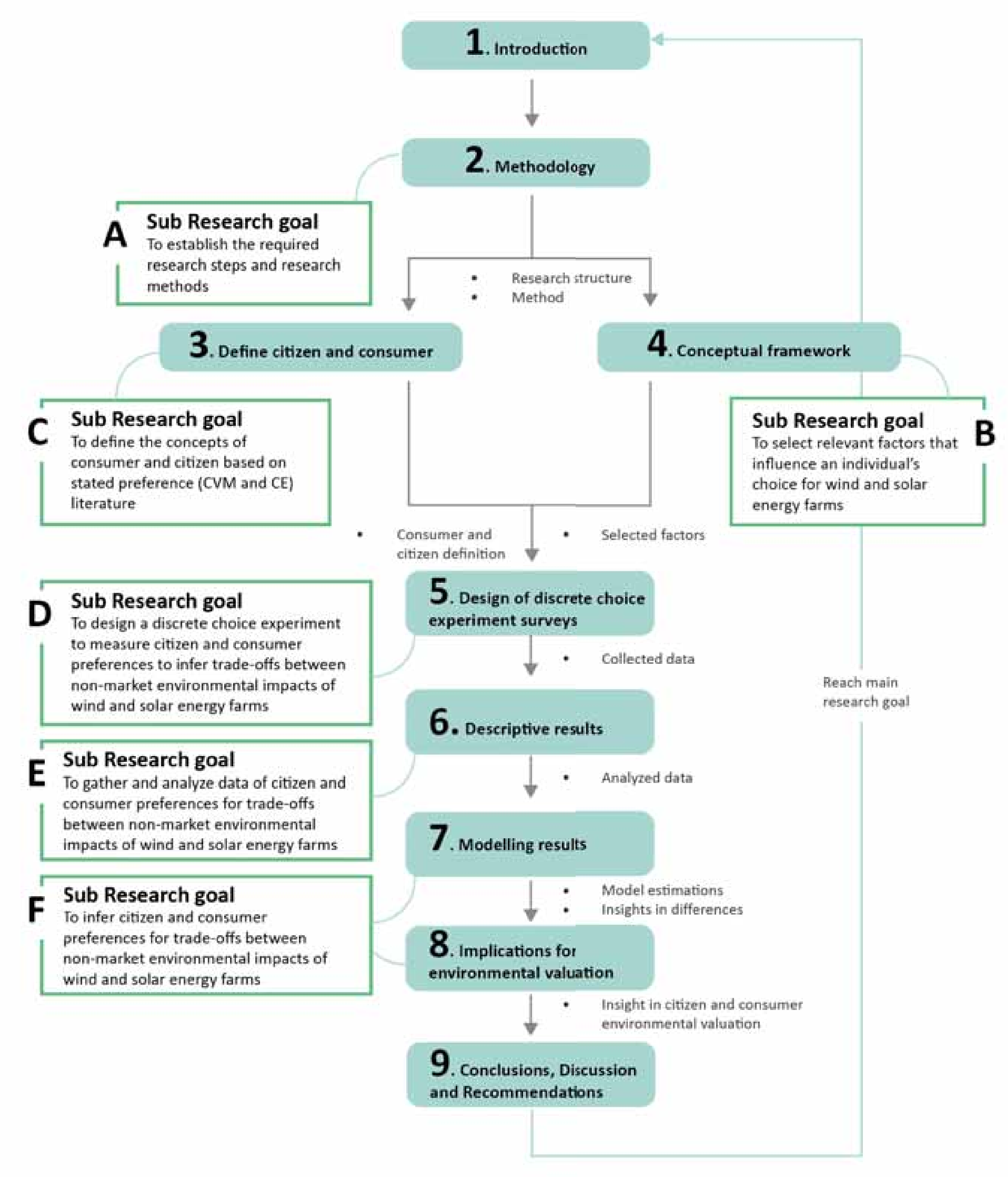


Figure 2: Thesis outline

2 METHODOLOGY

2 Methodology

This chapter presents the main research steps and research methods in this chapter, congruent with sub-research goal a. The following methods are used to reach the research goals and are discussed in the following sections.

- Conceptualization: Sub-research goal b, c
- Survey Design: Sub-research goal d
- Analysis: Sub-research goal e, f
- Conclusions: Main research goal

2.1 Conceptualization

The first part of this study works towards a conceptualization that demarcates the exact scope of this research, which serves as input for the survey design phase. The literature review is divided into two parts which address different parts of the main goal of the research, as presented in section 1.3. First a literature review demarcates the meaning of the role of an individual as a *consumer and a citizen*, by discussing the state of the art from stated preferences literature. The second part aims to select and quantify relevant environmental attributes of wind and solar energy farms. This is done by means of literature study and expert consults. The literature study identifies relevant (non-market) environmental impacts from renewable energy projects and focusses on technological and institutional factors. From this analysis three logical experiments are derived. One citizen experiment incorporates all technical characteristics of wind and solar energy farms. The consumer experiment assesses the same attributes, but includes a cost attribute. Besides this a second citizen experiment an institutional characteristic.

2.2 Survey design

The survey design follows specific steps in order to gather the data to analyze trade-offs/choices of individuals. Such data can be gathered through the method of choice modeling. The study constructs three choice modeling surveys. These surveys will each address a slightly different part of the main goal of the research.

2.2.1 Stated choice versus revealed preferences

There are many choice model methods and techniques that allow gathering data on non-market goods and services. These various techniques are typically split according to whether they are revealed or stated preference methods (Cook et al., 2016). Figure 3 is directly extracted from Cook et al. 2016 and shows an overview of the different revealed and stated preference methods.

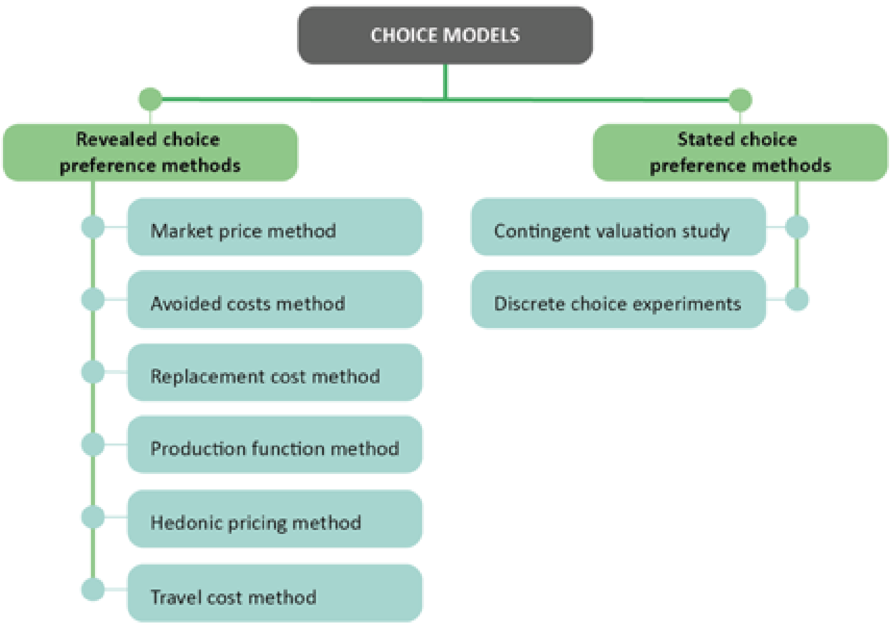


Figure 3: Overview of preference methods to value environmental non-market goods and services

Revealed preference methods assume that actual preferences from individuals can be derived from direct observations and responses from individuals to complement or substitute goods. So, the gathered data is based on what an individual did in a specific situation. Contrarily, stated preference is based on the individual's reaction to hypothetical situations. So, the individual indicates what they would choose in a situation (Cook et al., 2016). For instance, an individual may be confronted with hypothetical changes in environmental quality (i.e. noise hinder or no noise hinder) or the quantity (amount of hectares recreational area) of the landscape.

Ideally, revealed preference methods are chosen, since stated preference methods do not estimate real income decrease and could lead to socially desirable answers. However, revealed preference data is often not available. Stated preference methods are a more practical alternative to revealed preference. For instance, an advantage of the use of stated preference methods like the contingent valuation method (CVM) or the discrete choice experiment (DCE) is that the data can be collected through a survey which can be distributed easily. Therefore, this study focuses on stated preference methods.

The CVM and the DCE method are both generally based on random utility theory and assume that individuals behave in a rational and utility maximizing way. The CVM has been the most frequently used non-market valuation method to estimate the benefits of environmental goods and services (Jin et al., 2006; Mitchel and Carson 1989). Respondents are asked to put a single value (specific price) on a decrease or increase of the quantity and quality of an environmental effect. However, this method is considered less suitable for situations when multiple options and attributes are considered (Stevens et al, 2000). The discrete choice experiment method is a relatively new non-market valuation method that specifically allows the analyst to identify trade-offs individuals make between attributes or alternatives. Yin et al. (2006) found that researchers have found positive results for the use of CE in the valuation of environmental goods and services. An advantage of DCE over CVM is that DCE is less dependent on the accuracy and completeness of the description of the good or service (Boxall et al., 1996). Instead, the focus is put on the accuracy and completeness of the attributes (characteristics) that are used to describe the situation. Therefore, respondents are asked about a set of events rather than one specific event. This is a more experimental approach, where packages of attributes represent different states of the environment. The choice of the individual reflects a trade-off of a respondent. These advantages are in line with the main goal of this research, which focuses on eliciting preferences of individuals who trade-off different non-market goods and services. This indicates adopting the DCE method. Moreover, A brief review purports that transport literature that aims to elicit citizen preferences, have also opted for the DCE method. An overview can be seen in Table 2. Therefore, the survey design follows the methodology of the design of a DCE.

Table 2: Overview of modelling approach citizen-based DCE

Author	Modelling approach
Mouter & Chorus (2016)	Discrete (stated) choice experiments
Mouter et al. (2016)	Discrete (stated) choice experiments
Mouter et al. (2017)	Discrete (stated) choice experiments

2.2.2 Design explanation: attributes, alternatives, attribute levels

The design of a discrete choice model survey requires the design of multiple elements: attributes, attribute levels, alternatives and the choice question. The choice question that is answered is: '*which alternative would you prefer?*'. The attributes are the selected non-market environmental goods and services and the alternatives are a (labeled) combination of these factors. Table 3 shows a generic set-up of a choice that is presented to a respondent. The next step of this research is to decide what combinations of these attributes (choice sets) are presented to respondents.

Table 3: Set-up choice set

Alternative A	Alternative B
Environmental good A1	Environmental good B1
Environmental good A2	Environmental good B2
Environmental good A3	Environmental good B3
Environmental good A4	Environmental good B4

Which alternative would you prefer?

Alternative A: 0 *Alternative B: 0*

Every respondent answers a series of such choice sets, with different values for the different attributes. The next step of the design phase is to determine what and the amount of choice sets will be stacked together for a single respondent to answer. This thesis adopts a two-staged D-efficient design approach.

2.2.3 Two-staged D-efficient design

A two-staged D-efficient design approach is selected. The first stage entices the design of an orthogonal experimental to generate a pilot study. The advantage of an orthogonal design is that no prior information on the utility parameters are necessary. This is important since there is no prior information available in literature on citizen preferences. The orthogonal design is estimated with the Ngene software program (ChoiceMetrics, 2012). The pilot study provides insight into the understandability of the study, the ranges of the attributes and general choice behavior. This may help to improve the survey. Furthermore, model estimates can derive attribute utility parameters, which can be inserted as prior values in the final D-efficient survey design.

The goal of an efficient design is to generate a series of choice sets that results in the maximum amount of information. A consequential advantages is that this leads to a relative short survey because useless choice sets (that provide no additional information) are omitted in the efficient design procedure. This reduces respondent fatigue and ultimately improves the data.

Three experimental designs are generated. The designs are similar in prior use, number of levels, choice situations and attribute ranges to improve the comparability of the results across surveys. from these three surveys, difference between the three designs are kept to a minimum.

2.3 Data analysis

The generated data is analyzed and estimated in order to obtain relevant empirical insights. There are a range of choice models that can be used to estimate the data. These are discussed below.

As a start, a brief review of the aforementioned citizen preference estimation studies shows that so far, mostly multinomial logit models (MNL), mixed logit models (ML) and latent class analyses (LCA) are used to estimate citizen preferences. Table 4 shows an overview of these studies and the used choice models.

Table 4: Overview of estimation models used in citizen based DCE

Author	Modelling approach	Model estimations
Mouter & Chorus (2016)	Discrete (stated) choice experiments	MNL model (attempt for ML model)
Mouter et al. (2016)	Discrete choice modelling methodology	MNL model and Mixed Logit model
Mouter et al. (2017)	Discrete choice methodology	MNL model and latent class analysis

Next, a review of the choice model use in some studies that elicit consumer preferences for renewable energy technologies is used as a cross-reference. Table 5 below shows the estimation models used in several renewable energy technology choice experiments.

Table 5: Estimation models used in consumer-based choice experiments

Author	Modelling approach	Model estimations
Bergmann et al. (2006)	Choice experiment	MNL model
Bergmann et al. (2008)	Choice experiment	Random Parameter Logit (RPL) is a generalization of the Conditional Logit model
O'Keeffe (2014)	Stated choice experiment	Mixed Multinomial Logit model (also called Mixed Logit model) to include heterogeneity of preferences
Ku et al (2010)	Choice experiments	Multinomial Probit
Longo (2008)	Stated choice experiment	Conditional logit model/ Random parameter logit model
Vecchiato & Tempesta (2015)	Stated choice experiment	MNL and Random Parameter Logit
Brennan and Rensburg (2016)	Stated choice experiment	MNL and Random Parameter Logit

This overview shows that there is more variety in the use of choice models for consumer preferences of renewable energy technologies. However, similarly to the citizen experiments, consumer-based choice experiments for renewable energy technologies often adopt MNL and ML models.

The findings are linked to the main objective of this study to determine the type of choice models used for this study. Denote that this is the first study that attempts to estimate both citizen as well as consumer preferences. Therefore, this study limits generating empirical insights in the differences between citizen and consumers preferences for main effects, within the research context. The Multinomial Logit model is an efficient and relative simple model to estimate such main effects. The underlying assumptions of this methods as well as the underlying model estimation theory are discussed in the following sections.

2.3.1 Model assumptions

The MNL model can be underlined by different choice model theories. However, generally the following two theoretical assumptions are used: Lancaster's theory of value and the Random Utility Theorem (RUT). The first building block is Lancaster's theory of value. Lancaster (1966) stressed that the utility an individual derives from a good originates from the characteristics of that good, not from consumption of the good itself. Goods normally possess multiple (shared) characteristics (attributes). Lancaster asserts that the value of a good is given by the sum of the value of the characteristics.

The second building block addresses this "utility" in the Random Utility Theory (RUT) (Manski, 1977; McFadden, 1974). The "utility" is an expression of an individual's preference for a good or service. The amount of utility is represented by a relative and abstract numerical value, which cannot be observed or measured by itself. On the one hand, satisfaction and happiness towards a specific alternative (attribute) will be translated into a positive utility, whereas dissatisfaction will be expressed as a negative utility. Next to this, an underlying assumption is that every individual is rationally maximizing utility; each individual chooses an alternative that gives the largest relative utility. Furthermore, RUT states that it is difficult to completely describe any good in terms of the observable units. From the point of view of the analyst, there will always be an unobserved component of the attribute which may provide utility to the good as perceived by a respondent. Manski (1977) provides four different sources for this uncertainty: unobserved alternative attributes, unobserved individual characteristics, measurement errors and proxy variables.

The RUT addresses this problem and states that the direct utility function of a person is decomposed into an observable deterministic part (V) and an unobservable, non-deterministic part, modelled as the stochastic variable (ε). The key elements of a RUM-choice model are:

- Alternatives (wind, solar pv) i,j
- Attributes (time, cost) X
- Tastes/weights (to be estimated) β
- Randomness ε
- Decision rule (linear additive)

Then, the utility U_{iq} that individual q associates with alternative $i \in C_q$ where C_q is the set of available alternatives for individual q, is given by:

$$U_{iq} = V_{iq} + \varepsilon_{iq}, \forall i \in C_q,$$

where the deterministic observed part V_{iq} is described by a function $f(\beta, X_{iq})$, where β is a vector of taste parameters and X_{iq} for alternative *i* that can be observed or measured (like price, time). Furthermore, the deterministic part of the utility function can include socio-demographic attributes of decision-maker *q* (like gender/income). The non-deterministic non-observable part of the utility function ε_{iq} is assumed to follow a specific random probability distribution.

Since choice behaviour can be very complex, probability is used to take stochastic component of decisions into account (Train, 2003). This probability is expressed as:

$$P(i \mid C_q) = P\left[U_{iq} \geq U_{jq}\ \forall j \in C_q\right],$$

for all j options in choice set Cn. It is important to realize that only the differences between the utilities are relevant and not the utilities themselves. From this, the equation is rewritten to:

$$P(i \mid C_q) = P\left[U_{iq} - U_{jq} \geq 0\ \forall j \in C_q\right],$$

A decision about the function $f(\beta, X_{iq})$ and random variable ε_{iq} has to be made when this theory of utility maximizing is applied to the problem of renewable energy technology choices. In this research, every alternative i represents a type of technology. The different choice models that can be constructed for citizen's preferences are discussed in the next paragraphs.

2.3.2 Multinomial Logit model

The Multinomial Logit Model (MNL) is the simplest and most used discrete choice model. This model helps to estimate coefficients that make the 'tastes' of both citizens and consumers explicit. The model has a logit structure, based on two major assumptions: the perceived attractiveness of the alternatives are mutually independent and random variables are identically Gumbel distributed (Bovy, Bliemer, & van Nes, 2006). This leads to the use of multinomial (sometimes called conditional) logit (MNL) models to determine the probabilities of choosing i over j options (Hanley et al., 2001):

$$P_{iq} = P\ (i \mid C_q) = \frac{e^{V_{iq}}}{\sum_{j \in C_q} e^{V_{iq}})}$$

The simple mathematical structure and the ease of estimation has made the MNL so widely used since the 1970s. However, some assumptions about the error term ε have led to the development of more extensive/flexible models. The most important one is that in the MNL it is assumed that error terms are independent and identically Gumbel distributed, which results in the Independence from Irrelevant Alternatives (IIA) property. Antonini (2005) formulated this property as follows: "The ratio of the choice probabilities for two alternatives is not affected by the systematic utilities of the other alternatives" (Antonini, 2005).

2.4 Conclusion & Study Structure

In order to reach the sub goals, specific research steps are followed. First the exact scope of the research is conceptualized through several literature studies and expert consults. The output of this phase is a citizen and consumer definition (chapter 3) and selected relevant attributes (chapter 4). The next step is to design three final surveys that will generate data for the analysis (chapter 5). A two-staged D-efficient design approach is adopted. A pilot study is conducted to gain insight in the respondent's perception of the survey, derive possible improvements and estimate parameter utilities for the main effects. The analysis of the survey data entices a quantitative analysis of descriptive results (chapter 6) and MNL model estimations of the main effects for all three experiments (chapter 7). The model estimates are interpreted and compared to gain insights in differences. The implications of these insights for environmental valuation are explored and discussed (chapter 8). Finally, the main conclusions are posited to assess if the main objective is reached. Furthermore, limitations of this study are discussed and scientific and societal recommendations are formulated. The study structure is visualized in Figure 4.

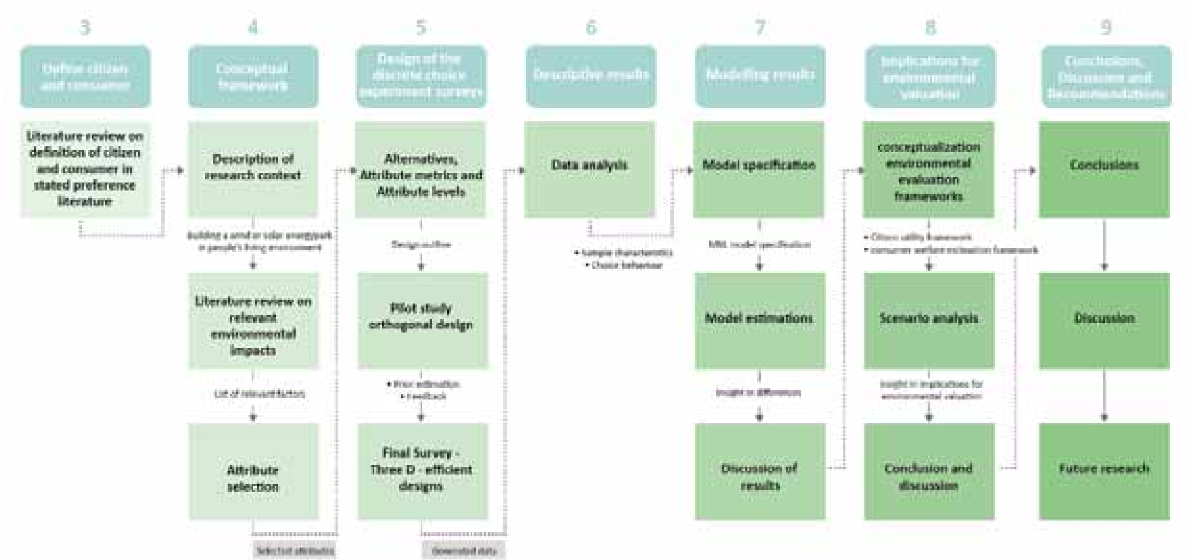


Figure 4. Study structure

3 STATE OF THE ART ON THE CITIZEN-CONSUMER DUALITY

3 State of the art on the citizen-consumer duality

This chapter reviews a selection of stated preference studies and aims to "*define the concepts of consumer and citizen, based on stated preference literature".* Section 3.1 introduces the scientific discussion on whether the role of an individual influences their trade-offs of non-market environmental goods and services. Within this discussion, two main conceptualizations of the citizen-consumer duality are identified. Section 3.2 outlines the first conceptualization that regards the citizen as an ethical consumer. Section 3.3 discusses the second conceptualization where a citizen is a tax allocating individual. Section 3.4 compares both approaches. Section 3.5 concludes the chapter and adopts the definitions that are used in this study.

3.1 Introduction

The stated preference methods used to value non-market goods are the contingent valuation method (CVM) and the discrete choice experiments (DCE), as stated in section 2.2.1. These type of studies are reviewed in this chapter. More CVM studies are reviewed than DCE since, CVM has been the status-quo in the valuation of non-market (environmental) goods and services for a couple of decades.

In this field, there has been an ongoing discussion on what Vanhonacker et al. (2007) labeled the consumer-citizen duality. The remainder of this section predominantly draws from the literature review from Tienhaara et al. (2014) that discusses this ongoing debate in the non-market valuation literature. The basis of the discussion is formed around the debate whether respondents behave as consumers or citizens in stated preference surveys and whether their willingness to pay (WTP) responses differ depending on these different roles (e.g. Alphonce et al., 2014; Howley et al., 2010; Ovaskainen & Kniivilä, 2005).

With this as a starting point, scholars indicate two different motivations for possible differences between a citizen and a consumer. Prevailing literature considers a citizen as an ethical consumer in a market-setting, bases their preference on *some notion of responsibility (Homo Politicus)*. For instance, Blamey et al. (1995) states that an imperative assumption of the contingent valuation method (CVM) is that responses can be interpreted as consumer preferences. They denote that WTP can also be caused by ethical concerns which goes beyond what a consumer considers. In line with this, Sagoff (1988) states that individuals can act as either a citizen or a consumer, and when facing ethically difficult decisions, they act as citizens. On the other hand, Nyborg (2000) has stated that it is easier for a respondent to behave as a consumer when requested to assess market goods, but when asked to value issues such as biodiversity conservation, it might be more natural to take the citizen point of view. This implies that in many valuation studies, respondents act more like citizens expressing social or political judgments rather than preferences over consumption bundles. Mouter & Chorus (2016) specifiy this and conclude that the citizen makes decisions in a political setting facing taxpayer decisions (versus purchasing decisions of the consumer). In the next sections, both approaches are discussed. Then, a definition of an individual in a role as consumer and as a citizen is determined.

3.2 Conceptualization 1: Individual in a market setting: citizen as an ethical consumer

3.2.1 Theoretical difference between consumer and citizen

The first conceptualization of the consumer-citizen duality in stated preference literature makes a distinction between a 'self-interested' individual and an 'other-regarding' individual. The latter is the citizen, also called an 'ethical observer', "*who judges matters from society's point of view*". The formalization of this version of a citizen is provided by Nyborg (2000, p305).

Nyborg (2000) formalizes the foundation of this conceptualization by making a distinction between consumer and citizen, or *Homo Economicus* and *Homo Politicus* within the neoclassical welfare economics domain. The formal model of Nyborg (2000) designates different preference functions to these two distinct roles. A consumer, *Homo Economicus*, who maximizes his own well-being and his preference, is expressed in a personal well-being function. A citizen, *Homo Politicus* aims to maximize social welfare, which is expressed in a subjective social welfare function. Nyborg (2000) further demarcates her conceptualization of the citizen/*Homo Politicus* by making a distinction between a *Homo Politicus* with sole responsibility and with shared responsibility. Here, a citizen considers what is best for society and determines the amount of their personal budget they are willing to pay for this issue. The citizen is a person who interprets valuation questions as: "*What is the maximum amount I find it socially right for everybody to pay, in order to ensure this project*?" (Nyborg, 2000, p311).

The *Homo Politicus* formalization is often interpreted by scholars as an ethical consumer. McShane & Sabadoz (2015) extensively elaborate on the origin of the concept of ethical consumerism. McShane & Sabadoz (2015) explain that the ethical consumer is concerned with broader human interests (e.g. environmental impact, community building, human rights) and expresses them in marketplace transactions. Essentially, the individual expresses their citizenship role as a consumer who can make choices in the marketplace either as primary goal or in conjunction with material pursuits. For instance, McShane & Sabadoz (2015) denote, the people's growing concern about the environment and rising gas prices voiced in the media have led to consumers demanding alternatives to the in the US popular gas guzzling SUVs. In response, they now have ecofriendly alternatives, like the Toyota Prius. In ethical consumerism, social attributes are traded off just as the many products attributes.

The next subsection will discuss empirical stated preference studies that have adopted this formalized definition of a citizen.

3.2.2 Empirical approach to citizen and consumer in stated preference methods

There are plenty of contingent valuation studies that derive their definition from Nyborg (2000) and label the citizen as an ethical consumer in a market setting.

For instance, Howley et al. (2010) constructed a referendum-style CV survey on the valuation of landscape attributes and defined the citizen as an individual that takes into account benefits to others as opposed to a consumer, who is a purely self-interested individual. The aim of this research is to assess to what extent individuals express different preferences, expressed in individual WTP, when adopting a social (citizen) or personal perspective (consumer). This difference in perspective was achieved through a small change in the valuation question. In order to move respondents to the personal individual ((self-interested consumer) the following question was asked (Howley et al., 2010, p1526):

> *"Bearing in mind* ***the importance or unimportance*** *of conserving traditional landscapes* ***for you personally****; if you could be sure that your money would go to landowners for protecting traditional rural landscapes in Ireland only,* ***would you be prepared to pay*** *to support agricultural activities contributing to the protection of the traditional farm landscape as portrayed in Showcard 11."*

The key terms in this valuation question in bold form the essence of the valuation question: elicit the self-interested preferences through the measurement of the WTP from their *private income* to support agricultural activities. The valuation question for the social individual (citizen) was changed from this to (Howley et al. 2010, p. 1526):

> "*Bearing in mind* ***the importance or unimportance*** *of conserving traditional landscapes* ***for society as a whole****"….."****would you be prepared to pay*** *to support…."*

In this valuation question the respondent adopts a social perspective by eliciting their WTP from their private income considering the importance of traditional landscape for society. We can see that the experiment is explicitly set up in a market setting (asking individual WTP) and asks respondents to make a tradeoff between their after-tax income (private budget) and landscape conservation. Interestingly, the study concludes that this does not yield a significant difference in WTP for personal consumers or social citizens.

Similarly, Curtis and McConnell (2002) concluded from their contingent valuation study on the control of deer population in the USA that the WTP for citizen (as explained by Blamey et al) and an altruistic consumer are indistinguishable. Based on these findings, Ovaskainen & Kniivilä (2005) define for their valuation study of a conservation issue in Finland citizen as synonymous to consumer preferences with altruism.

3.2.3 Summary first conceptualization

To summarize, we have discussed the definition of consumer and citizen according to the first conceptualization in stated preference literature. A consumer is an individual in a market setting revealing their individual WTP when considering benefits to themselves. A citizen is an individual in a market setting who reveals their individual WTP when considering benefits to society as a whole. Table 6 sums up these findings. The next section discusses the second conceptualization of the consumer-citizen duality debate.

Table 6: Examples of of the citizen as an ethical consumer in (stated preference) literature

	Consumer: Homo Economicus (s.i. welfare)	**Citizen:** Ethical consumer (Welfare for society)
Market setting revealing indiv. WTP	← Howley et al (2010) Ovaskainen & Kniivilä (2005) Curtis & McConnell (2002) →	

3.3 Conceptualization 2: Individual in a political setting: citizen allocating tax money

3.3.1 Theoretical difference between consumer and citizen

The second conceptualization distinguishes itself from the first in two ways. The first distinction is the fact that the citizen is taken out of the market setting into the political setting. The second distinction is that as a result, a citizen is not making a purchasing decision (with their private income) but a taxpayers decision (allocating tax money).

Within the consumer-citizen duality debate, a whole body of studies build on this conceptualization. Amongst others (Tienhaara et al., (2014); Orr et al., (2007)) Blamey et al., (1995) identify a *citizen as an individual expressing social or political judgments rather than preferences over consumption bundles.* This fundamental difference is summarized by Orr (2007, p109) in terms of type of motivation, proper forum, view of the good and source of public decision-making. The comparison of this citizen and consumer frame can be seen in Table 7.

Table 7: Issues for citizen and consumer frames, extracted/copied from Orr (2007, p109)

	Frame	
Issue	**Citizen**	**Consumer**
Type of motivation	Reasons, values, attitudes	Preferences, desires
Proper forum	Politics	The market or market-like mechanisms
View of the good	The public interest The common good	Satisfying individual preferences (utilitarianism)
Source of public-decision making	Offering good reasons Deliberating about right answers Expressing attitudes	Eliciting and aggregating individual preferences

These scholars argue that an individuals' different roles in a consumption/market setting or a political setting induces different preferences. A recent example that demonstrates this is the 2008 ballot proposition in California on animal welfare. Californians voted massively in support of a proposition prohibiting battery-farm-produced eggs, which at the time of the vote were the most popular type of eggs purchased and consumed in California (Norwood & Lusk, 2011).

Furthermore, as another example, Hardin (1982) points out the enormous divergence between the number of Americans who profess their concern for environmental issues (over 100 million) and the number of Americans who actually contribute to environmental organizations (about one million). Even the one percent contributing very low sums to further their desired goals, around $10 per person, per year on average. The divergence with respect to other honored causes, such as civil rights, women's movements, and control is even more dramatic.

The study from Howley et al. (2010) finds a clue for these different preferences by citizens in a political setting and consumers in a market setting. In their research on the WTP of individuals on landscape conservation, a major reason proposed by people that do not display a WTP (in both consumer as ethical person/citizen) is because they believe *the government should pay from* ***existing*** *revenue*. Similarly, in a CV study on wildlife preservation by Stevens (1991) 40% of people who refused to pay said that the *money should come from taxes or license* fees.

Indeed, an earlier theoretical contribution from Kohn (1993) provides a theoretical basis in line with these results. The author derives separate functions to elicit both a statement of the desirable level of public spending *and* a statement of individual willingness to pay for consumption benefits for habitat preservation.

Rolfe (1996) builds on this and concludes that the differences between a consumer and a citizen come from the different incentives in a market-based consumption choice and a political voting setting. In a market-based consumption choice, the costs and benefits directly accrue to the individual, since it impacts their personal income budget (also Mouter & Chorus, 2016). On the contrary, people may feel relieved of *their personal budget constraint* in a referendum (and may even perceive the choice being based on a limitless *public* purse).

These examples not only give a feeling for the plausibility of varying consumer and citizen preferences in their different settings, but also introduce the key distinction based on budgets: *private and public budget spending*.

Following this line of argument, we can identify research with two distinct interpretations of the separation of private and public budget as core difference between consumer and citizen. Here, one interpretation puts the respondent in a taxpayer role, but still makes them tradeoff their own income. In this case, the researchers actually elicit the individuals willingness to pay, in the form of a tax. This can be called an ex-ante taxpayer decision, where the individual the allocation of tax before they contribute their own taxes. The other interpretation truly separates the private (personal) income from the public budget. Here, the study finds a citizen's preference on previously collected tax money and lets the respondent tradeoff a (limited) public budget with specific effects. This can be called an ex-post taxpayer decision, where taxpayers decide on the allocation of tax money *after* they have paid their tax. The use of these two different taxpayer roles in empirical stated preference studies is discussed in the following sections.

3.3.2 Citizen as ex-ante taxpayer

Several CV studies have conducted experiments where the distinction between a consumer and a citizen is defined as follows: a consumer forms preferences in a market setting, making purchasing decisions from their personal income. A citizen forms preferences in a political setting making taxpayer decisions from their personal income.

For instance, Martinez-Espineira (2006) concludes that *"a citizen perspective can be induced when there is a dichotomous choice procedure based on referenda using* ***taxes as payment vehicle.*** They induce a citizen perspective by asking the following question:

"If farmers were to be compensated for the loss of livestock to coyotes and a compulsory tax were imposed on all PEI residents to fund the conservation of coyotes, how much would you say would be a reasonable annual contribution?"

The responses from this question could be used to estimate what citizens think the government should consider when making decisions about coyote conservation. However, the respondents consider what additional mandatory tax would be reasonable and therefore this does still impact the persons private budget (after-tax income).

Similarly, Tienhaara et al. (2014), focuses on examining how the citizen and consumer roles are emphasized in two different contexts: **a purchasing decision** (of a native breed product) and **a taxpayer decision** (of a conservation program of agricultural genetic resources). They found a willingness to pay tax for the conservation program (€48) and a willingness to pay a product price premium of 14%. They elicited preferences for the conservation program through an increase of income tax during a future ten-year period (2012-2021).

Thus, while both studies divide consumer and citizen preferences through purchasing and taxpayers decisions, they do not alleviate the tradeoff between an effect and an individual's personal budget. The studies suggest increasing future taxes, which affects their personal budget. We conclude that the authors elicit values we interpret as a willingness to be taxed in a 'ex-ante' taxpayer decision. This distinction is presented in Table 8.

Table 8: Examples of the citizen as an ex-ante tacpayer in (stated preference) literature

Consumer: Market setting	**Consumer decision:** Preferences individuals reveal with their after tax income on their willingness to be pay	Martinez-Espineira (2006) Tienhaara et al (2014)
Citizen: Political setting	**Ex-ante taxpayer decision:** preferences individuals reveal with their after tax income on their willingness to be taxed	

3.3.3 Citizen as ex-post taxpayer

The second interpretation (of the second conceptualization) asks individuals how to allocate *previously* collected tax money. This truly disconnects trading-off the private budget and induces decisions between effects and public budget.

Recent studies (Mouter & Chorus, 2016; Mouter et al. 2016) have in fact designed experiments eliciting citizen preferences on government tax money spending without asking respondents to tradeoff their private budget. They established that citizen preferences can be derived from stated choice experiments where respondents are asked to tradeoff policy alternatives *when the after tax income of the individual is not directly affected.* They conclude that the experiments in their study would have been 'consumer experiments' if they would have included attributes that affect an individual's "*after tax income"* or have a "*one-time increase in taxes included*".

Within this context, for instance, Mouter et al. (2016) find that consumers and citizens have different preferences when trading off travel time and safety. Moreover, Mouter & Chorus (2016) found that an individual's WTP from previously collected tax money is *statistically significant* higher than their WTP from their after-tax income. Table 9 shows an overview of (stated preference) studies that adopt this conceptualization.

Table 9: Examples of the citizen as an ex-post taxpayer in (stated preference) literature

Consumer: Market setting	**Consumer decision:** Preferences individuals reveal with their after tax income on their willingness to be pay	↑ Kohn et al (1993) Blamey et al (1995) Rolfe (1996) Mouter et al. (2016) Mouter & Chorus (2016) ↓
Citizen: Political setting	**Ex-post taxpayer decision:** preferences individuals reveal on the allocation of previously collected tax money by the government	

3.3.4 Summary second conceptualization

In this section, two conceptually different interpretations of the definition: *consumers make purchasing decisions in a market setting, whereas citizens make taxpayers' decisions in a political setting* were discussed. The first elicits an individual's willingness to be taxed from their private income. The second interpretations purports that an individual is a citizen when the trade-offs are about the public budget and decoupled from their (after-tax) private income. This is summarized in Table 10.

Table 10: Overview of second conceptualization: citizen as an ex-ante or ex-post taxpayer

Consumer: Market setting	**Consumer decision:** Preferences individuals reveal with their after-tax income on their willingness to be pay	↑ Martinez-Espineira (2006)
Citizen: Political setting	**Ex-ante taxpayer decision:** preferences individuals reveal with their after-tax income on their willingness to be taxed	Tienhaara et al (2014) ↓ ↑ Kohn et al (1993) Blamey et al (1995) Rolfe (1996)
	Ex-post taxpayer decision: preferences individuals reveal on the allocation of previously collected tax money by the government	Mouter et al. (2016) Mouter & Chorus (2016) ↓

3.4 Discussion

This chapter discussed two conceptualizations of the consumer-citizen duality. The first separates consumers and citizens on the basis of self-interested and other regarding preferences from individuals. The second categorizes them on the basis of the preference towards private or public budget spending. Within this second conceptualization we have discussed two different interpretations and have argued that one truly separates preferences for public (citizen) budgets when individuals consider previously collected tax money. Several issues point towards the selection of a definition for this thesis.

The analysis in this chapter derives that the primary difference between consumers and citizens is preferences for different budget: private or public budgets. From here several inferences can be made. First, denote that the definition purported in the first conceptualization (self-interested or other-regarding individuals) does not adhere to this distinction. Both the self-interested individual and the other-regarding (ethical) individual elicit preferences from their (after-tax) budget spending. For instance, an individual may buy cheap electricity generated buy a coal-fired power plants, without considering the health and climate impacts it has. An other-regarding individual may have a wind farm electricity contract because he thinks it is better for society.

Second, observe a similar comparison can be made for the ex-ante taxpayer formalization. Despite being in a political setting, the tax increase is inferred ex-ante and will reduce their after-tax private budget. The individual trade-offs their after-tax budget, just to a different payment vehicle. Furthermore, the ex-ante taxpaying individual may also be self-interested or other-regarding.

In contrast, the interpretation of Mouter & Chorus (2016) truly separates private and public budget allocating. Denote that individuals allocating previously collected tax money may still have self-interested or other-regarding motivations. For instance, an individual protests against the construction of a government financed wind energy farm in their neighborhood, while being aware of the potential reductions in greenhouse gas emissions. Furthermore, an individual could prefer that the government allocates previously collected tax money to projects that benefit society the most, without personal benefits. Table 11 highlights these different roles.

Table 11: Different roles of a consumer and citizen in line with Mouter et al. (2016)

Consumer: Preferences individuals reveal with their after-tax income on their willingness to be pay	**Self-interest consumer:** An individual buys cheap electricity generated by a coal fired power plants, without considering the health and climate impacts it has	**Ethical consumer:** An individual has wind farm electricity contract because he thinks it is better for society.
Citizen: preferences individuals reveal on the allocation of previously collected tax money by the government	**Self-interested Citizen:** An individual protests against the construction of a government financed wind energy farm in their neighborhood, while being aware of the potential reductions in greenhouse gas emissions	**Ethical citizen:** An individual prefers that the government allocates previously collected tax money to projects that benefit society the most, without personal benefits

This categorization corroborates with the findings from Lewinsohn-Zamir (1998) who contends that **both** private and public settings of preferences are a mix of self-centered and other-regarding preferences. Furthermore, Tienhaara (2014) finds that respondents do not only act either as an ethical consumer considering social welfare in public policy contexts or only as self-interested consumers in purchasing decision contexts. They find that individuals exhibit both considerations.

The insights from the discussion direct to the selection of a definition for the citizen and the consumer. The definition of a citizen is an individual in a political setting, making ex-post tax-payer decisions. This definitions adheres to the fundamental criterion that a citizen preferences are decoupled from (after-tax) private budget spending. In line with this, individuals spending their (after tax) private budget to tax increases are defined as consumers making ex-ante tax-paying decisions. Finally, an individual allocating their (after-tax) private budget in market setting is defined as making consumer decisions.

3.5 Conclusion: research goal and summarizing table

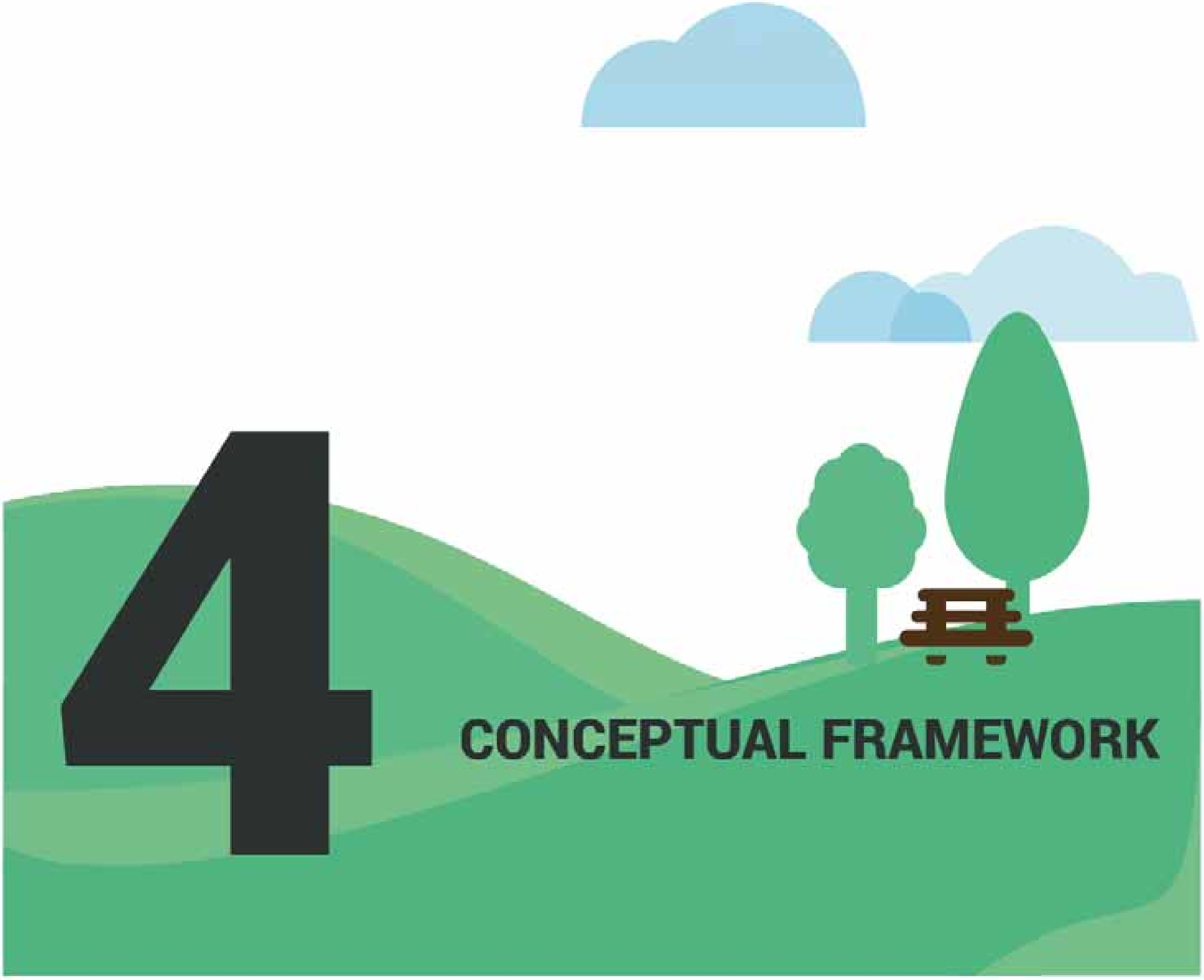
The goal of this chapter is to define the concepts of “citizen” and “consumer” based on existing definitions in stated preference literature. We have seen that literature on the consumer-citizen duality formulate two distinct conceptualizations.

This thesis adopts the following definition: a consumer is an individual who reveals preferences on spending their personal budget in a market setting. A citizen is an individual who reveals preferences in a political setting on the allocation of (previously collected) tax money by the government. This conceptualization elegantly deals with the problems from the first conceptualization by acknowledging that preferences may be composed of self-interested and/or other-regarding benefits. Following this, we conclude this chapter by depicting these findings in Table 12.

Table 12 Overview of literature study on consumer and citizen definitions

		Homo Economicus **(self-interested)**	Homo Politicus **(other-regarding)**
Consumer: Market setting	**Consumer decision:** Preferences individuals reveal with their after-tax income on their willingness to be pay	← Howley et al (2010) Ovaskainen & Kniivilä (2005) Curtis & McConnell (2002) →	
Consumer: Political setting	**Ex-ante taxpayer decision:** preferences individuals reveal with their after-tax income on their willingness to be taxed		Martinez-Espineira (2006) Tienhaara et al (2014)
Citizen: Political setting	**Ex-post taxpayer decision:** preferences individuals reveal on the allocation of previously collected tax money by the government	Kohn et al (1993) Blamey et al (1995) Rolfe (1996) Mouter et al. (2016) Mouter & Chorus (2016)	

Figure 5: Definition citizen and consumer



4 CONCEPTUAL FRAMEWORK

4 Conceptual framework

This chapter outlines the conceptual framework and aims to *select relevant factors that influence an individual's preference for a wind or solar energy farm* (sub-research goal c). Section 4.1 provides a context description to demarcate the research focus. Next, section 4.2 reviews stated preference literature to identify relevant factors that influence an individual's preference for wind energy and solar energy technologies. Section 4.3 highlights the steps towards the selection of relevant factors in order to create the attributes. First the selection process is explained, second the attribute quantification is explained. The chapter concludes in section 4.4 with an overview of all quantified attributes which is the input for the experimental design of surveys, described in chapter 5.

4.1 Context description

The Dutch government aims to transition towards a low-carbon electricity supply in 2050. In order to achieve this, the SDE+ subsidy scheme finances renewable energy infrastructure projects to increase the capacity of low-carbon electricity supply. A large portion is of the subsidy fund is reserved to finance large wind energy farm projects. In fact, the government prescribes an increase in onshore wind energy farm capacity from 2500 MW in 2015 to 6000 MW in 2020. In order to achieve this, the 'Rijksoverheid' has mandated and coordinates the construction of 11 large (100 + MW) on-shore wind energy farms on (economically) 'ideal' locations (Ministry of Economic Affairs, 2015). Furthermore, provincial agreements prescribe the construction sites of smaller (5MW-100MW) wind energy farms (RVO, 2017).

The 'Monitor Wind op Land' (RVO, 2017) outlines the yearly progress of wind energy farm construction, The study shows that the Netherlands has an installed capacity of 3300 MW, which means that 2700 MW still needs to be constructed in the next three years. However, the study denotes that the construction of 1400 MW from this 2700 MW is uncertain and potentially at risk. One of the reasons put forward is the lack of public acceptance due to the environmental impacts, like noise and visual hinder. The study acknowledges that in some cases, forcing current wind energy projects may have a counter-productive effect on the public acceptance. Therefore, other options like offshore wind or solar energy could be evaluated. This assumption is confirmed by Langler et al. (2017) and Kaldellis et al. (2013) who pose that environmental impacts (and community participation) of renewable energy technologies may indeed negatively impact the public acceptance of local communities.

In fact, an increasing amount of communities protest against the planned construction of wind energy farms in the Netherlands. An explorative study of Elzinga & Oterdoom (2015) on the construction of the planned wind farm in the Province of Drenthe highlights that residents mostly worry about two (non-market) environmental impacts: visual hinder and noise hinder. In fact, residents in this area started a foundation to fight the planned wind energy farm in Drenthe (Platform Storm). In fact, local initiatives are started to promote the building of a solar energy farm on the designated building sites (RTV1, 2017). However, residents also protest against such large renewable energy projects and worry about the visual impacts (Trouw, 2017).

This debate demonstrates a recurring issue in the integration of renewable energy farms in the Netherlands. The Netherlands is a densely populated country and therefore, construction sites of wind and solar energy farms are almost always in the public space. Thus, the landscape of the living environment of people changes. This study focuses on wind and solar energy farm siting in (open) (public) spaces. Specifically, this study looks at those non-market environmental impacts from the construction of wind and solar energy by designing discrete choice experiments. Therefore, this chapter reviews stated preference literature to identifies and select relevant factors that may influence the preferences of individuals for wind or solar energy farms. These selected factors are the input for chapter 5 that aims to design the DCE and surveys. Several different type of factors are reviewed and selected.

Section 4.1 discusses relevant physical landscape non-market goods and services that affect a person's choice for a wind or solar energy farms. Section 4.2 reviews literature on institutional and process non-market goods and services that affect a person's choice for a wind or solar energy farm.

4.2 State of the art on environmental impacts

This section aim to list relevant factors that affect an individual's preference for wind and solar energy by a review of stated preference literature. Ek and Persson (2014) conclude from their research on technological characteristics of wind energy farms that both characteristics regarding *where* a renewable energy farm is built as well as *how* it is build affects an individual's preference. Therefore, this section summarizes both relevant technological (section 4.2.1) and institutional (section 4.2.2) characteristics of wind and solar energy farms that impact the living environment and gives an overview of the characteristics in section 4.2.3.

4.2.1 Technological characteristics

The respective technological characteristics of wind (4.2.1.1) and solar (4.2.1.2 energy farms are discussed separately in the next subsections.

4.2.1.1 Wind technological characteristics

The effects of wind energy farms on the living environment of people is studied abundantly. For instance, Mattman et al., (2016) conducted a quantitative meta-analysis of 32 non-market valuation literature studies of externalities of wind power production. They deduce that the following three factors are most occurring environmental impacts of wind energy farms in their analysis: 1. visual impacts (21/32 studies), 2. biodiversity impacts (11/32) and 3. noise impacts (5/32). In the next paragraphs, the statistical significance of these three impacts is assessed.

Visual impacts

Visibility can be operationalized in various ways. Table 13 summarizes studies that incorporate visibility in their stated choice preference study and whether visibility was significant. Denote that landscape attributes are often expressed in different visual impacts. On the one hand, studies (Bergmann, 2006; Bergmann, 2008) *only* use visibility as an attribute for landscape effects and approach aspects like size of power plant and location in one qualitative variable. These studies only find a significant relation for the largest qualitative difference (from none to high visual hindrance). On the other hand, studies (O'Keeffe, 2014; Mariel, 2015; Vecchiato & Tempesta, 2015) decompose the landscape attribute in separate attributes (size, height, distance) and measure these individually. This approach mostly results in significant relations between the factor and choice of an individual.

Biodiversity impacts

Several biodiversity impacts are found in literature. Table 14 highlights stated preference studies that assess the biodiversity impacts from wind energy farms. The overview deduces that biodiversity impacts often significantly influences an individual's preference and that both qualitative expressions (Bergmann et al., 2006; Bergmann et al., 2008) as well as quantitative approaches (Ku et al., 2010; Mariel, 2015; Hoyos et al, 2015) are used.

Noise impacts

The literature is inconclusive about the impacts of noise on the living environment. In early literature, Ek (2002) finds that noise is significant on 90% confidence interval. However, it did not lead to a significant WTP (which is explained further in the next section). No other studies are found that incorporate noise impact in a stated preference study. Interestingly, while the studies presented in Mattman et al. (2016) stress the importance of noise impacts, none conduct discrete choice experiments to attest the statistical significance.

However, in more recent scientific contributions, Langer et al. (2017) concludes in their study on public preference of wind energy project in Germany that noise is the most important factor to influence the local public acceptance. This builds on papers like Kaldellis et al. (2013) who assert that noise impact is one of the main environmental impacts and often limits the development of wind energy farms.

Table 13: An overview of landscape attributes expressed in visual impacts from wind energy farms

Author	Landscape attributes label	Units	Levels	Significance
Bergmann et al (2006)	Landscape	Visual impact caused by size and location	None, low, moderate, high	Only for change from " none" to " high impact"
Bergmann et al (2008)	Landscape	Visual impact caused by size and location	None, low, moderate, high	Only for change from " none" to " high impact"
Ku et al (2010)	Landscape	% improvement compared to fossil fuel plan	0%; 25%, 50%	No
O'Keeffe (2014)	- Visibility - Action to reduce environmental impact	- Distance to energy source - Measures to reduce environmental and ecological impact.	- <10 miles and visible from house; <10 miles and *not* visible; between 10 and 20 miles and not visible - No measures taken; measures taken	- Yes - Yes, at 5% level
Mariel et al (2015)	Visibility	- Size - Height - Distance from house	- Large, 16-18 mills; medium, 10-12 mills; small, 4-6 mills - 110m; 150m; 200m - 750m; 1000m; 1500;	- Yes, for two out of three classes - No - Yes, but for one class
Brennan and Rensburg (2015)		- Number of turbines - Turbine height - Setback	- 8, 20, 40 turbines - 80m, 130m, 180m - 500m, 1000m, 1500n	- Yes, at a 1% level - Yes, at a 1% level - Yes, at a 1% level
Garcia et al (2016)	Visual impact	- Number of wind turbines	- 9, 18 wind turbines	- Yes, at a 1% level

Table 14: An overview of biodiversity impact attributes

Author	Wildlife attributes	Units	Levels	Significance
Bergmann (2006)	Wildlife	Change in habitat can influence the amount and diversity of species living around a project	Slight improvement; no impact; slight harm	Yes, at a 1% level
Bergmann (2008)	Wildlife	Change in habitat can influence the amount and diversity of species living around a project	Slight improvement; no impact; slight harm	Yes, but higher for slight improvement versus slight harm
Ku (2010)	Wildlife	% improvement in species diversity compared to fossil-fuel power plant	0%; 25%; 50%	Yes, at a 5% level
Mariel et al.(2015)	Wildlife	Red kite population	5%, 10%, 15% reduction	Yes, for all classes at a 1% level
Hoyos et al (2015)	Wildlife	Biodiversity/ number of endangered species	25, 15, 10, 5	No

Langer et al. (2017) conduct a conjoint experiment to assess the relative importance of noise. Table 15 summarized the attribute levels and gives insights into the qualification of noise levels.

Table 15: Insights in qualification of noise levels

Attribute	Description	Levels
Sound level at place of residence	The sound generated by a wind turbine and audibility at the place of residence	Not audible
		Whisper
		Common domestic background noise (e.g. refrigerator)
		Conversation

It is demonstrated that visibility, biodiversity and noise are relevant environmental impacts from wind and solar energy farms. Furthermore, it is derived that prior stated preference research more often considered visibility and biodiversity than noise.

4.2.1.2 Solar technological characteristics

This section reviews several literature studies that search for solar farm characteristics that impact the environment. The most important characteristic is the size, which can be expressed as land-use impacts.

Hernandez (2013) denotes that the disadvantageous environmental impacts of grounded utility-scale solar pv installation have not yet been carefully evaluated, or weighted against the benefits. Vecchiato & Tempesta (2015) is one of the few studies that incorporates solar PV on (agricultural) land. They research the visibility of the solar farm through the distance to residents and its size. The study showed that the attribute distance was not significant for choices and they conclude that this is in line with people believing that grounded PV power plants are not bad for the landscape. However, mind that the research area was Northern Italy and attribute levels of 1 km, 3 km and 10 km were used. In the Netherlands, solar PV plants will likely be placed closer (100-500 meters) from residential areas. However, the size of the solar PV plant was a significant factor for persons in their choice between solar, forest biomass and agricultural biomass (or none). Moreover, the respondents prefer to have small PV power plants providing a WTP of €1.06 per month. The size of grounded solar energy farms directly impact the land-use. However, no prior stated preference literature are found.

Non-academic literature elaborates more on the characteristics of solar energy farms that impact the living environment. For instance, an explorative study of the Dutch Enterprise Agency (RVO) on grounded solar energy farms indicate that per hectare a capacity of 0.8 MW can be built. RVO denotes that in rural areas, this may conflict with recreational and agricultural areas. Especially if solar energy farm intends to replace wind energy farms, future solar energy farms will be large span hundreds of hectares. For instance, CE Delft (2016) compares a large solar PV installation with an on-shore wind farm. In order to produce the same amount of electricity of as a 180 MW wind farm, the solar farm needs to have a capacity of 560 MW, installed on an area of 700 acres (7 km^2). Therefore, land use (area and type) is an imperative environmental landscape impact for future utility-scale solar pv farms.

This demonstrates that land area use is an important environmental impact of (future) solar energy farms. Furthermore, the initial function of the landscape may also be an important factor. Therefore, in order to review the operationalization of land area use in stated choice preference experiments, we focus on the land function and land are use of in stated preference studies of other renewable energy technologies outside the renewable energy domain.

Some studies only incorporate landscape *type* and do incorporate the size of the area. For instance, Ek and Persson (2014) incorporate landscape types qualitatively in their discrete choice experiment to measure consumer preferences for wind farm characteristics. They identify four relevant landscapes in their analysis: offshore, open landscape, mountainous area, forest. They found that the attribute level *mountainous* is significant and negative, whereas *offshore* is significant and positive.

More studies other than energy-related literature provide more examples of the use of landscape in discrete choice experiments. Giergiczny et al. (2015) use a qualitative attribute "forest type" to assess the recreational value of forests based on their characteristics. Forest type is defined by coniferous, broad-leaved and both. Similarly, Newell and Swallow (2013) use the qualitative attribute "character of surrounding land" to assess the real money value of forested wetlands through spatial attributes within a landscape context. For this attribute the levels woodland, residential and farmland are chosen. However, these choice experiments do not consider the size of the land area, which is a key characteristic of utility-scale solar energy. The incorporation of the area size component as an landscape attribute done is done is two ways: attributes divided per landscape type with area size levels or a separate attribute for area size and landscape type.

The first method is demonstrated by Hoyos et al. (2015) who study the effects of different land types on an individual's willingness to pay for a conservation program. Here, three land types were defined in three different attributes: native forest, vineyards, exotic plantations. The attribute level is defined as "area size" and expressed as *"% of land covered by*.." In line with this, Ayala et al. (2015) use discrete choice experiments for landscape management in the Basque area and assess four types of landscapes: intensive farming, organic farming, native forests and cemented surface. These four separate attributes have incorporated quantitative percentage land use levels. Furthermore, a separate recreational attribute is added with an ordinal scale. Some studies do not use quantitative area size metrics, but qualitative. For instance, Rambonilaza (2007) uses separate attributes for different landscape features like scrubland, hedgerows and farm buildings. For these attributes ordinal levels like: high level of reforestation, low level of reforestation, trimmed scrublands.

The second method is demonstrated by Liekens et al. (2013) who incorporate both *type* of nature as well as the *size* of the area for their research to develop a value function for nature development and land use policy in Flanders. Liekens et al (2013) includes landscape type as attribute with the levels: pioneer vegetation, mud-land and marshes, natural grassland, forests, open water, heathland and agriculture. The size of the landscape is presented in acres (10 ha, 50 ha, 100 ha and 200 ha). Liekens et al. (2013) derive the inclusion of a quantitative land size attribute on their literature study that discusses a number of studies that include the size of an area as a land characteristic. For instance, Adamowicz et al. (1994) included the size of wilderness area and restrictions on accessibility as attributes in a choice experiment on woodland programs to facilitate caribou habitat in Canada. Liekens et al (2013) finds a significant relation for the size of the developed area and the choice individuals make and a WTP of €0.05 per acre irrespective of the other attributes. However, respondents indicated that size was not the main criterion for the choice between nature areas, which is reflected in the small coefficient.

4.2.2 Institutional characteristics

Brennan and Rensburg (2016) denote in their review of choice experiment literature on local externalities from renewable energy technologies that institutional and social factors significantly affects the choice of individuals (and even public acceptance). They find that respondents are willing to make monetary trade-offs (willingness to accept) to allow wind power initiatives if the local residents are offered private compensation (through discount in their utility bill) or when a community representative is actively involved in the project.

Furthermore, Ek and Persson (2014) contend statistical significant relationships and marginal willingness to pay estimates for community participation, ownership and compensation in their discrete experiment on wind energy farm characteristics. For instance, an extended community consultation level yields in an marginal WTP of 0.32 Öre/kWh (€0.03/kWh) . Furthermore, 0.5% of benefits as community compensation earmarked for nature compensation yields a marginal WTP of 0.77 Öre/kWh (€0.09/kWh).

Besides this, Brennan and Rensburg (2016) pose other relevant institutional factors in their literature review, like community wind farm ownership, employment, benefit sharing arrangements.

Interestingly, Brennan and Rensburg (2016) concluded from their expert group discussions that while community ownership is viewed positively, there were a lot of practical implications: it could be expensive or difficult to implement. There was an unanimous consensus that enhanced community consultation through more open, transparent and unbiased information as well as more influence on the development process and better representation of their interests and needs is a key factor. This is, according to Brennan & Van Rensburg (2016) more important than ownership and could be effectively achieved through a community representative. Indeed, the introduction of a community representative in the design process lead to significant lower WTA for policy packages.

Another relevant paper outside the discrete choice literature is Langer et al. (2017), who conduct a conjoint experiment to find the relative importance of different levels of community participation. They find that transparency and information to citizens is the most preferred level of community participation. The second most preferred level is cooperation, where citizens are actively involved in the decision-making process of wind energy projects. Furthermore, they find that information is preferred over financial participation. This implies that respondents prefer the right to have their opinion in a wind energy project over potential financial profit

4.2.3 Overview of relevant factors

The previous subsections reviewed different categories of technological and institutional characteristics that may influence an individual preference (or increase their WTP for green electricity) for a wind or solar energy technology. Table 16 provides an overview of these categories and the respective reviewed factors.

Table 16: Overview of all relevant factors

Technological characteristics		Institutional characteristics
Wind energy	**Solar energy**	**Common**
Visibility - Size - Distance - Height Biodiversity Noise	Land type - Forest - Recreation - Agriculture Land area	Compensation Ownership Employment Community participation

Three experiments logically follow from this overview. The research ameliorates the knowledge gaps on how citizens trade-offs technical and institutional characteristics of renewable energy projects. Therefore, the first citizen experiment incorporates technical characteristics. A second experiment includes an institutional characteristic. To assess differences between citizens and consumers, a consumer experiment is designed.

4.3 Attribute selection

This section discusses the attribute selection for the design of the discrete choice experiment. Section 4.3.1 describes the selection process of the main characteristics that will be as attributes in the DCEs. Section 4.3.2 describes the quantification of the selected attributes.

4.3.1 Attribute selection process

This section outlines the steps in the attribute selection process. The selection of attributes is based on several criteria:

- Expected influence on an individual
- Societal relevance of the factor
- Measurability in the discrete choice experiment

Table 16 provides a list of attributes that prior research has identified as a statistically significant influence on an individual's choice. Furthermore, the literature review gives clues for possible ways to measure the attribute.

The societal relevance of these factors is discussed in several expert consults with spatial planners from research and consultancy firm Decisio BV, researchers from Delft University of Technology and (energy) policy-makers from the Ministry of Economic Affairs. As a result the attributes for the three experiments were selected. The basis experiment in the citizen experiment, that aims to elicit citizen preferences environmental impacts from wind and solar energy farms. The consumer experiment incorporates the same attributes, but adds a cost attribute to elicit consumer preferences for environmental impacts of wind and solar energy farms. Finally, the third experiment expands the citizen experiment by adding the attribute 'level of community participation'. Figure 6 shows an overview of the attributes used per experiment.

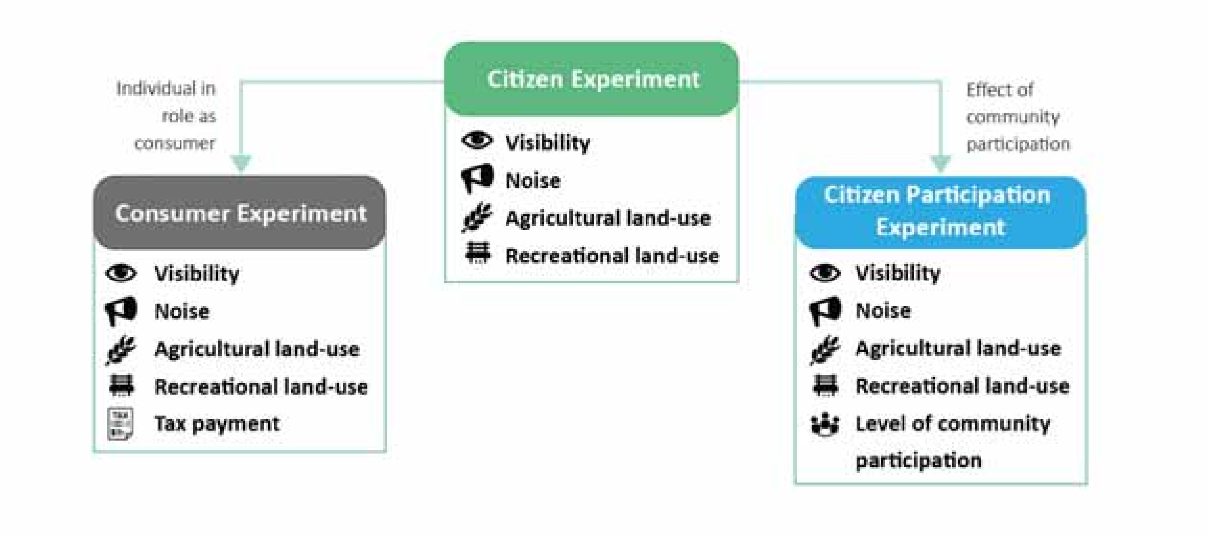


Figure 6: Overview of attributes per experiment

4.3.2 Attribute quantification

This section quantifies the selected attributes to be able to incorporate them in experimental design. First, the unit of measurement is determined in section 4.3.2.1 and then the attribute ranges are determined in 4.3.2.2.

4.3.2.1 Unit of measurement

The attribute unit of measurements follows from a brief literature study and the expert discussions with spatial planners from research and consultancy firm Decisio BV, researchers from Delft University of Technology and (energy) policy-makers from the Ministry of Economic Affairs.

First the unit of measurement of noise was based on a parallel study of citizen preferences for the environmental impacts from transport projects. Noise impact is defined as number of household with noise hinder. In line with this, it was decided to adopt similar units of measurements for visual hinder: number of households with visual hinder. As an added benefit, similar units simplifies the choice task for respondents.

The units of measurements for land-use were derived from the studies discussed in section 4.2.1.2.and shown in Table 17.

Table 17: Summary of the different units of measurements for landscape type and landscape area

Option 1:		Option 2:	
Attribute	***Metric***	***Attribute***	***Metric***
Landscape type	Agriculture, recreation, nature etc.	Area of agricultural land	% decrease
Landscape area	# hectares	Area of recreational land	% decrease

Two approaches were identified. One option separates landscape type and land area into separate attributes. The other option combines these factors; every attribute is an area of a specific landscape type. This research adopts this strategy, in line with for instance Hoyos (2015), Ayala (2015) and Dominguez-Torreiro (2011). However, the use of qualitative data or percentages will be omitted. Instead, the unit of measurement from Liekens et al. (2013) (option 1) is adopted and use number of acres to express area size. It is assumed that the quantitative approach improves the understanding for respondents and statistical power. The two most common land functions for open landscape building site are selected: agricultural and recreational land-use

The payment vehicle is inspired by Liekens et al. (2013) who use a mandatory annual tax to be paid by all Flemish households to a fund exclusively used for the creation and conservation of nature areas in Flanders. In discussion with research experts of the TU Delft, a similar payment vehicle is adopted. Denote that this payment vehicle categorizes as a consumer ex-ante tax-payer decision as defined in chapter 3. This research does not elicit consumer's willingness to pay from an explicit market setting, for instance through a surcharge on the electricity bill.

The level of community participation is derived from the ladder of citizen participation from Arnstein (1969). This ladder identifies several levels of increasing levels of participation, categorized in non-participation, tokenism and citizen power. It is posed that real participation occurs at step six, when citizens can make *binding* decisions in the political process.

Langler et al. (2017) uses this in their conjoint analysis on wind farm externalities and participation. The following levels of participation are selected:

- Level of participation
- No participation
- Alibi participation
- Information
- Consultation
- Cooperation
- Financial participation

Denote that the included financial participation falls outside the scope of this research.

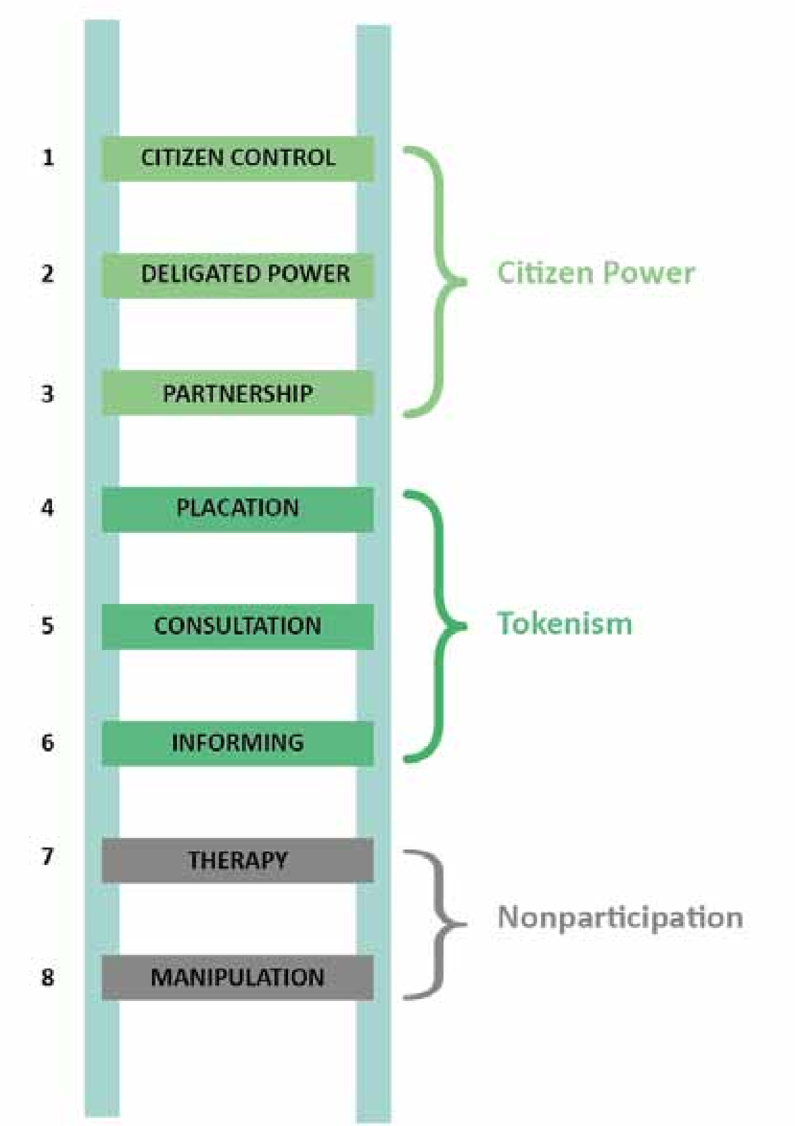


Figure 7: Ladder of citizen participation from Arnstein (1969)

4.3.2.2 Attribute ranges

The next step is to select feasible ranges of the attribute levels, based on the chosen unit of measurement. Several case studies that analyze the construction of wind or solar energy farms were analyzed to identify feasible attribute ranges. Furthermore, a GIS analysis of the case study area was conducted to approximate feasible levels of hindered amount of residents.

Visibility

Renewable energy technologies like large wind farms and utility scale solar power plants directly impact the surrounding residential areas. The visibility of these farms is an impact that concerns residents in the vicinity. The type of windmills used in this specific area are about 150-200 meters high. Wind farms will be built at a minimum distance of 500 meters but can be visible from a couple kilometers away. Naturally, the presence of the wind farm on the horizon decreases over the distance. Utility scale solar power plants are typically constructed on 2 meters high poles and cover large agricultural fields. The visibility of such parks is different than wind farms: solar panels take in the complete landscape (left to right) but are significantly lower.

The major concern of citizens is the *permanent* experience of a disrupted open (rural) landscape. Therefore, in this research this specific attribute focuses on households, more specifically the visibility of the energy park from the houses in the vicinity. Respondents will consider the change from an open landscape to a wind farm or solar park at a minimum distance of 500 meter and more (other factors will address the *optional* hindrance individuals experience during recreating activities in the area). In order to assign attribute levels an estimation of the amount of residents is based on a GIS analysis of the planned wind energy farm in the province of Drenthe (Monden and Oostermoer). This yields the following results:

Table 18: GIS analysis planned wind energy farm construction site Drentse Monden and Oostermoer

Residents within distance	Residents
500 meters	23
750 meters	288
1000 meters	1977
1500 meters	6124

It can be seen that the amount of residents increases significantly over the distance. This means that the most people will be located more than a kilometer away. Typically, most of the residents living further away have houses, trees or other things blocking (parts of) an open landscape in the first place. Therefore, the visibility of the solar panels and to a certain extend wind mills, is limited. Therefore, it is argued that the scales of 500-750 meters provides a good starting point for this attribute level. The selected range is 0-300 residents.

Noise

Solar energy farms do not produce sound. Wind mills produce noise that affects surrounding residents. The amount of residents affected by the sound limit of 47 dB Lden (yearly average) varies per location. Houses at a distance of 500 meters are expected to be exposed to a 42 dB Lden noise level (expert consult). This is the anchoring point of this attribute.

Three different (future) wind farm sites are used to estimate the amount of residents within the Lden 42 dB zone, since this is very site-specific. First, the results of the GIS analysis in table 19 show that the amount of residents within 500 meters of the Drentse Monden and Oostermoer wind farm site equals 23 residents.

The methodology used by TNO and Pandora in an analysis of an 89 wind mill farm in Wieringermeer (van der Bilt et al. 2014) suggests to take a percentage of the residents within the 42 dB zone to approach the real amount of hindered residents. These upper and lower limits can be seen in table 19.

Finally, estimations of another smaller (14-17 wind mills) wind energy farm suggests noise hinder for 111 residents in the Lden 42 dB zone. The experiments will use different attribute levels for sound, but will base the initial value on an average of these three cases. Therefore, a range of 0-100 residents is selected.

Table 19: GIS Analysis of amount of residents within the L_{den} 42 dB zone

Source	Estimation of # households in Lden > 42 dB region in Drentse Monden
GIS Analysis DMOM	23
Pondera low scenario	9
Pondera high scenario	24
Classified research	111
Average	*50*

Land use

The directly converted land, or land-use of renewable energy projects affects agriculture in the surrounding areas. Wind farms can be built in a way that most land remains unaffected and keeps its original function. They are inserted in a large area, but the land can still be used for agriculture, recreation etc (RVO, 2017). The installation of solar pv requires the direct conversion of land. While wind farms are placed in a large area, this hinder is expressed in visibility for residents. The difference in actual land-use is vast (CE Delft, 2016).

According to a study of a wind farm in the Wieringermeer by Pondera Consult, the land converted at the wind mills' base is equal to 450m^2 (Van der Bilt et al., 2014) This would lead to 2 hectare of direct ground conversion for a wind park of 45 wind mills. However, the directly converted land for foundation, roads and other infrastructure for wind farms is about 4400 m2 per windmill. With a case project of 45 wind mills, the direct land conversion is equal to approximately 20 hectares.

On the other hand, CE Delft finds that the direct land use per wind mill (including fundament, access roads and other construction installations) is 1700 m2. That would bring the direct land use to 7 hectares. This same study uses 12m^2 per kWp for solar pv and argues that a solar pv park should be at a capacity of 560 MW to deliver the same amount of electricity as a wind farm of 180 MW. For our case of 135 MW, this would mean that a capacity of 420 MW is needed on an area of 500 hectares (5 km^2). Variations in land-use are possible for both wind farms and solar pv installation when they are integrated with dikes, or railways. Furthermore, recent design of solar pv farms looks at grazing possibilities for cattle.

Therefore, for wind energy farms the range of total land use is estimated between 0-50 hectares. The range of the total land-use of solar energy farms is estimated to be between 200-500 ha.

Tax payment vehicle:

Bergmann et al. (2006) derives a WTP of £8.10 (approx. €12.15 with rate of 1.5 in 2004) per household per year as a surcharge on the electricity bill. Furthermore, Liekens et al. (2013) used tax payments for households as a payment vehicle for the development and conservation of nature areas. The survey explicitly mentioned this tax money was earmarked put in a fund explicitly used for this purpose. Based on their pre-tests the range of contributions levels of the price attribute in the choice cards was set between €10 and €125 per household per year.

Table 20: Levels of price in choice cards for wind and solar pv

Attribute level Wind [€]	Attribute level Solar pv [€]
5	5
20	20
50	50

Community participation

In several expert consults with spatial planners from the Ministry of Economic Affairs, the participation ladder of Arnstein (1969) was discussed an relevant levels were selected. The aim is to integrate a level from the categories 'non-participation', 'tokenism' and 'citizen power'. Consultation is identified as the current status-quo, equal to step 5 of the ladder. Furthermore a base level of no participation assists the interpretation of the attribute. Table 21 summarizes the selected levels and description.

Table 21: Degrees of community influence in the development of a wind or solar energy park

Rol van omwonenden	Omschrijving
No participation (base)	The government decides on the development of the wind or solar energy farm without informing the local community.
Consultation (5th step)	The government decides on the development of the wind or solar energy farm, but the local community has been given the opportunity to formulate concerns and propose solutions. These ideas are not binding, but do play a significant role in the development of the renewable energy farm.
Cooperation (6th step)	The government and the community have collectively decided on the development of the renewable energy farm. Both parties have agreed tot his negotiated plan.
(Community) Decision-making (8th step	The community decides on the development of the wind or solar energy farm. The government has formalized the project conditions beforehand. Furthermore they advices the community and manage the process.

4.4 Conclusion

This chapter aims to derive a conceptual framework in which the attributes are select and quantify within the research context.

The context description illustrates the different perspectives of the government and communities regarding the construction of wind energy farms in the Netherlands. The government intends to expand the onshore wind capacity from 3400 MW in 2017 to 6000 MW in 2020. On the other hand, communities confronted with planned wind energy farms oppose the construction due to the impacts on their living environment. Solar energy farms are suggested as an alternative of these building sites, yet may similarly impact the living environment.

The literature review on relevant environmental impacts of wind and solar energy farms has yielded a list of technological and institutional factors. The societal relevance of these factors are assessed in several round of expert discussion with spatial planners, researchers and (energy) policy-makers. Based on this, the relevant attributes for the three experiments were selected. These are depicted in figure 8.

Figure 8: Overview of all quantified attributes selected for the design of the surveys

Finally, the attributes were quantified by establishing their unit of measurement and their ranges. The level of community participation is measured through qualitative levels. All other attributes have numerical attribute levels. The ranges are derived from a GIS analysis of a case study situation.

5 DESIGN OF DISCRETE CHOICE EXPERIMENT SURVEYS

5 Design of the discrete choice experiment surveys

This chapter outlines the experimental design of the stated choice preference surveys and aims to *“design stated choice experiments to measure citizen and consumer preferences to infer trade-offs from the non-market environmental goods and services of wind and solar energy farms”* (sub-research goal d). As explained in chapter 2, a two staged D-efficient design approach is selected. The first stage concerns the design of a pilot study. The second stage uses the results from the pilot study to design the three final surveys. The output of the surveys (the gathered data) is used as input for the data analysis and model estimations conducted in chapter 6. Section 5.1 discusses the major design choices like determining the alternatives, attribute metrics and attribute levels. Section 5.2 presents the pilot survey and section 5.3 outlines the final surveys. Section 5.4 concludes the chapter.

5.1 Alternatives, Attribute metrics and Attribute levels

The main goal of this study ‘to gain insights in how individuals in their role as citizen and consumer trade-off non-market environmental goods and services of wind and solar energy farms. In order to ‘gain insights’ and compare results, a coherent design of the three final surveys is required. This means that the alternatives, attribute metrics and attribute levels should be as similar as possible. This section provides an overview of the alternatives (section 5.1.1), attribute metric (5.1.2) and attribute levels (5.1.3) from the three different experiments. The three experiments are designed in a coherent way by minimizing the design differences, in order to legitimize the comparison of data.

5.1.1 Alternatives

The three experiments each aim to measure the preferences of individuals for wind or solar energy farms. Therefore, all three experiments are *labeled* experiments, which means that respondents have a *“label with which attributes are associated, that remain constant in the experiment”* (Molin, SPM4612 Lecture 2 – Orthogonal experimental design, 2015). This means that an alternative specific constant (ASC) can be estimated. This constant is the base difference between the two alternatives, before considering the attributes. Therefore, this difference is captured by other factors than the characteristics in the experiment.

For the citizen based DCEs, the respondents between two alternatives: 1) wind energy farm and 2) solar energy farm. These experiments do not have a base alternative. Within the context of the planned long-term subsidy schemes for wind energy technology, the author is interested in the trade-offs that are made between the ‘obvious’ alternative, solar energy. It is assumed that either way, a renewable energy farm is built. The consumer based DCE does have a base option because it includes a willingness to pay component. The base option is designed in line with Mariel et al. (2015) and does not represent a full opt-out from the construction of renewable energy technologies, but shows a base wind energy farm that can be built against relative low costs, but with specific values for the attributes.

5.1.2 Attribute level metrics

The discrete choice experiment considers labelled alternatives. Therefore, most of the attributes are specified as alternative specific attributes. Denote that visibility hinder from wind energy farms is different that visibility hinder from solar energy farms. However, level of community participation is the same for both alternatives. Table 22 shows an overview of the division of generic attributes and alternative specific attributes.

Table 22: The division of generic attributes and alternative specific attributes

Generic attributes	Alternative specific attributes
Level of community participation	Visibility
	Noise
	Agricultural land use
	Recreational land-use
	Tax Payment

The alternative specific attributes are estimated with their respective utility parameter. Table 23 shows the division of attributes per alternative for the pilot experiment. This shows that the pilot experiment has seven attributes.

Table 23: Specification of parameters pilot design

Wind	Solar
B_1 Visibility	B_5Visibility
B_2 Noise	B_6 Agricultural land use
B_3 Agricultural land use	B_7 Recreational land-use
B_4 Recreational land-use	

The levels of measurement and the unit of measurement for the different attributes is consistent between alternatives and is specified in Table 24. The unit of measurement is established by a literature study of stated preference studies that have incorporated these attributes.

Table 24: Overview of level of measurement and unit of measure

Attribute	Level of measurement	Unit of measurement
Visibility	Ratio	Number of residents with visual impact
Noise	Ratio	Number of residents with noise impact
Agricultural land use	Ratio	Number of hectares replaced
Recreational land-use	Ratio	Number of hectares replaced
Tax payment	Ratio	One single tax payment in €
Level of community participation	Ordinal	Dummy variables (dimensionless)

5.1.3 Attribute levels

This subsection discusses the value and amount of attribute levels. The amount of levels for the pilot study results from the selection of the required orthogonal design. The pilot survey is discussed more extensively in section 5.2. The orthogonal design allowed three levels for all seven attributes.

Next, the literature review and GIS analysis of a planned wind energy farm site outlined in section 4.3 provides insight into a feasible range of attribute levels for the pilot study. An overview of the values of all attributes for the pilot study is provided in Table 25.

Table 25: Overview attribute levels and values

Attribute	Alternative 1: Wind energy farm	Alternative 2: Solar energy farms
Visibility number of residents with visual hinder	0 residents 200 residents 400 resident	0 residents 200 residents 400 residents
Noise	0 residents 200 residents 400 residents	N/A
Agricultural land use	5 hectares 25 hectares 45 hectares	50 hectares 150 hectares 250 hectares
Recreational land-use	5 hectares 25 hectares 45 hectares	50 hectares 150 hectares 250 hectares

5.2 Pilot survey

The pilot survey is the first phase of the survey design process and ultimately results in estimation coefficients for most of the attributes used in the three experiments. These so-called priors can be used to generate efficient models. Furthermore, the pilot study can be used to collect feedback on the survey length and understandability. Finally information on the choice behavior of respondents can be used to adjust attribute levels. Section 5.2.1 outlines the design of the pilot survey. Subsequent, section 5.2.2 discusses the results from the pilot survey. First, the following paragraphs elaborate on the different design steps to design a pilot survey. These steps are:

1. Model specification
2. Generating experimental design
3. Constructing the survey

Step 1: Model specification

The first step in the design of a stated choice experiment is the specification of the model. The pilot study model contains two labeled alternatives labeled attributes and an alternative specific constant (ASC). The utility functions for the two alternatives are shown in equations 5.1 and 5.2.

$$\mathrm{U(wind)} = \mathrm{B\_WVis} * \mathrm{WVis} + \mathrm{B\_WNoise} * \mathrm{WNoise} + \mathrm{B\_WAgr} * \mathrm{WAgr} + \mathrm{B\_WRecr} * \mathrm{WRecr}$$

$$\mathrm{U(solar)} = \mathrm{ASC\_Solar} * \mathrm{one} + \mathrm{B\_SVis} * \mathrm{SVis} + \mathrm{B\_SAgr} * \mathrm{SAgr} + \mathrm{B\_SRecr} * \mathrm{SRecr}$$

With:

Variable	**Definition**
U(wind)	Utility of the alternative: wind energy farm
U(solar)	Utility of the alternative: solar energy farm
ASC_solar	Alternative specific constant for the solar energy farm
B_WVis	Alternative specific parameter for the attribute visibility for the wind energy farm
B_WNoise	Alternative specific parameter for the attribute noise for the wind energy farm
B_WAgr	Alternative specific parameter for the attribute agricultural land use for the wind energy farm
B_WRecr	Alternative specific parameter for the attribute recreational land use for the wind energy farm
B_SVis	Alternative specific parameter for the attribute visibility for the solar energy farm
B_SAgr	Alternative specific parameter for the attribute agricultural land use for the solar energy farm
B_SRecr	Alternative specific parameter for the attribute recreational land use for the solar energy farm
ε	Random error component

The utility functions show that all parameters are alternative specific; the same attribute has a different β for the alternative wind energy farm and for the alternative solar energy farm. The next step is the generation of the experimental design of the pilot survey. Chapter 2 outlined that MNL models are estimated.

Step 2: Generation of experimental design

The second step in the survey design of the pilot study is the generation of the experimental design. This design shows the set of combination of attribute levels that respondents base their hypothetical choice on. There are several types of experimental designs: orthogonal designs, efficient designs and Bayesian designs. Efficient and Bayesian designs require prior information on the utility coefficients of the different parameters. An orthogonal design assumes that attribute levels are not correlated and therefore sets prior values to zero. No citizen preference based discrete choice experiments for choices between renewable energy technologies are present in literature. Therefore an orthogonal experimental design is generated.

A fractional factorial orthogonal design is selected to estimate the most reliable parameters with the lowest standard errors. Full factorial designs are not feasible because this leads to too many choice situations: 3^7 = 2187. Furthermore, the research budget does not allow to block the experiment. Therefore, a basic plan 4 design is chosen, with seven attributes with three levels and a total of 18 choice sets. The advantages of this plan is its simple orthogonal (reliable) design that measures all main effects. Furthermore, attribute level balance can be achieved, The disadvantage is that every respondent has to answer 18 choice sets. However, 30 respondents are sufficient to analyze the data, which is feasible.

Simultaneous construction of the alternatives and the choice sets is used since every attribute is alternative specific. The added value is that the *between* alternative correlations are zero. The wind energy alternative has four specific attributes, whereas the solar energy alternative exists out of three attributes. The simultaneous construction of the choice sets includes a constant that is the difference in utility of wind versus solar energy.

The software package Ngene is used to generate the orthogonal design for the pilot study. As discussed, this is a fractional factorial design (basic plan 4) with seven attributes and one alternative specific constant (ASC). Table 26 shows the overview of the 18 choice sets.

Table 26: Overview of choice situations for pilot study

Design	***Wind***				***Solar***		
Choice situation	*Visibility*	*Noise*	*Agricultural land-use*	*Recreational land-use*	*Visibility*	*Agricultural land-use*	*Recreational land-use*
1	0	0	5	5	0	50	50
2	200	200	25	25	200	150	50
3	400	400	45	45	400	250	50
4	400	400	25	25	0	50	150
5	0	0	45	45	200	150	150
6	200	200	5	5	400	250	150
7	400	200	45	5	200	50	250
8	0	400	5	25	400	150	250
9	200	0	25	45	0	250	250
10	0	200	25	45	400	50	50
11	200	400	45	5	0	150	50
12	400	0	5	25	200	250	50
13	200	400	5	45	200	50	150
14	400	0	25	5	400	150	150
15	0	200	45	25	0	250	150
16	200	0	45	25	400	50	250
17	400	200	5	45	0	150	250
18	0	400	25	5	200	250	250

Step 3: Construction of the Questionnaire

The generated experimental design shows the combination attribute levels that is presented to respondents. Every row from Table 26 is transformed into a choice situation in the survey. The online survey program SurveyGizmo is used to design the full pilot survey. The survey is constructed in Dutch and distributed to Dutch respondents within the network of the other.

5.2.1 Pilot survey design

An imperative step in the design of the final discrete choice experiments is the pre-testing phase. Pre-testing experiments helps to improve the realism and conceivability of the information. Also an MNL model can be estimated to find priors that can be used in the final experiment. This section discusses the different parts of the pilot study survey, which consists of: introduction, choice situations, general questions and statements.

5.2.1.1 Introduction

The aim of the introductory text of the pilot is to inform the respondent about the topic. The context is described and information on the attributes is given.

5.2.1.2 Choice situations

This is the main part of the survey where respondents choose between the alternatives based on the attributes (technology characteristics). Every choice situation included an impression of the visual changes for households as well as a maps that gave insights in the way the respective renewable energy technologies take in space and replace original agricultural and recreational land. Figure 9 shows an example of the pilot study choice situation.

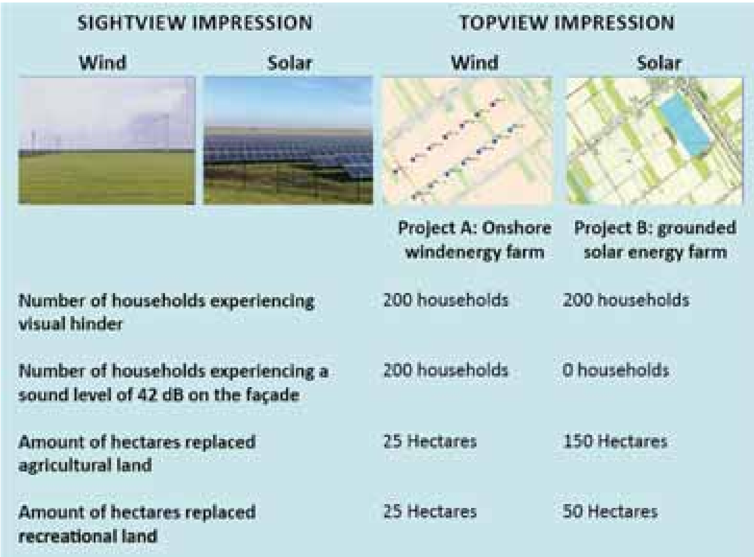


Figure 9: Example of pilot study choice situation

5.2.1.3 Statements

The next part of the survey consists of statements to measure the miscellaneous factors that may influence the preference of a citizen between a wind or solar energy farm. Furthermore, statements were constructed to:

- Provide insights into motivations for the most and least important attribute
- Provide insights into the difficulty, realism and relevance of the survey
- Provide insights into the usefulness of the visual impressions
- Generate a feedback report to evaluate and improve the survey for the final survey design

5.2.2 Pilot survey results

The pilot study results are divided into several section. First, generic descriptive results are presented to get an insight into the sample characteristics. A quantitative analysis of choice preferences helps to understand the importance of the different attributes. Finally, the respondent's motivations for their decisions helps to assess how the attributes were interpreted.

5.2.2.1 Descriptive results

The pilot study requires a small sample. The general rule is that at least 30 respondents should have completed the choice tasks. In total 56 persons started the survey and this pilot study was completed by 33 persons. This is a completion percentage of 58.9%. Of these 33 respondents, 27 are male (81.8%) and 6 are female (18.2%). The average person is 29-30 years old (born in 1987) with a standard deviation of 8.9 years.

After the choice experiments, several questions were asked to derive some additional information. Figure 10 shows the responses on the question: 'what is according to you the most important attribute?' Interestingly, almost half of the respondents marked 'noise' as the most important attribute. The use of recreational land is the least often considered the most important attribute, with 12.1%.

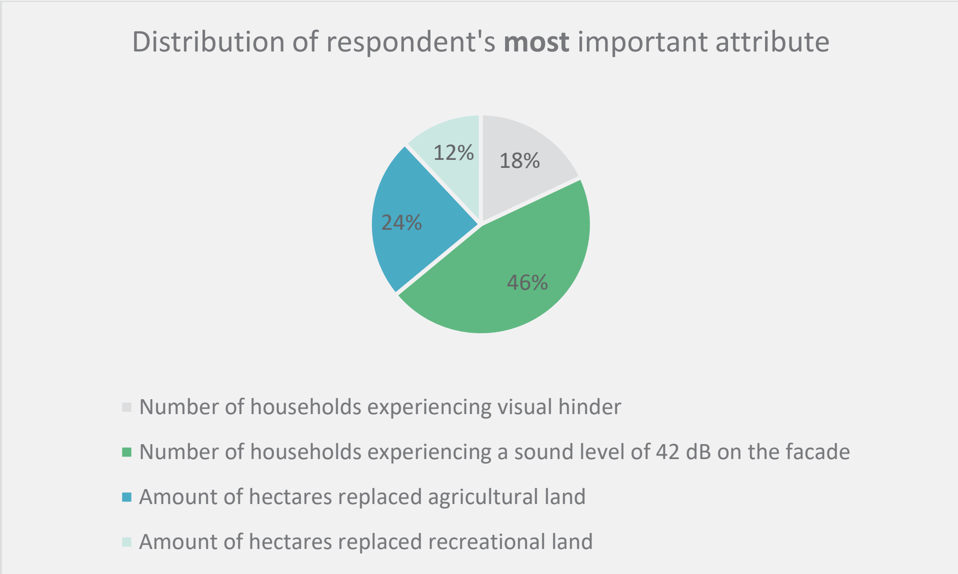


Figure 10: Distribution of respondent's most important attribute

The respondents reaction to the question: 'what is according to you the least important attribute?' is shown in Figure 11. The agricultural land use attribute was for almost 40% of the respondents the least important attribute, the visual hinder attribute was considered the least important by one-third of the respondents.

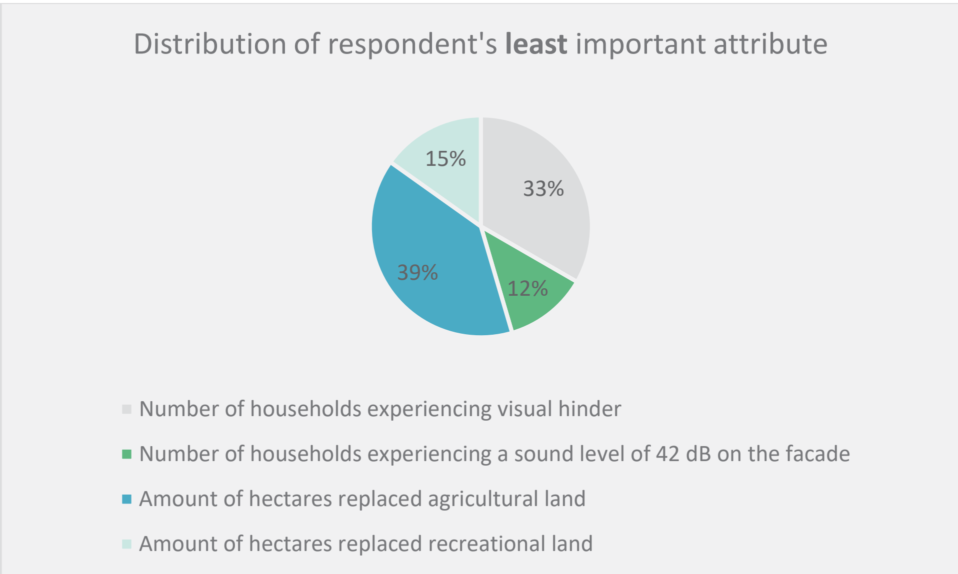


Figure 11: Distribution of respondent's least important attribute

These overviews show that there is reasonable spread between what respondents find the most important and least important attribute. This is a first indication that the pilot study does not lead to obvious homogeneous decisions by respondents.

5.2.2.2 Modelling results

The pilot study data is used to estimate an MNL model. This gives a first insight in the preferences of citizens for wind energy or solar energy farms when trading off non-market environmental goods and services. The scaled MNL model output are shown in Table 27 and were estimated with the freeware program Biogeme. In order to estimate an MNL model, a model file and data file need to be combined in Biogeme. The model file specifies the utility functions while the data file is a modification of the raw data to a specific format. The model file specification can be seen in appendix B. The coefficients are scaled by a factor hundred, which means in this case that the presented utility decrease of -0.509 for noise is measured per hundred households.

Table 27: Overview of utility parameters from pilot study per 100 units (households/hectare)

Name	Value	Std err	t-test	p-value
ASC_Solar	-1.21	0.397	-3.05	0.00
ASC_Wind	0.00	fixed		
B_WNoise	-0.509	0.0621	-8.21	0.00
B_WAgr	-0.302	0.589	-0.51	0.61
B_WRecr	-0.917	0.587	-1.56	0.12
B_WVis	-0.214	0.0579	-3.69	0.00
B_SAgr	-0.200	0.117	-1.70	0.09
B_SRecr	-0.200	0.114	-1.76	0.08
B_SVis	-0.274	0.0606	-4.52	0.00

This shows that the Solar alternative specific constant, noise hinder and visual from wind and solar significantly affect an individual's preference for wind or solar energy farms.

Furthermore, all utilities for the attributes show the expected negative relation. A negative relation is expected since higher values for hinder and land-use leads to a greater impact on the living environment. However, the negative sign of the solar energy ASC is unexpected. This shows that if we exclude the attributes, respondents have a preference for wind energy farms over solar energy farms. A possible explanation could be that the wind energy is a more proven technology to provide green electricity. Besides this, perhaps respondents are not aware that large scale solar energy plant can also provide green electricity and therefore have a preference for wind.

The model estimates show that citizens derive a significant utility for the aforementioned attributes. Denote that citizens the highest utility to noise hinder and is 2.38 times greater than wind visual hinder. This implies that a noise hinder reduction for one resident is equal to visual hinder reductions for 2.38 (2) residents. The findings are in line with descriptive results. Most respondents considered noise the most important attribute in their decision.

The reason that other parameters were not significant can be either because the number of respondents was too low to find a significant relation or the parameter just does not influence the preference of the respondent. For instance, 39% of the respondents indicated agricultural land-use was the least important attribute in their decision. The estimation coefficients of the different parameters can be used as priors in the final survey design.

5.2.2.3 Feedback

At the end of the survey, respondents were asked to provide feedback on the survey. In total, 20 respondents provided feedback. Feedback was asked on the following points:

Difficulty:

Overall, respondent were able to understand the descriptions in the introductory section of the survey. Furthermore, the choice situation were understandable either. A few respondents suggested the information to be abstract and perhaps a bit too long.

Sometimes, respondents found the questions difficult to answer, when values of the attributes were almost similar per attribute.

Realism
The respondents did not pose many questions about the presented choice situations.

Other remarks
The visualizations for the impression of the visibility of the renewable energy farms were considered helpful in the decision making process. However, the maps were considered too small, inconsistent (different map type for wind and solar) and lacked a proper scale. Furthermore, respondents indicated that the function of the visualizations could be explained in the introduction of the survey.

5.3 Final studies

The final survey design is based on the improvements suggested by the respondents and the respondent's choice behavior. First the improvements based on the feedback is discussed. Then the design for the final survey is given

5.3.1 Feedback from pilot

The respondents seemed to be able to go through the questionnaire. The most feedback provided was about the visualizations of the maps that was provided in the choice situations. Those who were able to work with the small maps did indicate its usefulness. Therefore, larger maps are included in the choice situations of the final design.

5.3.2 Design of final surveys

The MNL estimation of the pilot study orthogonal design allows for the design of D-efficient design for the final survey. Efficient designs aim to gather a maximum amount of information from the choice situations by minimizing the standard errors.

In order to increase the comparability of the three surveys, identical values and amount of choice levels are chosen. An integrated approach is used to come to such a coherent design. Linear relations are assumed for all attributes, except for the estimation of the ordinal 'level of community participation'. Here, the goal is to compare the utility increase per level. Therefore, this variable is dummy coded: one base level (non-participation) and three levels that need to be estimated.

The first experiment is identical to the pilot study. Seven parameters and one ASC need to be estimated with the MNL model, with two alternatives. The required amount of choice situations is calculated by the equation below (Molin, 2016). With eight parameters to estimate and two alternatives a minimum of 9 choice situations are required.

$$\#\,choice\ situations > \frac{\#\,parameters}{(\# - 1)\ alternatives}$$

The second experiment aims to estimate consumer preferences. Therefore, a generic attribute (tax payment) and a status-quo alternative is added. Following the equation above, this experiment needs at least 5 choice sets.

The third experiment includes an extra attribute (level of participation) and assumes non-linearity for this attribute. In chapter 4, four levels of participation were formulated. This means that three degrees of freedom should be added to the design of 8 attributes and constant. Therefore, an efficient design of 12 choice sets can be generated.

So, in order to create similar efficient designs for all experiments, 12 choice sets are required. In order to achieve level balance, three or four levels can be adopted for all attributes. Since the 'level of participation' consists of four levels, all attributes will have four levels as well. Table 28 shows an overview of the attributes and their levels used in the stated preference final design of the three surveys.

Table 28: An overview of the attribute levels per experiment

Attribute	Alternative 1: Wind energy farm	Alternative 2: Solar energy farms	Status quo: Planned Wind energy farm
Visibility	0 residents 100 residents 200 residents 300 residents	0 residents 100 residents 200 residents 300 residents	300 residents
Noise	0 residents 100 residents 200 residents 300 residents	N/A	150 residents
Agricultural land use	10 hectares 20 hectares 30 hectares 40 hectares	50 hectares 100 hectares 150 hectares 200 hectares	40 hectares
Recreational land-use	5 hectares 10 hectares 15 hectares 20 hectares	50 hectares 100 hectares 150 hectares 200 hectares	20 hectares
Tax Payment	€5 €25 €45 €65	€5 €25 €45 €65	N/A
Level of community participation	No participation Consultation Cooperation Decision-making	No participation Consultation Cooperation Decision-making	

Similar to the orthogonal design, the Ngene software program is used to generate the three efficient designs. The designs with the lowest D-error are selected. The resulting 12 choice situations are depicted in Appendix C

The complete surveys are included in appendix C. The completion time of the survey was about 10 minutes. The complete survey consists of three parts: an introductory text, the choice situations and questions on the respondent's perception (most important attribute, realism of the survey etc) attitudes).

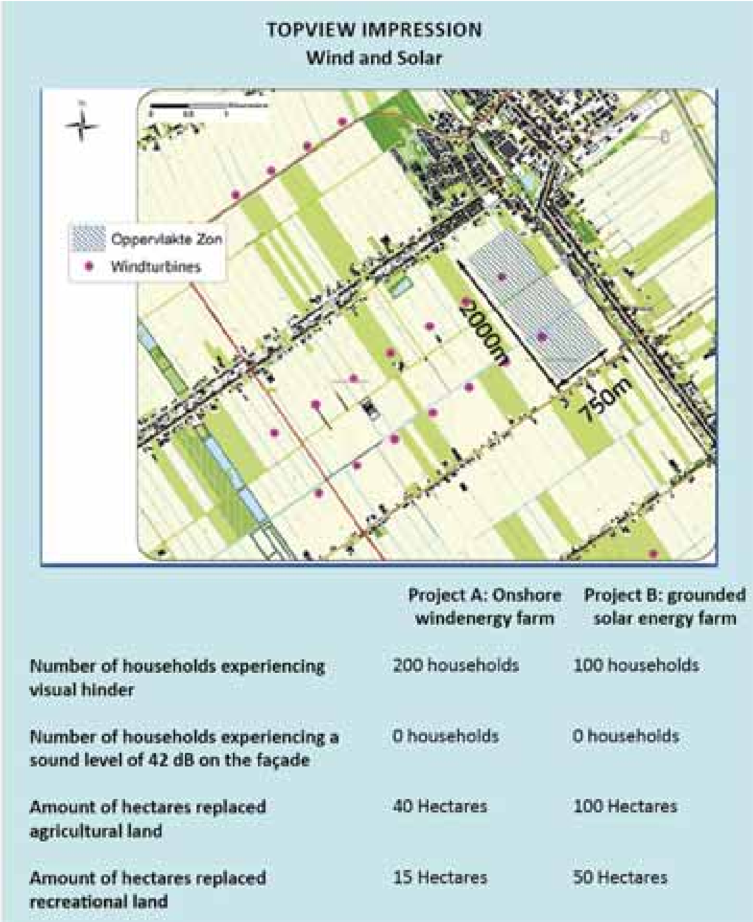


Figure 12: Example of choice situation for the citizen experiment

5.4 Conclusions

This chapter outlines the design steps for the three final surveys. The citizen experiments consisted of two alternatives (wind energy and solar energy) whereas the consumer experiment included an addition alternative totaling three: 1) planned wind energy farm, 2) alternative wind energy farm and 3) alternative solar energy farm.

A two staged D-efficient design approach was adopted for several reasons. First, the lack of prior information of citizen based estimations of trade-offs of non-market environmental goods of wind and solar energy farms required the design of an orthogonal design. Second, this orthogonal design could provide priors to estimate three different efficient designs for three separate surveys. The comprehensive design of three coherent design with maximum resemblance facilitates the comparison of data in the next phase of the study.

The final design consisted of three parts: an introductory text, the choice situations questions and other questions measure the respondents perception.

The final surveys are send to TNS NIPO, who will gather a minimum of 150 respondents for each experiment. The samples should be representative for the Dutch inhabitants. The data expectations are:

- The larger and more representative sample leads to more reliable parameters
- A specific amount of respondents will be non-traders; respondents have a fixed preference for wind or solar
- The other specified characteristics will have a significant influence on the preferences of citizens and consumers.

The next chapter discusses the results of the three final surveys.

6 DESCRIPTIVE RESULTS

6 Descriptive results

This chapter highlights the main descriptive results and aims to *gather and analyze data of citizen and consumer preferences for trade-offs between environmental non-market goods and services of wind and solar energy farms."* (first part sub research goal e). The three final survey designs outlined in chapter 5 provide the data that is analyzed in this chapter. First, section 6.1 describes the sampling method. Section 6.2 outlines descriptive statistics that give insight into the choice behavior of respondents and reflects on the perceived difficulty, realism and relevance of the survey. Section 6.3 discusses the portion of non-traders per experiment. Finally, section 6.4 concludes the chapter.

6.1 Sampling methods

The data was collected from the 3rd of July until the 10th of July by means of an online panel. The data was gathered by TNS NIPO, a survey company with a large online panel. This large online panel allows TNS NIPO to invite people for the survey based on specific sample needs. In this case, the samples should represent the Dutch population to generate reliable results and parameter estimations. The selected online panelist receive an invitation to take survey 1, 2 or 3 and are rewarded with nipoints upon completion. Nipoints can be used to purchase things in an online web-shop. There is a risk that respondents fill in the questionnaire to receive the point, without really considering the content. While this is a factor to take into account during the interpretation of the results, it is assumed that with a sufficient sized sample, enough 'serious' respondents can be collected. The available budget for this research to cover the costs to hire TNS NIPO allowed for three samples of a minimum of 150 respondents. The respondents did not have to meet any additional requirements.

6.2 Descriptive statistics

In this section the descriptive statistics of the three surveys are presented. First, section 6.2.1 assesses the representativeness of the samples, based on the respondent's personal characteristics. Next section 6.2.2 illustrates an exploration of respondent's perceived most and least important attribute. Then, section 6.2.3 analyzes the respondents with fixed preferences.

The response count from the three experiments is shown in Table 29. In total 572 respondents completed the online survey and there was a response rate of 79.5% for the citizen experiment, 71.2% for the consumer experiment and 69.8% for the citizen participation experiment. Note that the completion rate of the citizen experiment is somewhat higher compared to the consumer and citizen participation experiment. An explanation may be that both the consumer and citizen participation experiment included an extra attribute. This resulted in longer introduction texts that may have discouraged more respondents. Furthermore, respondents had to consider 5 attributes, which may have increased the choice situation complexity.

Table 29: Overview responses

	Responses	Complete	Completion rate
Citizen	298	237	79.5%
Consumer	306	218	71.2%
Citizen participation	278	194	69.8%
	Total	**572**	

6.2.1 Representativeness samples

The personal characteristics of the respondents are used to assess the characteristics of the samples. TNS NIPO was asked to collect data of Dutch citizen of 18 years and older, with a reasonable distribution in gender, age, education and income. Table 30 summarizes these statistics and shows fairly balanced sample sets.

Table 30: Sample characteristics

	Citizen experiment		Citizen experiment		Citizen participation	
Gender						
Female	108	56%	90	52%	79	49%
Male	85	44%	82	48%	81	51%
Age						
18 to 29 yr	33	17%	26	15%	32	20%
30 to 39 yr	25	13%	23	13%	15	9%
40 to 49 yr	29	15%	32	19%	21	13%
50 to 59 yr	46	24%	32	19%	41	26%
60 + yr	60	31%	59	34%	51	32%
Education						
Secondary education or lower	51	26%	47	27%	42	26%
MBO	71	37%	57	33%	47	29%
HBO/Bachelor University	52	27%	46	27%	53	33%
Master University/PhD	19	10%	22	13%	18	11%
Income						
0 - 27800	37	16%	43	25%	35	22%
27800 - 41200	52	23%	39	23%	29	18%
41200 - 69000	77	34%	40	23%	49	31%
69000 - higher	59	26%	50	29%	47	29%

6.2.2 Exploration of choices

This section illustrates an exploration of the respondent’s answers to the choice situations. Furthermore, the respondents to the survey statements are discussed. The following aspects are discussed:

- Most influential attributes
- Distribution of choice answers
- Survey perceptions

6.2.2.1 Distribution of most important attributes:

First, the distribution of the most important is discussed. This first exploration provides several insights. In all three experiments, the attribute ‘noise’ is considered the most influential by most respondents. Furthermore, it is interesting to note that the payment attribute in the consumer experiment is more often chosen as most influential attribute than visibility, agricultural land use and recreational land use. Finally, the citizen participation experiment demonstrates that ‘level of community participation’ is more often selected as most influential attribute to a respondent’s choice than the different land-use attributes.

Table 31This first exploration provides several insights. In all three experiments, the attribute ‘noise’ is considered the most influential by most respondents. Furthermore, it is interesting to note that the payment attribute in the consumer experiment is more often chosen as most influential attribute than visibility, agricultural land use and recreational land use. Finally, the citizen participation experiment demonstrates that ‘level of community participation’ is more often selected as most influential attribute to a respondent’s choice than the different land-use attributes.

Table 31 shows an overview of the distribution of answers to the question '*what attribute influenced your decision the most?*'

This first exploration provides several insights. In all three experiments, the attribute 'noise' is considered the most influential by most respondents. Furthermore, it is interesting to note that the payment attribute in the consumer experiment is more often chosen as most influential attribute than visibility, agricultural land use and recreational land use. Finally, the citizen participation experiment demonstrates that 'level of community participation' is more often selected as most influential attribute to a respondent's choice than the different land-use attributes.

Table 31: Overview distribution most important attribute and relative distributions

	Citizen	Consumer	Percentage deviation	Citizen participation	Percentage Deviation
Number of households with visual hinder	24,5%	17,0%	*-7,5%*	21,6%	*-2,9%*
Number of households with noise hinder	49,4%	42,2%	*-7,2%*	43,8%	*-5,6%*
Number of hectares agricultural land used	12,7%	8,3%	*-4,4%*	12,4%	*-0,3%*
Number of hectares recreational land used	13,5%	9,6%	*-3,9%*	7,7%	*-5,8%*
Single energy tax payment	N/A	22,9%		N/A	
Level of community participation	N/A	N/A		14,4%	

Furthermore, there are several differences to denote between the three experiments. First, the percentage of people who indicate noise is most influential is highest in the citizen experiment. The most obvious reason is that respondents chose between five attributes instead of four. Furthermore, it could be that the citizen experiment induces a higher relative importance for noise than the other experiments. However, the percentage deviation between the citizen and consumer experiment does not necessarily indicate this. Visual hinder and noise hinder show the highest percentage deviations between the citizen and consumer experiments, of -7.5% and -7.2% respectively. But the difference with the percentage deviations from agricultural (-4.4%) and recreational (-3.9%) land-use attributes is not that large. The model estimations in section 6.3 present more useful insights on the relative importance of the attributes.

Besides this, there is a difference between the importance of the added attribute in the consumer and citizen participation experiment: 22.9% of the respondents state that the 'single energy tax' attribute is the most important and 14,4% of the respondents affirm 'citizen participation' is most influential. The model estimations in section 6.3 shows if this quantitative difference results in different statistical results.

This analysis shows that noise is most often considered the most influential attribute in all three experiments. This may indicate that respondents may have a preference for solar energy farms. Furthermore, the analysis shows that the percentage deviations do not provide convincing clues that less respondents consider noise as most influential attribute in the consumer and citizen participation experiment. The model estimations will show if these quantitative observations translate to statistical significant differences technologies and between the experiments.

6.2.2.2 Distribution of answers:

Second, the distributions of the answers to the choice situations are assessed to study possible dominant choice situations. Figure 13, Figure 14 and Figure 15 present the choice distribution for the citizen, consumer and citizen participation experiment respectively.

The distribution of answers in the citizen experiment show a decent spread, with on average 60% of the respondents choosing a solar energy farm and 40% a wind energy farm. Only three choice situations led to a majority of respondents choosing a wind energy farm. This may indicate (on a basic level) a higher preference for solar energy parks. The distribution of answers in the consumer experiment is reasonably evenly spread over the three alternatives. Interestingly, on average 25% of the respondents choose the planned wind park, that required no additional payment. This shows that on average 75% of the respondent's chose a willing to pay option over the 'free' status-quo. Furthermore, on average, the solar energy alternative was chosen more often than the wind energy alternative. Finally, the choice situations in citizen participation experiment resulted on average for 60% of the respondents for a choice for solar energy and 40% for the wind energy farm.

Overall, the observations of these quantitative results indicate more respondents choosing solar than wind energy farms. This is in line with the quantitative analysis of 'the most influential attribute' in the previous section, that shows that 'noise' is most often chosen as the most influencing factor. Furthermore, the frequency of alternative voters in the consumer experiment induces an expectation that WTP for several attributes can be elicited. The model estimation phase aims to gain more insights into such preferences.

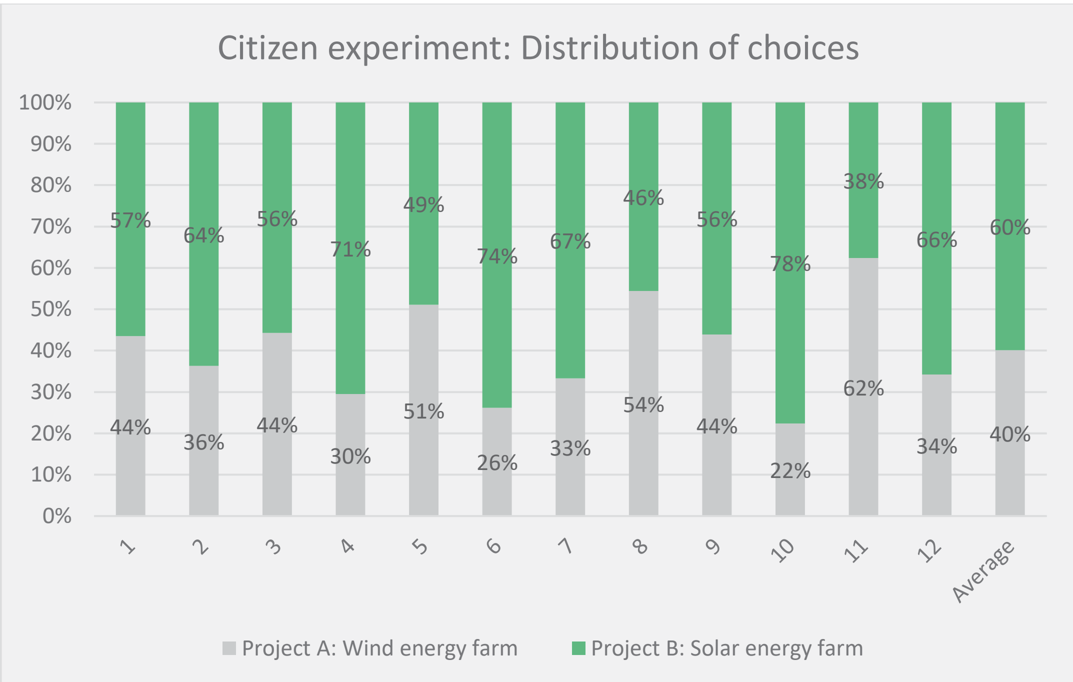


Figure 13: Distribution of choice answers for the citizen experiment

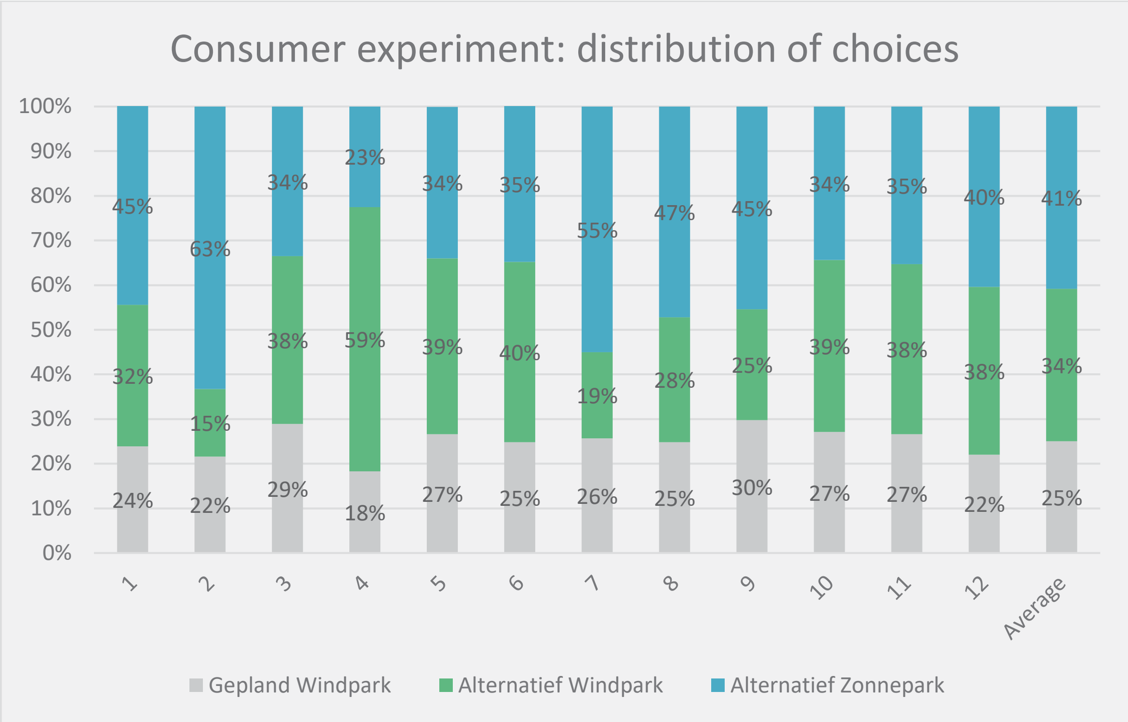


Figure 14: Distribution of choice answers for the consumer experiment

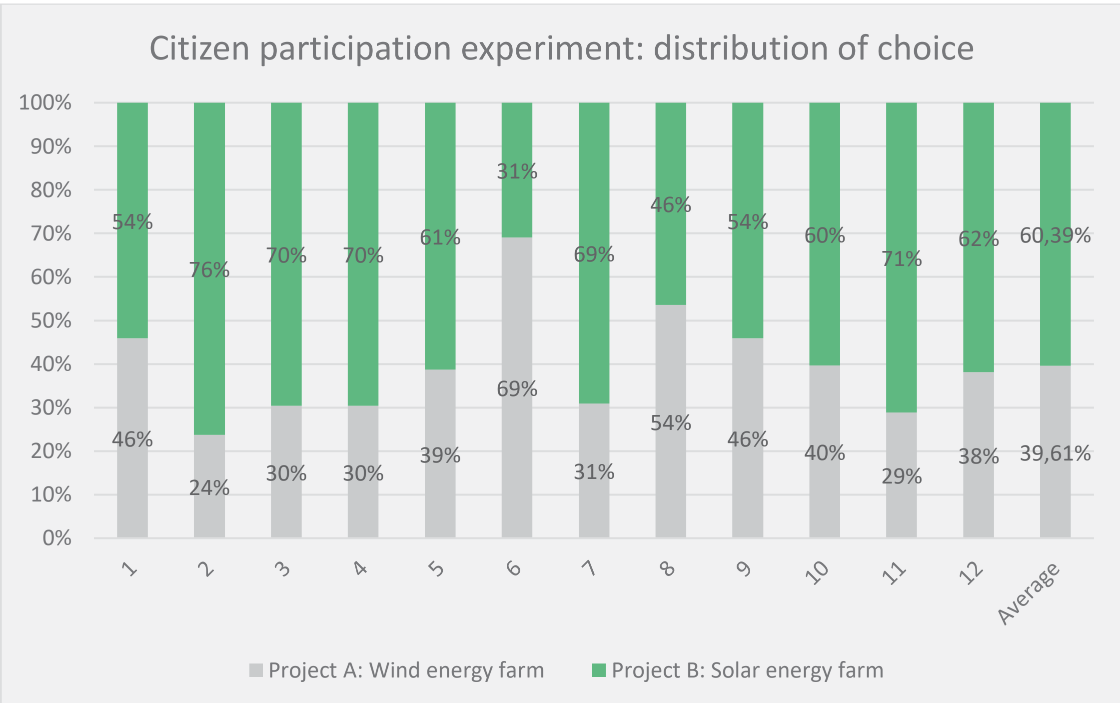


Figure 15: Distribution of choice answers for the citizen participation experiment

6.2.2.3 Perception of survey

The next analysis assesses how the respondents perceived the different surveys. Table 32, Table 33 and Table 34 show the answer distributions to the statements about the difficulty, realism and relevance of the survey. The statements are:

- I was frequently convinced of my choices
- The choice situations were realistic
- This experiment provides the Government with relevant information for choices between renewable energy farms

The first row of these tables discusses if respondents were convinced of their choices. The results indicate that respondents did not find the survey choice situations too difficult. In fact, 75% of the respondents of the citizen experiment (strongly) agreed with this statement, while only 6% (strongly) disagreed. Furthermore, a slightly higher percentage of the respondents of the consumer experiment were convinced of their choices; 77% (strongly) agreed with this statement and only 2% (strongly) disagreed. Similarly, 77% of the citizen participation respondents (strongly) agreed with this statement, whereas only 4% disagreed. This quantitative assessment indicates that the inclusion of an extra attribute (and alternative) did not reduce a respondent's choice conviction. Mind that respondents could have set preference, or focus on only one attribute, which may simplify their decision. Overall, the data indicates that respondents are generally convinced of their choices, which improves the result's feasibility. A higher understandability leads to more consistent answers, which in turn may lead to lower biases. The model estimation section assesses these propositions.

The respondents perceive the choice situations as realistic. Table 34, 35 and 36 show that 54%, 57% and 61% of the respective respondents (strongly) agree with this statement. Interestingly, the consumer and citizen participation experiment show a higher perceived realism than the citizen experiment. This could be because these experiments include more attributes, therefore take more aspects into account that concerns the respondents. Contrarily, slightly more respondents of the consumer experiment (strongly) disagree with this statement (13%) than both the citizen (10%) and citizen participation experiment (9%). The differences give some insights into the differences between the respondent's perception of the realism of the survey. However, no large differences are found, so no rigorous conclusions can be drawn. Despite this, it can be concluded that overall, the high perceived realism a positive insight; respondents may not take a survey serious if they perceive it as unrealistic.

Finally, the respondents were fairly positive of the added value of the surveys. The distribution of answers for the citizen experiment shows that 57% (strongly) agrees with this particular statement, while 8%% of the respondents (strongly) disagrees. The consumer and citizen participation experiment show an almost similar perceived added value, with respectively 56% and 57% of the respondents (strongly) agreeing. This is a rough indicator of the perceived relevance of non-market environmental goods and services from renewable energy technologies.

Table 32: Perceived attitudes of survey characteristics: citizen experiment

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was frequently convinced of my choice	26%	49%	20%	5%	1%
I think the choice situations are realistic	11%	43%	37%	8%	2%
This experiment provides relevant information for the Government to make decisions	14%	43%	35%	6%	2%

Table 33: Perceived attitudes of survey characteristics: consumer experiment

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was frequently convinced of my choice	27%	50%	21%	1%	1%
I think the choice situations are realistic	16%	41%	30%	11%	2%
This experiment provides relevant information for the Government to make decisions	17%	39%	32%	9%	3%

Table 34: Perceived attitudes of survey characteristics: citizen experiment

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was frequently convinced of my choice	24%	53%	20%	3%	1%
I think the choice situations are realistic	10%	51%	30%	8%	1%
This experiment provides relevant information for the Government to make decisions	11%	46%	32%	8%	2%

6.2.3 Non-trading behavior

The experimental designs prompt respondents to make tradeoffs between wind and solar energy farms based on the selected attributes. This way, the relative importance of the attributes can be estimated, which can be used to (1) predict an individual's preference for wind or solar energy farms and (2) identify which factors statistically significantly affect an individual's preference for wind or solar energy.

However, it may occur that respondents are non-trading individuals. This means that an individual has a set preference for an alternative and is unaffected by the choice situations presented. Such respondents do not yield any statistical information on the relative importance of the attributes. Insights into the amount of non-traders can give a first hint of the usefulness of the data and should be taken into account when interpreting the model estimations in 6.3.

A quantitative analysis of all three experiments shows that a substantive amount of the respondents are so-called non-traders. The citizen experiment results show that in total 37,7% of the respondents are non-traders: 25.7% of the respondents are non-traders for the solar energy farm alternative and 12% are non-traders for the wind energy farm alternative. The percentage of non-traders for the consumer experiment and the citizen participation experiment is slightly lower. The consumer experiment has a total of 28.9% of non-trading respondents with 14.7% consistently choosing an alternative solar energy park. Denote that these individuals consistently prefer a tax raising alternative over the (no payment) status-quo. The citizen participation experiment has 31.4% of non-trading respondents, with 20.1% consistently opting for the solar energy farm. Notice that for all experiments more non-traders have a preference for the (alternative) solar energy farm over the (alternative) wind energy farm.

Table 35: Non-traders citizen and citizen participation experiment

	Citizen	Citizen participation
Wind energy farm	12%	11.3%
Solar energy farm	25.7%	20.1%
Total	37.7%	28.9

Table 36: Non-traders consumer experiment

	Consumer
Planned wind energy farm	9.6%
Alternative wind energy farm	4.6%
Alternative solar energy farm	14.7%

Several causes may have induced this choice behavior, that can be ascribed to the two model components that determine an individual's choice, a deterministic observed component and a random unobserved component. The deterministic observed component is represented by the respective choice situations. The random unobserved component consists of unobserved alternative attributes, unobserved personal characteristics, measurement errors and proxy variables.

Hence, the substantive amount of non-traders can be caused by design choices that induce the observed component or by a respondent's prior knowledge that lead to a specific preference. For instance, one design choice for the observable component is the range of the attribute levels: the range may not be large enough to trigger a respondent to switch their preference. An example of the unobservable component may be that the possibility to build larger, cost effective off-shore wind energy parks induces a reluctance to build on-shore wind energy farms.

The larger share of non-trading respondents in the citizen experiment can be caused by the fact that a lower amount of attributes may have resulted in a larger random unobserved component. Overall, this analysis provides a first hint of the usefulness of the data and should be taken into account when interpreting the model estimations.

6.3 Conclusion

The analysis of the descriptive results explores the sample and observations. An online survey company gathered 572 respondents: 237, 218 and 194 respondents for the citizen, consumer and citizen participation surveys respectively. The exploration of choices illustrated that most respondents considered noise the most important attributes for their decision. Furthermore, the distribution of answers was fairly spread, with a majority of respondents choosing solar energy farms. Finally, the exploration showed that respondents were fairly convinced of their answer, perceived the choice situation realistic and the survey useful. The non-trading analysis outlined that more respondents non-traded for solar than wind energy farms for all three experiments. Furthermore, in the consumer experiment, there were more non-trading respondents for the alternative (payment required) than the 'free' status-quo.

7 MODELLING RESULTS

7 Modelling results

This chapter outlines the main modelling results and aims to "*estimate data of citizen and consumer preferences for trade-offs between environmental non-market goods and services of wind and solar energy farms"*(second part sub-research goal f). The respondents' answers to the three survey's choice situations is input for the model estimations. First, section 7.1 briefly recaps relevant MNL theory. Next, the MNL model specification are summarized in section 7.2. Then, section 7.3 highlights the main model estimation results. Section 7.4 discusses the results implications for policies to reduce environmental impacts from wind and solar energy farms. Section 7.5 provides a discussion on the model, model estimate results and the policy implications. Finally, section 7.6 concludes the chapter.

7.1. Multinomial Logit Model

As discussed in chapter 2, the **Multinomial Logit Model (MNL)** is the simplest and the most used discrete choice model. The model has a logit structure, based on two major assumptions: 1) the perceived attractiveness of the alternatives are mutually independent and 2) random variables are identically Gumbel distributed (Bovy, Bliemer, & van Nes, 2006).

This leads to the use of multinomial (or: conditional) logit (MNL) models to determine the probabilities of choosing i over q options (Hanley et al., 2001):

$$P_{iq} = P\ (i\ |C_q) = \frac{e^{V_{iq}}}{\sum_{j \in C_q} e^{V_{iq}}\ )}$$

Where:

P_{iq} is the probability an individual i chooses alternative q
V_{iq} is the utility of individual i to choose alternative q
C_q is the choice set of j alternatives for individual i

The simple mathematical structure and the ease of estimation has made the MNL widely adopted since the 1970s. The MNL model suits the main goal of this study to gain insights between the main attributes. However, one important disadvantage is that MNL models assume homogeneous preferences for a sample. This may lead to a low model fit; the level of uncertainty that a model is able to reduce for an analyst.

7.2. MNL model specification

This section discusses the MNL model parameter specification for the citizen, consumer and citizen participation experiments. For all three experiments, MNL models are estimated. The models are estimated with 237, 218 and 194 respondents for the citizen, consumer and citizen participation experiment respectively. All three experiments adopt a similar parameter specification approach; each alternative specific attribute was estimated by a utility parameter. This results in 8, 10 and 11 estimated parameters for the three experiments. The utility parameters for all hinder and land-use attributes for all experiments are estimated linearly. The attribute 'level of community participation' is dummy coded where the levels represent qualitative states of participation. The dummy coding scheme is sketched in Table 37.

Table 37: Dummy coding scheme

Levels	B_Decis	B_Coop	B_Cons
Level 3: Decision-making	1	0	0
Level 2: Cooperation	0	1	0
Level 1: Consultation	0	0	1
Level 0: No partcipation	0	0	0

Table 38: Parameter specification for all attributes adopted in the three experiments

MNL model parameter specification					
Citizen experiment		Consumer experiment		Citizen participation experiment	
Variable	*Parameter*	*Variable*	*Parameter*	*Variable*	*Parameter*
ASC_Solar	β_0	ASC_Solar	β_0	ASC_Solar	β_0
B_WNoise	β_1	ASC_Wind	β_1	B_WNoise	β_1
B_WAgr	β_2	B_WNoise	β_2	B_WAgr	β_2
B_WRecr	β_3	B_WAgr	β_3	B_WRecr	β_3
B_WVis	β_4	B_WRecr	β_4	B_WVis	β_4
B_SAgr	β_5	B_WVis	β_5	B_SAgr	β_5
B_SRecr	β_6	B_WTax	β_6	B_SRecr	β_6
B_SVis	β_7	B_SAgr	β_7	B_SVis	β_7
		B_SRecr	β_8	B_Cons	β_8
		B_SVis	β_9	B_Coop	β_9
		B_STax	β_{10}	B_Decis	β_{10}

Several hypotheses for the signs of the utility parameters are set up. First, negative estimate signs are expected for the alternative specific attributes ‘visibility’, ‘noise’, ‘agricultural land-use’ and ‘recreational land-use’. Specifically, it is expected that increase of hindered residents or hectares land-use results in a decrease of respondent’s utility for an alternative. Furthermore, it is expected that the cost attribute ‘tax payment’ is negative, which is consistent with basic economic theory. An increase in tax payment costs results in a decrease in a respondent’s utility for an alternative. Also, in line with the findings of Ek & Persson (2014) a positive sign is expected for the ‘level of community participation’. Thus, a respondent’s utility for an alternative will increase if the level of community participation increases. Finally, it is expected that the sign of the alternative specific constant for a solar energy farm will be positive. Currently, citizens are mostly confronted with on-shore wind energy farm construction in the media and in the physical living environment. Contrarily, only a few solar energy farms have been constructed, but not of a size that can replace planned wind energy farms. It is expected that respondents are more familiar with the negative attention for wind energy farms and therefore have a more positive attitude towards solar energy farms.

7.3. MNL model estimation results

MNL models are typically generated with (Bison) Biogeme, a free software package (Bierlaire, 2003). The Biogeme software program estimated three MNL models: the citizen, consumer and citizen participation model. This section highlights the main results of these estimated MNL models. First, the model fit estimations are outlined. Next, the utility estimates are sketched and compared. Finally, the marginal rates of substitutions (MRS) are assessed. Table 39 summarizes the model fit variables and the utility estimates. Table 40 outlines the statistical differences between the utility estimates based on the t-ratio test. The MNL model files are included in Appendix D.

Table 39: Model fit variables and utility estimates

Context	1. Citizen experiment				2. Consumer experiment				3. Citizen participation experiment			
Observations:	2844				2616				2328			
Individuals:	237				218				194			
Rho-square:	0,067				0,047				0,075			
Adjusted rho-square:	0,063				0,043				0,069			
Estimates												
	Est	*Std. err*	*t-test*	*p-value*	*Est*	*Std. err*	*t-test*	*p-value*	*Est*	*Std. err*	*t-test*	*p-value*
ASC_ Solar	0,411	0,202	2,040	0,04*	1,440	0,173	8,300	0*	-0,011	0,238	-0,050	0,960
ASC_ Wind	0.00	Fixed	--	--	1,880	1,180	1,600	0,110	0.00	Fixed	--	--
B_WNoise	-0,634	0,072	-8,760	0,00*	-0,507	0,190	-2,680	0,01*	-0,498	0,081	-6,120	0*
B_WLand	0,028	0,362	0,080	0,940	-0,824	1,520	-0,540	0,590	-0,029	0,399	-0,070	0,940
B_WRecr	0,075	0,713	0,110	0,920	-1,300	2,950	-0,440	0,660	-1,320	0,807	-1,630	0,100
B_WVis	-0,128	0,035	-3,640	0,00*	-0,175	0,116	-1,520	0,130	-0,204	0,041	-4,960	0*
B_WTax	--	--	--	--	-1,720	0,459	-3,750	0*	--	--	--	--
B_ZLand	-0,050	0,073	-0,680	0,490	-0,216	0,073	-2,980	0*	-0,062	0,081	-0,760	0,450
B_ZRecr	-0,001	0,001	-1,950	0,05*	-0,209	0,076	-2,750	0,01*	-0,0002	0,001	-0,280	0,780
B_ZVis	-0,269	0,037	-7,330	0,00*	-0,158	0,038	-4,190	0*	-0,197	0,040	-4,950	0*
B_ZTax	--	--	--	--	-0,562	0,227	-2,470	0,01*	--	--	--	--
B_Cons	--	--	--	--	--	--	--	--	0,099	0,079	1,260	0,210
B_Coop	--	--	--	--	--	--	--	--	0,436	0,076	5,740	0*
B_Decis	--	--	--	--	--	--	--	--	0,258	0,077	3,340	0*

Table 40: Statistical differences between the utility estimates based on the t-ratio test

T-ratio test			
	Citizen vs Consumer*	Citizen vs Citizen participation	Consumer vs Citizen participation
ASC Solar	3,88	N/A	N/A
B_WNoise	0,62	1,25	0,04
B_WLand	N/A	N/A	N/A
B_WRecr	N/A	N/A	N/A
B_WVis	N/A	-1,40	N/A
B_ZLand	N/A	N/A	N/A
B_ZRecr	-2,73	N/A	N/A
B_ZVis	2,11	1,33	-0,71

* The values reflect the deviations from the consumer experiment relative to the citizen experiment

7.3.1. Goodness of fit

The McFadden's Rho-squared statistic is typically measured to evaluate the model fit. The Rho-squared expresses the level of uncertainty the model reduces, compared to a model with all zero estimations. The *adjusted* Rho-square allows for a comparison of model fit across models, by correcting for the amount of estimated parameters. The adjusted rho-squares for the three experiments are 0.063, 0.043 and 0.069, which are considered low numbers. As a rule of thumb, a well-fitted model a rho-square value greater than 0.2 and rho-square higher than 0.4 are hard to find (Henscher and Johnson, 1981). For instance, the citizen experiment adjusted rho-square of 0.063 signifies that the estimated model is able to reduce the level of uncertainty by 6.3%, compared to a model with all zeros. Therefore, the MNL model's ability to predict citizen and consumer choices between wind and solar energy farms is arguable. However, the model is still suitable to identify statistically significant attributes.

7.3.2. Model estimates

Table 39 summarizes the model estimations for the citizen, consumer and citizen participation experiments. Denote that all statistically significant attributes have their a priori expected sign. Furthermore, the estimation parameter and p-value of the statistically significant utility parameters (on a 95% confidence interval) are highlighted in red. The next paragraphs highlight the major results and conclusions of the three model estimates. The next sections elaborate on each model's estimation.

7.3.2.1. Citizen experiment estimates

The statistically significant citizen experiment attributes are: the solar 'alternative specific constant' (ASC), wind noise, wind visibility, solar visibility and solar recreational land-use. The ASC for a solar energy farm is statistically significant with an estimation parameter of 0.411, which means that when all attribute levels are zero, an individual utility for solar energy farm a wind energy farm. The significant parameter estimates for the wind energy farm alternative 'wind noise' and 'wind visibility' are -0.634 and -0,128 utils. Both attributes are estimated linearly. Therefore, this means for 'wind noise' and 'wind visibility' that an increase of 100 households with hinder, utility for the alternative decreases with 0.634 util and 0.128 utils. The significant parameter estimates for the solar energy farm alternative 'solar visibility'' and 'solar recreational land-use' are -0.269 and -0.0014 respectively. This means that the for every 100 households extra exposed to visual hinder, the utility drops with 0.269. Furthermore, an increase in 100 hectares use for a solar energy farm induces a utility decrease of 0.0014.

7.3.2.2. Consumer experiment estimates

The statistically significant consumer experiment attributes are: the solar ASC, wind noise, wind tax, solar visibility, solar agricultural land-use, solar recreational land-use and solar tax. The ASC for solar energy contends that consumers have a highly significant preference for a solar energy farm over a wind energy farm, for attributes not present in the alternatives. The wind energy ASC does not significantly influence the choice of consumers. The wind 'noise' utility parameter is negative, as expected, and shows that every 100 households with noise hinder induces a utility drop of 0.507. The 'wind tax payment' is significant and negative, where a payment of €100 leads to a decrease in utility of 1.72 utils. This shows that the utility of the alternative wind energy farm decreases strongly when the tax payment price of the alternative program increases. The significant solar energy attribute coefficients for 'solar visibility', 'solar agricultural land-use' and solar 'recreational land-use' are -0.158, -0.216 and -0.209 respectively. This means that a visual hinder increase per 100 households reduces the alternative utility with 0.158. Furthermore, an increase of 100 hectares of agricultural or recreational land-use results in a decrease of the alternative's utility by 0.216 and 0.209. Finally, the estimated parameters 'solar tax payment' is -0.562. This means that for every €100 tax payment the solar energy farm's utility decreases with 0.562. The 'tax payment' attribute can be used in conjunction with the other attributes to determine the willingness to pay for an increase or decrease of the quality and quantity of an attribute. This is called the "implicit price" and is calculated by the following formula:

$$Implicit\ price = -\frac{\beta\ nonmarket\ attribute}{\beta\ monetary\ attribute}$$

Note, that by dividing one parameter by the other, the scale is reduced to a decrease of a single unit, rather than 100. The calculated implicit prices are determined 'per household', since the survey asked for a single energy tax increase and energy tax is contributed per household. Furthermore, consider that the implicit price shows the marginal willingness to pay from a single energy tax payment to reduce noise hinder (wind) or visibility hinder (solar) for one resident from its base level.

Table 41 shows an overview of the calculated implicit prices and their values on 95% confidence interval. Denote that the implicit price of environmental attribute is calculated with their respective alternative specific 'tax payment' attribute. The implicit prices represent the relative marginal willingness to pay for the non-market environmental impacts. The negative sign indicates that an increase of 1 households or 1 hectare yields a value loss of the equal to the implicit price. Therefore, an improvement of the environmental quality, which is similar to a decrease of the attribute value (number of households or number of hectares) yields a positive implicit price and a specific willingness to pay.

Table 41: Overview of calculated implicit prices

	Wind energy farm	Solar energy farm		
	Noise	Visibility	Agricultural land-use	Recreational land-use
β non-market attribute	-0,507	-0,158	-0,216	-0,209
β tax-payment	-1,72	-0,562	-0,562	-0,562
Implicit price	-€0,29/resident	-€0,28/resident	-€0,38/hectare	-€0,37/hectare
Standard error	€0.14	€0,13	€0,20	€0,20
95% confidence interval	€ 0,03 -€ 0,56	€ 0,02 - € 0,54	€ 0,003-€ 0,77	€ -0,02 -€ 0,77

Table 42: Overview of t-ratio test for implicit prices

T-ratio test implicit prices				
	Noise	Solar Visibility	Solar Agricultural land-use	Solar Recreational land-use
Noise		0,07	-0,37	-0,32
Solar Visibility			-0,43	-0,38
Solar Agricultural land-use				0,04
Solar Recreational land-use				

The most important insights are that the average implicit prices for solar agricultural and recreation land-use are larger than the average implicit price for noise and solar visibility. Furthermore, observe that it can be concluded that on a 95% confidence interval consumers have a positive willingness to pay for noise, solar, but not for agricultural and recreational land-use. Therefore, the results should be interpreted cautiously. In line with this, a t-ratio test is conducted to attest whether the marginal willingness to pay values are statistically significantly larger or lower to one another. The major conclusion from this analysis is that none of the implicit prices is statistically higher or lower to another. This should be taken into account when comparing the implicit prices.

7.3.2.3. Citizen participation experiment

The statistical significant citizen participation attributes are: wind noise, wind visibility, solar visibility and the community participation levels cooperation and decision-making. The estimates for the wind alternative specific attributes 'wind visibility' and 'wind noise' are -0.204 and -0.498, which purports that an increase of 100 households subjected to visual or noise hinder induces a utility decrease of 0.204 and 0.498 respectively. Similarly, 100 households with visibility hinder from a solar energy farm induces a utility reduction of 0.197. The generic nominal attribute 'level of community participation' is dummy coded and estimated. Three utility parameters for the levels 'consultation', 'cooperation' and 'decision-making' are estimated, all relative to the reference level 'no participation'. Figure 16 shows the non-linear attribute estimation. Respondents do not find the first level and current status-quo, 'consultation' (the possibility to submit non-binding objections, alterations or alternatives in design and planning matters), a significant improvement from the reference level 'no participation'. However, 'cooperation' and 'decision-making' have a positive statistically significant utility parameter of 0.436 and 0.258. This means that these levels of community participation yield a significant improvement in utility compared to 'no participation'. More specifically, cooperation has the highest estimated utility, which represents the level that both the local community and the government have (equal) decision-making power. Besides this, citizens see 'decision-making' as a significant improvement compared to 'no participation', which represents the level that only the local community (and not the government) has decision-making power. Note that, respondents assign the highest utility to cooperation.

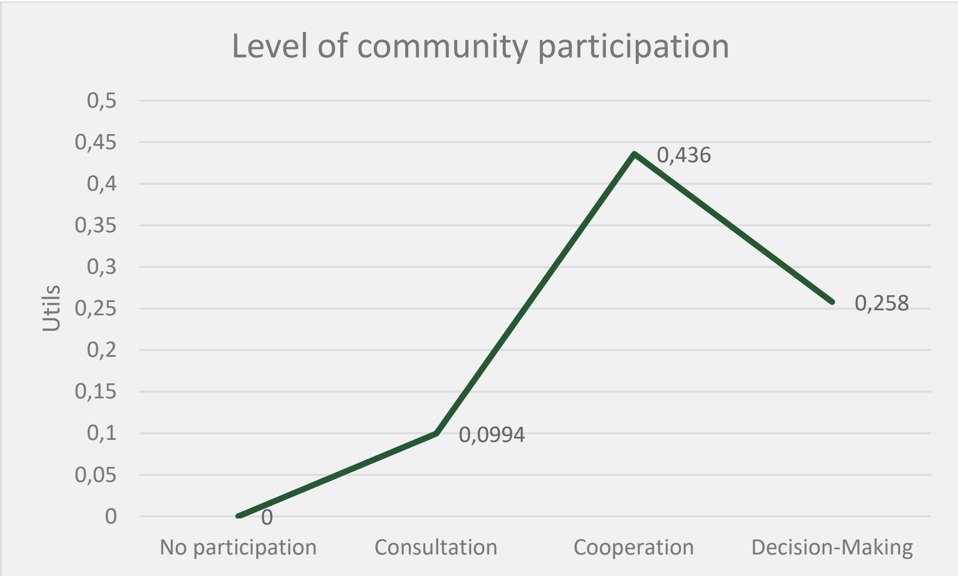


Figure 16: Utility estimates level of community participation

7.3.2.4. Comparison model estimate results

The first major difference is that there are differences in the statistical significant attributes for the citizen and consumer and citizen participation experiments. Table 43 highlights these differences between the estimated utility parameters per experiment.

Table 43: T-ratio test across experiments

	Citizen experiment	Consumer experiment	Citizen participation experiment
ASC Solar	0,411	1,44	
Wind Visibility	-0,128		-0,204
Wind Noise	-0,634	-0,507	-0,498
Wind Agricultural land-use			
Wind Recreational land-use			
Solar Visibility	-0,269	-0,158	-0,197
Solar Agricultural land-use		-0,216	
Solar Recreational land-use	-0,0014	-0,209	

Several differences between the citizen and consumer experiments can be derived. Wind visibility is statistically significant in the citizens experiment, but not in the consumer experiment, suggesting that an individual allocating previously tax money does consider wind visual hinder, but an individual spending their after-tax income does not. Contrarily, the agricultural land-use of solar energy farms is statistically significant for consumers, but not for citizens, suggesting that an individual spending their after-tax income is willing to pay to reduce the agricultural land-use of solar energy farms, but an individual allocating previously collected tax money is not. Furthermore, some numerical differences between the statistical significant attributes are found. For instance, ASC solar is larger for a consumer (1.44) than for a citizen (0.411). Similarly, solar recreational land-use is much larger in the consumer experiment (-0.209) and the citizen experiment (-0.0014). Also, noise hinder is larger in the citizen than in the consumer experiment.

Some differences between the common citizen and citizen participation attributes are found. The ASC solar is statistically significant in the citizen experiment (only just), but not in the citizen participation experiment. Similarly, the solar recreation land-use estimate is significant in the citizen experiment but not in the citizen participation experiment. Besides this, some differences between attributes that are statistically significant for both experiments. The noise and solar visibility estimates are larger for the citizen experiment than the citizen participation experiment. Contrarily, the wind visibility estimation is larger in the citizen participation experiment.

7.3.3. Comparison Statistical differences

A t-ratio test is conducted to assess if attributes estimates are statistically higher or lower between experiments on 95% confidence interval. Table 44 summarizes the statistical significant differences between utility parameters of the three model estimations.

Table 44: Statistical significant differences between utility parameters

T-ratio test			
	Citizen vs Consumer*	Citizen vs Citizen participation	Consumer vs Citizen participation
ASC Solar	3,88	N/A	N/A
B_WNoise	0,62	1,25	0,04
B_WLand	N/A	N/A	N/A
B_WRecr	N/A	N/A	N/A
B_WVis	N/A	-1,40	N/A
B_ZLand	N/A	N/A	N/A
B_ZRecr	-2,73	N/A	N/A
B_ZVis	2,11	1,33	-0,71
* The values reflect the deviations from the consumer experiment relative to the citizen experiment			

Denote that only t-ratios are determined for utility parameters that are significant between both experiments. Several main inferences are deduced. First, denote that a consumer has a statistically significantly higher preference than a citizen for solar energy farms when all attribute values are zero (t-ratio = 3.88). Furthermore, striking is that no significant difference is found between the utility that respondents attribute to noise hinder in the citizen, consumer and citizen participation experiment. Next, the data approximates that consumers attribute a statistically significant lower utility value to solar recreational land-use. In absolute terms, this means that the utility reduction from solar recreational land-use is statistically higher for consumers than citizens. Finally, the t-ratio estimation indicates that consumers derive a statistically significant higher utility from solar visibility hinder than citizens. In absolute terms, this means that the utility reduction from solar visibility hinder is lower for a consumer than a citizen. Finally, no statistically significant differences are deduced for the citizen and citizen participation experiments.

7.3.4. Model estimate conclusions

In this section, the major conclusions from the analysis of model fit, model estimates and t-ratio tests are deduced.

The MNL model's ability to predict citizen and consumer choices between wind and solar energy farms is arguable. However, the model is still suitable to identify statistically significant attributes.

The findings from the three model estimations translate into several insights. The most important insight is that citizens and consumers derive statistically significant different utility for several environmental impacts from wind and solar energy farms. Two main observations are deduced.

1. A citizen derives significant utility for wind visibility but the consumer does not. Contrarily, the consumer derives significant utility from agricultural land-use while the citizen does not (in both experiments)
2. For differences between statistical significant attributes there are two major observations discussed. Citizens derive a statistically significant higher utility for solar visibility hinder reduction, while hinder, while consumer derive a significantly higher utility for solar recreational land-use reductions.

Another major finding is that the relative importance of statistically significant attributes are inferred. A first key observation is that noise hinder induces the highest negative utility in all three experiments. Furthermore, citizens derive significant utility for the two community participations levels that entail the provision that the community has *binding* decision-making power. The current status-quo 'consultation' (without binding decision) is no significant improvement from no participation.

The last major finding is that respondents do not elicit statistical significant higher or lower marginal WTP from noise, solar visibility, agricultural land-use and recreational land-use. However, the average marginal WTP suggests that consumers may have a higher marginal WTP for agricultural and recreational land-use over noise and solar visibility. This is in contrast with citizen experiment results. Furthermore, it is inferred that respondents have a positive marginal WTP for wind noise and solar visibility on a 95% confidence interval. However, solar agricultural and recreation land-use have a small chance for a negative (or no) significant relationship.

7.4. Policy implications

This section proffers directions to research feasible policy implications. The policy implications are congruent with the context described in section 4.1. The next sections translate the model results per attribute to interesting policy implications. Denote that implications for wind energy farm policies mostly suggests researching alterations of current policy. However, the insights for solar energy farms provides a starting point for research to develop consistent policies.

Section 7.4.1 elaborates on policy implications noise for wind and solar visual hinder. Next, section 7.4.2. discusses implications for Furthermore, section 7.4.3 assess implications for agricultural and recreational land-use. Finally, section 7.4.4 highlights the model result implications for participation.

7.4.1. Visual hinder

The model results show that individuals significantly care about both wind and solar visual hinder.

This implies that research can focus on identifying policy measures that reduce visual hinder. A feasible option is to conduct a study that identifies building site locations that naturally reduce visual impact, in order to advice provinces to strategically locate the smaller wind energy farms (5-100MW). For instance, studies could research how and where wind and solar energy farms can be integrated with current (road and rail) infrastructure, mounted to public rooftops or incorporated in industrial areas. The research could compare these options and make recommendations for policies to increase capacity of these technologies applications.

Besides this, research could be conducted to inform policy-makers on effective strategies to reduce solar visibility hinder for planned solar energy farms that impact the living environment. For instance, several solar energy farm lay-outs can be compared, reducing visibility hinder in different ways, such as blocking the view with trees, build a dike around the perimeter or deploying low mounted solar energy panels. Policy-makers could stimulate specific options that prove effective.

7.4.2. Noise hinder

The model results illustrate that individuals significantly care about noise hinder. Moreover, noise hinder reduction is attributed the highest utility increase in all experiments. This implies that research efforts should focus on effective policy measures that aim reduce noise hinder.

Research efforts could evaluate a range of policy measures that may stimulate both short and long term innovations for noise reduction. For instance, a noise provision in the SDE+ grant criteria could drive innovations of construction companies that wish to tender for a wind energy farm. Furthermore, setting up a research fund could drive long-term noise reduction innovations. Besides this, studies could aim to identify effective institutional arrangements to reduce noise hinder. For instance, Nieuwehuizen and Köhl (2015) already analysed and compared the noise regulations of four European countries and concluded that the Dutch regulation scheme allows for the most flexible noise levels. The Netherlands is the only country that has a yearly averaged maximum noise level, whereas other countries have adopted an absolute noise level maximum.

Similar to visual hinder, research could advice provinces on the selection of building sites that generate the lowest noise hinder. For instance, the research could identify 'noisy' locations, where wind turbine noise is reduced through background noise of infrastructures or industrial installations.

7.4.3. Land-use

The model results illustrate that individuals significantly care for the solar energy farm land-use. Spatial planners and construction companies could adopt strategies to reduce the agricultural and recreation land-use of solar energy farms. The selection of the type of solar panel construction can be in congruence with the original function of the land. For instance some solar panel set-ups allow cattle grazing better than others.

7.4.4. Community participation

One of the major findings of this study is that the level of community participation significantly affects the preferences of individuals for a government financed renewable energy project. Research could focus on:

- How can *binding* decision making power for local community be (lawfully) guaranteed?
- How can a cooperative community participation be embedded in the development of the decision-making process?
- What are interesting planned wind energy farm projects to experiment with cooperative decision-making?

For example, the cooperative decision-making process could be organized as proposed by Koers (2017), by organizing a citizen parliament. A representative selection of 150 individuals forms a citizen parliament through a voluntary lottery system for several years. These parliaments design and discuss the strategic allocation of renewable energy capacity on a local level, congruent with local sustainability goals. Independent project management companies work side-by-side and provide relevant information, translate ideas to feasible design and manage the decision-making process. Visualization and sound simulations can be used to imitate potential future hinder of designs. Furthermore, mapping methods can assist with the spatial planning and account for land-use.

7.5. Discussion

The model estimations generate insights into the way citizen and consumers make trade-offs between the environmental impacts of wind and solar energy farms. The next sections elaborate on the model, the results and policy implications generated in this chapter.

7.5.1. Discussion of the model

The estimated models have a low goodness of fit, which implies that the models ability to predict choices of citizens and consumers between wind and solar energy farms is arguable. Several additions to the model may increase the model fit and can be categorized as design and estimation options.

Several design changes in the experimental (survey) design may have improved the model of fit. First, other or more attributes could have been incorporated in the choice situations to reduce the preference of respondents for attributes not specified. For instance, the literature study in section 4.2.1.1 deduced that biodiversity impacts often yield statistical significant utilities. Furthermore, the attribute ranges may have been too small to induce enough relevant data. Non-trading behavior can occur, in which respondent's choice is unaffected by the level of the attributes. Section 6.2.3 deduced that for every experiment around 30% of the respondents are non-trading. As an exploration, for the citizen experiment, an MNL model for a subset sample of only trading respondents was estimated to get insight into the effect on the model fit. The adjusted rho-square increased from 0.063 to 0.102. The model fit estimation data of this subsample is outlined in Appendix E. This shows that non-traders may affect the model fit.

Several model estimation strategies can be identified to improve model fit. Denote that linear relations are assumed for all attributes, but 'level of community participation'. Estimating non-linear relations between attribute levels may increase the model fit. However, this goes beyond the scope of this research. Also, the MNL model estimates homogeneous preferences, which may induce a low model fit. The inclusion of the interaction of main effects with covariates, like personal or socio-economic factors may lead to a higher fit. However, this goes beyond the scope of this research.

Furthermore, the use of different models that account for heterogeneity of tastes, like the Random Parameter Logit model, the Mixed Logit model and the Latent Class Analysis may increase the model fit, Table 45. Several selected studies from section 4.2 (with both MNL and other models) do not provide a conclusive insight. On the one hand, the study of Brennan and Rensburg (2016) shows a an increase of model fit by 27%. On the other hand, Ek and Persson (2014) generated MNL and RPL estimates with only a 1% increase of model fit.

Table 45: Comparison of model fit MNL and RPL

Author	Model estimations	MNL Goodness of fit [rho-squared]	Other	
Vecchiato **&** Tempesta (2015)	MNL model	0.22	RPL	0.33
Brennan and Rensburg (2016)	MNL model	0.11	RPL	0.38
Ek and Persson (2014)	MNL model	0.11	RPL	0.12

This shows that there are several design and modelling strategies possible to increase the low model fit.

7.5.2. Discussion of the results

This section elaborates on the citizen and consumer results. First, the citizen experiments are discussed. Then, the consumer model estimate results are compared.

7.5.2.1. Citizen model estimate results

The citizen and citizen participation experiment results are the first empirical scientific contributions that elicits the preference of individuals allocating previously collected tax money to wind and solar energy farms. In both models, citizens derive the highest negative utility for noise impacts. This is consistent with the findings in chapter 5, that deduced that noise is the most influential attribute according to respectively 49% and 43% of the respondents. Furthermore, this is also in congruence with Langer et al (2017) who find that the sound level has the highest average importance compared to other attributes. Both wind and solar visual hinder are attributed significant utility by citizens. The quantitative analysis in chapter 6 demonstrates that 25% and 22% of the respondents indicate visibility is the most important attribute. Contrarily, agricultural land-use is considered by 13% and 12% of the respondents most important. The respondents provided motivations for their selection of the attribute that influenced their decision the most. An analysis of these responses provides some clues for the relative difference between these attributes.

"If you don't want to see it, you can close your eyes or look in another direction. Noise is really annoying. It is always there. Closing doors and windows is a solution but not in the summer."

"Continuous noise hinder can result in medical or psychological distress" and "noise hinder can lead to chronic health issues."

The latter statement is in line with Langer et al (2017), who state that the perceived health affects influences the acceptance of wind energy farms.

Furthermore, the citizen participation experiment finds a statistical significant relationship for the levels 'cooperation' and 'decision-making' from the community participations attribute. Moreover, denote that respondents derive a higher utility increase from 'cooperation' than an increase from most environmental attributes (except for noise). While this is the first stated preferences that find such a significant relation from a citizen perspective, the link is not unique.

For instance, Brennan and Van Rensburg (2016) and Dimitropoulos and Kontoleon (2009) assess environmental impacts that motivates communities to resist the installation of wind energy farms in their vicinity. They estimate a respondent's willingness to accept (WTA) environmental impacts and governance characteristics for the planning procedure measured in annual subsidies per household living in the vicinity. It may be interesting to research if and how the results from a citizen preference study can be translated to measures of public acceptance. This may concretize what this study implicitly suggests: a relative high negative citizen utility for environmental impacts may explain a low public acceptances.

7.5.2.2. Consumer model estimate results:

Comparison with other literature:
The state of the art research in section 4.2 outlined the key environmental impacts of wind and solar energy farms assessed in prior stated preference literature. Many studies derive a significant relationship for wind visibility hinder as presented in table 11. This study contends these results; the model estimates demonstrate no significant relation for the reduction of wind visual hinder (the study estimates a p-value of 0.13, thus a 87% of significantly influencing consumers). However, the majority of these studies use a fossil fuel alternative as opt-out (O'Keeffe, 2014; Bergmann, 2008; Bergmann, 2006). Interestingly, the results from our study are in agreement with Mariel et al (2015) who use a similar set-up as this experiment (wind energy status-quo with consistent attribute levels). This indicates that the definition of the status-quo option may influence the statistical significance of visual hinder. However, no strong conclusions can be drawn. Furthermore, this study derives statistical significant utility for visual hinder from solar energy farms. This challenges the findings from Vecchiato and Tempesta (2015) who purport that people are not disturbed by solar energy farms at a distance of 3 km and closer. In addition, this study purports the first statistical significant relations for solar agricultural and recreational land-use. The study is the first discrete choice experiment that deduces that noise impacts are highly significantly. While prior research frequently mentions the importance of noise, very few other stated preference studies substantiate this assertion. The results contradict the findings of Ek (2002) who purport that noise impacts are not statistically significant on a 95% confidence interval.

Aggregation of marginal WTP:
This study finds a marginal WTP to reduce noise hinder, solar visual hinder, solar agricultural land-use reduction and solar recreational land-use reduction. This marginal WTP should be interpreted as the average willingness to pay per household. Multiplying these values with the amount of households in the Netherlands (7,720,787 households) the aggregated WTP for these environmental impacts can be estimated.

Table 46: Implicit prices and aggregated WTP

	Noise	Solar visibility	Agricultural land-use	Recreational land-use
Implicit price	-€0,29/resident	-€0,28/resident	-€0,38/hectare	-€0,37/hectare
95%	€ 0,03 -€ 0,56	€ 0,02 - € 0,54	€ -0,003 -€ 0,77	€ -0,02 -€ 0,77
Aggregated WTP	€2,240,000/resident	€2,160,000/resident	€2,930,000/hectare	€2,860,000/hectare
Range	€231.624 - €4.400.000	€154.416 - €4.169.225	€ -23.162– € 6.022.213	€ -231.623– € 6.022.213

The aggregated WTP seems rather high. For instance, the aggregated WTP to reduce noise or solar visual hinder per resident is almost ten times higher than the average housing price (€264.000) in the Netherlands (CBS, 2017). Similarly, the average price per hectare for agricultural land is €57.800 (Kadaster, 2017). However, keep in mind that the ranges of a 95% are rather large. For noise and solar visibility, there is a 95% chance that the average WTP is higher than €231.624. However, for the land-use attributes, a positive WTP is uncertain on a 95% interval. Therefore, the results should be used carefully. However, a brief discussion on the high marginal WTP provides leads for future research.

The first influencing factor is drawn from the unit of measurement of the payment vehicle. The respondents were asked for a single tax increase for *one* particular building site. In reality, many more wind energy farms are planned. It is likely that a yearly tax payment increase, or an increase per wind energy farm may reduce the marginal WTP. In fact, an analysis of the motivations of respondents to the question: '*what attribute is **least** important for your decision*?' showed that 50% (13/26) of the respondents mentioned that this was because that it was only a *single* payment.

This may especially hold for respondents who prefer solar energy over wind energy independent of the attribute levels. The highly significant solar ASC indicates that many respondents may be willing to pay just to change the technology type. The quantitative analysis supports this explanation; there were more non-traders willing to pay for the alternative solar energy program (14.7%) than the 'free' option (9.6%). Respondents may have translated the hypothetical situation to their personal living environment and decided that living to next to a solar energy farm is better than living next to wind turbines. Respondents may have thought that a single payment to reduce hinder in their area is worth it. The analysis of the perceived most influential attributes underlines this; 42% of the respondents indicated that noise was the most important attribute in their choice. An analysis of the motivations to the most influential attribute provides some indicators.

Another cause for the high average WTP to pay is the assumption that all respondents have a similar marginal rate of substitution between income and the environmental effect. Instead, income effects may repress the WTP for a specific household. Finally, the warm glow effect may be a cause for the high willingness to pay. Respondents may consider that contributing to an improvement of environmental quality is their moral responsibility.

Finally, mind that an impact reduction of recreational land-use does not have the same implication as a reduction of noise hinder, solar visual hinder and agricultural land-use. A hinder increase by one residents is a very direct and clear concept: one extra house has noise or visual hinder. Similarly, a reduction of agricultural land-use also has a direct implication: one hectare can be used to grow crops or hold cattle. In contrast, a decrease of one hectare of recreational ground does not have such direct implications. It may be that the accessibility to the full area is unaffected. The direct consequences are not that intuitive and therefore, the value loss from a hectare recreational land may be to higher degree circumstantial.

7.5.3 Discussion of policy implications

The model estimate results deduce insights that may have implications for policies to deal with the environmental impacts of wind and solar energy farms. For wind energy farms, this gives clues how to amend existing policies. For solar energy farms it gives direction to move towards designing the first consistent policy facilitating building site selection and design principles to tailor the solar panels within the living environment. However, denote that this research is a first attempt to estimate environmental impacts of wind and solar energy farms by asking individuals to allocate previously collected tax money. Research efforts should be expanded to build a robust body of literature that may inform policy-makers more specifically about the relative importance of environmental impacts.

The results of this study may mostly convey the general insights to renewable energy policy-makers that environmental impacts affect the choices of individuals and research effort should aim to identify policies that aim to address this.

7.6 Conclusion

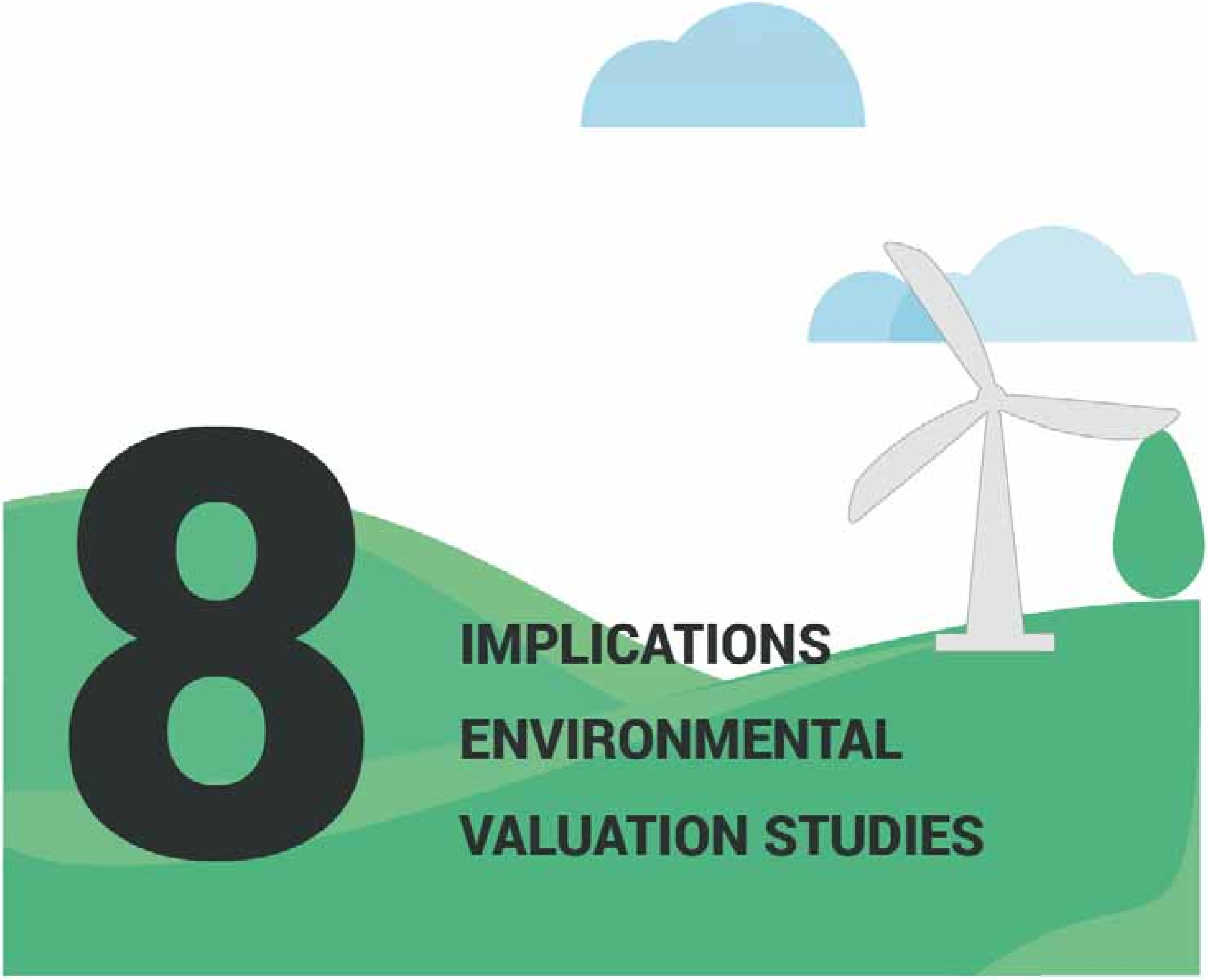
This chapter outlined the model estimation results. The influence of visual hinder, noise hinder, agricultural land-use, recreational land-use and community participation are tested by means of an MNL model estimation. The results are compared and statistical differences between models are derived. The gained insights are translated in several to implications for renewable energy policy, that can be researched.

The analysis of model results conveys what attributes significantly influences the choice of citizens and consumers make different trade-offs between environmental impacts of wind and solar energy farms. Several attributes significantly influence the choice of both citizens and consumers, noise, solar visibility and recreational land-use. Furthermore, citizens derive significant utility for the two community participations levels that entail the provision that the community has *binding* decision-making power. The current status-quo 'consultation' (without binding decision) is no significant improvement from no participation. The consumer experiment conveys that respondents do not elicit statistical significant higher or lower marginal WTP from noise, solar visibility, agricultural land-use and recreational land-use. However, the average marginal WTP suggests that consumers may have a higher marginal WTP for agricultural and recreational land-use over noise and solar visibility.

Several differences between citizens and consumers are identified. The citizen derives significant utility for wind visibility but the consumer does not. Contrarily, the consumer derives significant utility from agricultural land-use while the citizen does not. Furthermore, the t-ratio test derives differences across experiments for the attributes that are statistically significant in both citizen and consumer experiments. Two major observations are discussed. Citizens derive a statistically significant higher utility for solar visibility hinder reduction, while hinder, while consumer derive a significantly higher utility for solar recreational land-use reductions.

Policy implications are derived from the model estimation results. Policy-makers may increase research efforts to inform on policies to identify strategic construction sites that naturally mitigate visual and noise hinder. Furthermore, research should give insights into the effectiveness of several design approaches to reduce solar visibility and solar agricultural and recreational land-use.

The reflection on the model identifies several approaches to potentially increase the model fit, such as including unobserved attributes, exclude non-traders, introduce non-linearity and introduce heterogeneity of tastes.



8 IMPLICATIONS ENVIRONMENTAL VALUATION STUDIES

8 Implications environmental valuation studies

The goal of this chapter is to explore how citizen and consumer preferences can be used by policymakers for the valuation of the environmental impacts of wind and solar energy farms. Currently, the government uses economic valuation studies like the (social) cost-benefit analysis (SCBA) and the (social) cost-effectiveness analysis. These appraisal studies allow to compare all societal effects of renewable energy project alternatives. This includes the direct financial costs and indirect costs, like the impact on the (living) environment. Typically, the (living) environmental impacts are measured through a revealed preference method, the hedonic pricing method and aims to estimate devaluation of house prices. However, often no statistical significant relation is deduced between locally constructed wind energy farm and housing prices (CE Delft, 2016).Therefore, mostly a qualitative positive/neutral/negative impact is asserted to a range of environmental impacts. Interestingly, both citizen and consumer preferences find significant relationships for factors the SCEA could not incorporate.

Thus, the citizen and consumer preferences could perhaps provide more insight into these environmental costs of renewable energy projects. Furthermore, it is interesting to conclude and discuss differences in policy recommendations based on these valuations. Therefore, first, section 8.1 conceptualizes several renewable energy technology projects. Then section 8.2 evaluates the insights from the different environmental valuation frameworks. Section 8.3 outlines a discussion on the differences of these results.

8.1 Conceptualization evaluation frameworks

This section conceptualizes four renewable energy technology alternatives. Section 8.1.1. summarizes and reflects on the theoretical framework from chapter 3, in order to derive a citizen and consumer valuation framework. Next, section 8.2 draws from the research context in chapter 4 and the policy recommendations in chapter 7 to develop feasible renewable energy technology project alternatives.

8.1.1 Difference citizen and consumer valuation framework

This section reflects on the citizen-consumer duality literature in order to define a citizen and consumer environmental valuation framework.

First, the fundamental difference between the citizen and the consumer is as defined in chapter 3 is:

- Individuals in a political setting, allocating previously collected tax money
- Individuals in a market setting, spending their after-tax private income

The central assertion in this study is that an individual’s preference to spend either budget may significantly differ. As a result, eliciting consumer preferences to assess government financed renewable energy projects could lead to wrong conclusions. Moreover, as described in chapter 1, the government aims to value the environmental impacts in infrastructural appraisal studies. This may inherently lead to wrong policy-making decisions. Therefore, it is interesting to assess what policy-decisions may result from environmental valuation frameworks based on the elicited citizen and consumer preferences in this study.

However, this is not a straightforward endeavour. Denote that the citizen and consumer preferences have a different unit of measurement and are therefore not interchangeable in environmental valuation frameworks. Citizen preferences are elicited for renewable energy projects alternatives with a constant previously collected tax budget. Therefore, they cannot be expressed in monetary terms. Contrarily, consumer experiments include a cost attribute, which allows for the estimation of the marginal rates of substitution between environmental impacts and private after-tax money spending. As a result, so called implicit prices express the relative importance of environmental impacts in monetary terms.

This conceptual difference evidences that the evaluation of the environmental impacts of renewable energy project alternatives is fundamentally different. In fact, so far no extensive empirical assessment of a citizens utility valuation framework has been applied to evaluate project alternatives. Contrarily, typically a consumer preference welfare estimation analysis is widely adopted in stated preference literature to evaluate renewable energy project alternatives.

Therefore, section 8.1.2 deduces a citizen utility valuation framework, while section 8.1.3 outlines the consumer welfare valuation framework.

8.1.2 Citizen utility valuation framework

This section explores how the acquired citizen preferences can be translated into an renewable energy technology appraisal study.

The citizen estimations results acquired in this study cannot be translated directly into existing economic appraisal methods like the CBA or CEA, since the estimations are not traded-off with costs. Therefore, Mouter, et al. (2016) suggest that the utility parameter estimations can be used in a 'opportunity cost analysis'. The respondents in the experiment were asked to choose between two renewable energy projects that require the same of previously collected tax money. Therefore, the trade-offs that individuals make, result in utility per tax money budget. Let's assume the government has designated a total of 100 million euros to finance one of these projects over a lifetime of 15 years. A renewable energy alternative consists of a package of environmental impact, which results in a citizen utility. One can compare these two projects by the unit 'utility per 100 mln tax money'. In this research, the relative utility of several statistically significant attributes are identified. Table 47 summarizes these utilities per resident.

Table 47: Utility Evaluation Framework

Utility Evaluation Framework	Utility	Unit
Wind Visibility	-0,00128	resident
Wind Noise	-0,00635	resident
Solar Visibility	-0,00269	resident
Solar Recreational land-use	-0,000014	hectare
Solar alternative specific constant (ASC)	+ 0.411	
Community participation: Cooperation	+0.436	
Community participation: decision-making	+0.258	

Let's consider an example choice situation as formulated in the citizen choice experiment. The wind and solar energy alternatives are expressed by a combination of environmental impacts, presented in a package deal. The environmental impacts are presented in Table 48.

Table 48: Overview of environmental impacts

	Wind	Solar	Unit
Visibility	100	200	Residents
Noise	50	0	Residents
Agricultural land-use	10	150	Hectares
Recreation land-use	20	150	Hectares

Now a citizen utility framework is constructed to assess what a citizen utility valuation framework looks like. Denote that each project's utility per tax money budget (of 100 mln euro). Furthermore, the impact of each attribute is multiplied with the unit utility (the amount of utility decrease when the impact increases with one unit).

The utility function of a wind energy farm is determined by the visibility and noise hinder it inflicts on the residents that live next to the building site. The utility function of the solar energy farm is determined by the alternative specific constant, the visual hinder and the solar recreational land-use. These two tables are combined into one citizen utility framework and is presented in Table 49.

Table 49: Combined citizen utility framework

Attributes	Wind energy farm		Solar energy farm	
	Impact	Utility	Impact	Utility
ASC				0,411
Visibility	100	-0,128	200	-0,538
Noise	50	-0,318	0	0
Agricultural land-use	10	0	150	0
Recreational land-use	20	0	150	-0,002
Total		**-0,45**		**-0,129**

The interpretation of the framework could be as follows: the citizen value per government budget of 100 million is -0.45 for the specified wind energy farm and -0,13 for the specified solar energy farm. The difference in citizen value for the non-market environmental impacts of these specific renewable energy projects is 0.321 for the 100 million euro tax money budget.

Moreover, it provides insights in the quantitative contribution of specific environmental impacts to the final score. The latter can be the input for several follow-up steps for policy-makers. In this case, the policy-maker now *understands* that citizens derive a negative utility for wind energy from noise hinder and visibility hinder. Furthermore, it shows that the negative utility derived from noise hinder is almost three times larger than visual hinder. On the other hand, the policy-maker now understands that negative utility from solar energy farms is almost solely caused by visibility hinder for local residents. These insights may help to formulate policy measures that may improve the citizen utility value for environmental impacts.

8.1.3 Consumer welfare estimation framework

This section explores how the acquired consumer preferences can be translated into a consumer welfare estimation of renewable energy project alternatives.

The consumer valuation method is the status-quo typically used to assess relative performances of renewable energy projects.

Typically, the consumer utilities estimated in discrete choice experiments are translated to a welfare estimation (Bergmann, 2006; Bergmann, 2008; Ek and Persson, 2014). Such an estimation allows to compare a series of alternative energy projects to a reference project. The change in utility can be transformed to a change in welfare (in single tax payment in €/household) by incorporating the cost attribute, as shown in the equation below.

$$Welfare\ change = -\frac{1}{b_a}(U_0 - U_1)$$

Where b_m is the estimated tax payment attribute, U_0 is the utility from the base experiment and U_1 is the utility from the alternative renewable energy project. This gives a sense of relative performance of several projects which helps a decision-maker to select a project.

The consumer model estimations show for what attributes consumers are willing to contribute. Attributes that significantly affect a consumer are shown in Table 49. Denote that the utility parameter are a numerical representation of the utility loss caused by a unit increase of hinder or land-use. Within this study, three project alternatives are compared. Thus, a base project that is equal to the “planned wind energy farm” option from the consumer survey. And the other two projects are similar to the option described in the citizen utility evaluation. The three project alternatives are present in Table

Table 50: Attributes that significantly affect a consumer

Consumer welfare estimation	Utility	Unit
Noise	-0,00507	Resident
Solar Visibility	-0,00158	Resident
Solar Agricultural land-use	-0,00216	Hectare
Solar Recreational land-use	-0,00209	Hectare

Table 51: Three project alternatives and their attribute impact

	Planned wind energy farm	Alternative wind energy farm	Alternative solar energy farm	Unit
Visibility	300	100	200	Residents
Noise	150	50	0	Residents
Agricultural land-use	40	10	150	Hectares
Recreation land-use	20	20	150	Hectares

To provide better insights, the values of the three alternatives are incorporated in a consumer welfare estimation that is shown in Table 52.

Table 52: Consumer welfare estimation

Attributes	Planned wind energy farm		Alternative wind energy farm		Alternative solar energy farm	
	Impact	Utility	Impact	Utility	Impact	Utility
Constant				0		1,44
Visibility	300	0	100	0	100	-0,158
Noise	150	-0,7605	50	-0,2535	0	0
Agricultural land-use	40	0	10	0	150	-0,324
Recreational land-use	20	0	20	0	150	-0,3135
Total		-0,7605		**-0,2535**		**0,6445**
Welfare		0		€ **29,48**		€ **250,00**

The consumer welfare estimation shows that both the alternative wind energy farm and the alternative solar energy farm generate welfare improvements compared to the base project. On the one hand individuals are willing to pay for noise hinder reductions for wind energy farms. On the other hand, there is a significant preference for solar energy over wind energy farms. Despite the agricultural and recreation land losses people are willing to pay for solar over the base project.

The interpretation of this evaluation is that individuals are asked if they want to contribute a share of their after-tax income to reduce environmental impacts. The attribute package deals formulated in an alternative wind energy farm and an alternative solar energy farm results in a willingness to pay €29,48 or €250,00 for these alternatives respectively.

8.2 Scenario analysis

In this section renewable energy project alternatives are assessed in a citizen and consumer framework. First, section 8.2.1 outlines the translation of several policy implications from section 6.4 to renewable energy project alternatives. Then, section 8.2.2 evaluates and compares these alternatives in a citizen and consumer framework. Finally, section 8.2.3 compares and discussed these results. The construction site of the planned wind energy farm at Monden and Oostermoer in Drenthe is taken as a case study. The visual and noise hinder attribute level estimation from section 4.3 was derived from this site and is therefore used. Furthermore, CE Delft (2016) studies and compares a 180 MW and 560 MW solar energy farm on this location. Their land-use approximations for wind and solar energy farm are depicted in table Table 53.

Table 53: Case study attribute levels

	Wind	Solar
Number of households with visual hinder	155	155
Number of households with noise hinder	30	0
Amount of hectares agricultural land-use	7,5	525
Amount of hectares recreational land-use	2,5	175

8.2.1 Renewable energy alternatives

This section develops four different renewable energy projects, derived from the identified policy implications from section 6.4. The most important wind attribute is noise. Furthermore, community participation is major influential attribute for both wind and solar. In this example, two wind energy farms alternatives are developed, varying in either noise or community participation. The most important attributes for solar energy farms are solar visibility and agricultural land-use. Therefore, two solar energy farm alternatives are derived.

Wind alternatives

1: Noise reduction. The government attempts to reduce hinder by legislating an absolute noise limit. As a result, construction companies tender for wind energy projects with innovated 'quiet' wind turbines.

2: Community participation. The government mandates that communities close to construction site have binding veto power. As a result a citizen parliament is actively involved in the planning and design phase of the constructed renewable energy farm.

Solar alternatives

1: Reduction visibility hinder. The government sets up solar energy farm fitting guidelines to reduce visibility hinder. As a result, the perimeter of the solar energy farm is masked by embankments/trees and bushes to reduce its visibility. Furthermore, a low solar energy panel construction set-up is adopted.

2: Reduction land-use. The government sets up standards to minimize agricultural land-use, by regulating the use of high pole solar panel configuration. We assume that agricultural land-use is reduced by 20% and farms can continue to use these parts of the land for crops and cattle grazing.

Renewable energy alternatives overview

Wind 1: Noise	hinder reduced to 0
Wind 2: Participation	Cooperative participation
Solar 1: Visibility	Hinder reduced to 0
Solar 2: Agricultural land-use	-20%

8.2.2 Citizen renewable energy project evaluation

This section evaluates the citizen utility of specified renewable energy project alternatives within the context of the specified construction site. The utilities for the different technology citizen utilities are outlined in Table 54.

Table 54: Citizen utility framework

	Reference	Wind 1: Noise	Wind 2: Participation	Solar 1: Visibility	Solar 2: Agricultural land-use
ASC	**No**	**No**	**No**	**Yes**	**Yes**
Visual hinder	*(155)*	155 residents	155 residents	**0 residents**	155 residents
Noise hinder	*(30)*	**0 residents**	30	0 residents	0 residents
Agricultural land-use	*(7,5)*	7,5 hectare	7,5	525 hectares	**420 hectares**
Recreational land-use	*(2,5)*	2,5 hectares	2,5	175 hectares	175 hectares
Community participation	*(Consultation)*	Consultation	**Cooperation**	Consultation	Consultation
Utility	-0.35	-0.20	0.05	0.41	-0,01

A couple of inferences can be made from this table. First, denote that in this evaluation framework, with constant previously collected tax budget Solar 1 induces the highest citizen utility and Wind 1 the lowest. Second, denote that the utility for the solar alternatives is also affected by the significant alternative specific constant. Third, observe that Wind 2 induces a higher utility than Wind 1, indicating that in this example, increasing participation is a more effective policy measure to increase citizen utility. participation is a more effective policy measure than noise reduction. Furthermore, denote that Solar 1 has a much higher utility than Solar 2, indicating that reducing visibility hinder is a more effective policy measure than reducing agricultural land-use. Based on this analysis, a policy analyst would recommend to deploy a solar energy farm with reduced visibility to minimize environmental impacts.

8.2.3 Consumer renewable energy project valuations

This section evaluates the specified renewable energy project alternatives within the context of the specified construction site. Table 55 outlines the consumer welfare estimation for the different technologies. The attribute community participation is omitted in this framework; since this was not tested in the consumer experiment. However, keep in mind that several studies have already purported that consumers make trade-offs between community participation and their after-tax income.

Table 55: Consumer welfare estimation

	Reference	Wind 1: Noise	Solar 1: Visibility	Solar 2: Agricultural land-use
ASC	No	No	Yes	Yes
Visual hinder	*(155)*	155 residents	**0 residents**	155 residents
Noise hinder	*(30)*	**0 residents**	0 residents	0 residents
Agricultural land-use	*(7,5)*	7,5 hectare	525 hectares	**420 hectares**
Recreational land-use	*(2,5)*	2,5 hectares	175 hectares	175 hectares
Welfare	€0	€ 8,84	€ 16,43	€ 33,58

Several observations can be made from this welfare estimation evaluation. First, this welfare estimation based on consumers preferences for the allocation of after-tax income, shows that the Solar 2 generates the highest welfare gains and Wind 1 the lowest welfare gains. Furthermore, Solar 2 results in higher welfare gains than Solar 1, which indicates that in this example, reducing agricultural land-use is a more effective policy measure than reducing solar visibility hinder. Based on this analysis, a policy analyst would recommend to adopt an agricultural land-use reduction policy to increase the consumer welfare.

8.2.4 Comparison results from citizen and consumer evaluation

A comparison of the results of the citizen utility framework and consumer welfare estimation infers several insights. The major insight is that (within the assumption of this case study), citizen and consumer valuation methods of environmental impacts may result in different policy recommendations. For instance, the results demonstrate that in this case study, citizens derive the highest utility for a solar energy farm that minimizes visual hinder. Contrarily, more welfare benefits are derived by consumers for a solar energy farm that reduces noise hinder. Several factors contribute to this difference. First of all, citizens do not derive utility from agricultural land-use, while consumers do. Furthermore, citizens derive significantly less utility from recreational land-use than consumers (as concluded in section 7.3. Furthermore, citizens derive significantly more utility from solar visibility hinder reductions than consumers.

8.3 Conclusion

This chapter explores how citizen and consumer preferences are incorporated in environmental valuation frameworks. This is done by establishing the conceptual difference between citizen and consumer valuation frameworks and assessed by means of a case study. The analysis demonstrates that citizen utility valuation frameworks may consider utility points per consistent previously collected tax money budget. The welfare estimation allows to derive monetary impacts.

This chapter demonstrates that the use of citizen or consumer preferences for the valuation of the environmental impacts of renewable energy technologies may lead to different policy recommendations. More specifically, this exploration elucidates that the question 'which renewable energy project would you recommend the government to finance from previously collected tax money, based on the environmental impacts' may lead to different policy recommendations than the question 'which renewable energy project would you recommend the government, based on the allocation of one after-tax income to reduce environmental impacts.

In the case study, a solar energy farm with minimized solar visibility hinder induces the highest relative citizen utility per tax money budget. Contrarily, the solar energy farm with reduced solar agricultural land-use induces the highest welfare gains. The fundamental difference is derived from the differences in utility parameters for solar visibility and solar agricultural land-use in the different experiments. Mind that these results are based on a case study with the intent to illustrate rather than conclude.

8.4 Discussion

This section reflects on the conclusions drawn in this chapter. The first major consideration is that the this chapter merely aims to explore if differences can occur. The results are based on a simplified case study with many assumptions.

Finally, denote that the results from the citizen utility framework are not directly applicable to existing infrastructure appraisal studies like the SCBA and SCEA because it establishes utility per consistent tax money budgets. However, SCEA studies assume consistent electricity production and so far, wind energy has a higher electricity yield per tax euro. Future scientific contributions could aim to bridge the conceptual differences between citizen utility approaches to environmental impacts and current economic appraisal tools.

9 CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

9 Conclusions, discussion and recommendations

This study aimed to gain insights in how individuals in their role as a citizen and as a consumer make trade-offs between non-market environmental goods and services from wind and solar energy farms. Three discrete choice experiments were designed to create hypothetical choice situations that elicited citizen and consumer preferences from respondents. The results from the MNL model provide first empirical results on the choice behavior of citizens for (technical and institutional) environmental impacts of wind and solar energy technology. Furthermore, the comprehensive design of all three experiments allows to compare results from both citizen and consumer based experiments. These results could be used in future studies on the citizen consumer duality. Furthermore, the results give policy-makers insights into the relative importance of non-market environmental characteristics of wind and solar energy farms, which may help in spatial planning projects or renewable energy technology investment programs. Section 9.1 outlines the main conclusion of this research, through a step-by-step assessment of all sub-research goals, ultimately determining whether the main research goal is reached. Section 9.2 discusses the results of this research. Subsequently, section 9.3 outlines the recommendations for science and society.

9.1 Conclusions

This research assessed which factors affect the preferences of citizens and consumers for wind or solar energy farms. The study included (non-market) environmental impact of the wind and solar energy farms. These preferences were elicited through the design of three discrete choice experiments. The next sections each address a research sub-goal.

9.1.1 Defining citizen and consumer

The first sub-research goal is:

> "To *define the concepts of consumer and citizen, based on stated preference literature".*

The stated preference methods used to value non-market goods are the contingent valuation method (CVM) and the discrete choice experiments (DCE). In this field, there has been an ongoing discussion on what is labeled as the consumer-citizen duality. The basis of the discussion is formed around the debate whether respondents behave as consumers or citizens in stated preference surveys and whether their willingness to pay (WTP) responses differ depending on these different roles. Research attempts to assess if such differences exist yet remains inconclusive about the definition of citizen and consumer. Essentially two conceptualizations are identified within the citizen-consumer duality discussion. The first separates consumers and citizens on the basis of self-interested and other regarding individuals. The second categorizes them on the basis of the preference towards private or public budget spending. Within this second conceptualization we have discussed two different interpretations and have argued that one interpretation truly separates preferences on private (consumer) and public (citizen) budgets. This thesis adopts the following definition: a citizen is an individual who reveals preferences in a political setting on the allocation of (previously collected) tax money by the government. A consumer is an individual who reveals preferences on spending their personal budget in a market setting.

9.1.2 Selecting relevant factors

The second sub-research goal of this study is:

> *"To select relevant factors that influence an individual's preference for a wind energy farm or a solar energy farm"*

So far, no empirical studies have been conducted to determine factors that may influence preference of an individual in the role of citizen for wind or solar energy farms. However, an abundance of contributions assess what factors significantly influence the choice of consumers for renewable energy technologies. The context description demarcates the situation of a selected construction site for a government financed wind or solar energy farms. The surge of local resistance against wind energy farms demonstrates the asymmetry between the government and community's perspective on the societal effects. The government reasons that wind energy farms are the preferred solution, while Dutch citizens worry about the impacts on the living environment. A literature study was conducted to identify relevant factors technological and institutional characteristics of wind and solar energy farms (project), that are potentially incorporated as 'attributes' in the discrete choice experiments. The list of characteristics was tested for societal relevance and measurability by experts in several discussion sessions. Three experiments were identified. One citizen experiment aims to infer trade-offs between environmental impacts (from technical characteristics). A similar consumer experiment allows for a comparison of results. Finally, a third experiment aims to infer how citizens trade-off both technical and institutional characteristics of wind and solar energy farms.

The following attributes were selected for all three experimental designs: visibility, noise, agricultural land-use, recreational land-use. The consumer experiment included an additional attribute 'tax payment' to adhere to a consumer market setting, while the citizen participation includes 'level of community participation'.

9.1.3 Design of discrete choice experimental surveys

The third sub-research goal is:

"To design stated choice experiments to measure citizen and consumer preferences to infer trade-offs from the non-market environmental goods and services of wind and solar energy farms."

A two staged D-efficient design approach was adopted to design three surveys. In the first stage a pilot study is constructed by means of an orthogonal design. This ultimately results in estimation coefficients for most of the attributes used in the three experiments. These so-called priors can be used to generate efficient models in the second stage. Furthermore, the pilot study can be used to collect feedback on the survey length and understandability. Based on this, changes to the introductory texts were made. Finally, information on the choice behavior of respondents is used to adjust attribute levels. The MNL estimation of the pilot study orthogonal design generates the priors for three D-efficient designs for the three final surveys. A comprehensive design of all three surveys was chosen to minimize the differences and allow a comparison of data across the surveys. The same amount of choice sets and the same value and number of level attributes were selected. The table below shows the end result of the experimental design. After that, the full surveys were designed.

9.1.4 Descriptive results

The fourth sub-research goal is:

> *"To gather analyze data of citizen and consumer preferences for trade-offs between environmental non-market goods and services of wind and solar energy farms."*

The analysis of the descriptive results explores the sample and observations. An online survey company gathered 572 respondents: 237, 218 and 194 respondents for the citizen, consumer and citizen participation surveys respectively. The exploration of choices illustrated that most respondents considered noise the most important attributes for their decision. Furthermore, the distribution of answers was fairly spread, with a majority of respondents choosing solar energy farms. Finally, the exploration showed that respondents were fairly convinced of their answer, perceived the choice situation realistic and the survey useful. The non-trading analysis outlined that more respondents non-traded for solar than wind energy farms for all three experiments.

Table 56: Recap attribute level per experiment

Attribute	Alternative 1: Wind energy farm	Alternative 2: Solar energy farms	Status quo: Planned Wind energy farm
Visibility number of residents with visual hinder	0 residents 100 residents 200 residents 300 residents	0 residents 100 residents 200 residents 300 residents	300 households
Noise	0 residents 100 residents 200 residents 300 residents	N/A	150 households
Agricultural land use	10 hectares 20 hectares 30 hectares 40 hectares	50 hectares 100 hectares 150 hectares 200 hectares	40 hectares
Recreational land-use	5 hectares 10 hectares 15 hectares 20 hectares	50 hectares 100 hectares 150 hectares 200 hectares	20 hectares
Tax Payment	€5 €25 €45 €65	€5 €25 €45 €65	N/A
Level of community participation	No participation Consultation Cooperation Decision-making	No participation Consultation Cooperation Decision-making	

9.1.5 Modelling results

The fifth sub-research goal is:

> *"To infer citizen and consumer preferences for trade-offs between non-market environmental impacts of wind and solar energy farms."*

The analysis of model results conveys what attributes significantly influences the choice of citizens and consumers make different trade-offs between environmental impacts of wind and solar energy farms. Table 57 highlights the model estimate results for all three experiments. Furthermore, Table 58 outlines the statistical differences between the utility parameters across experiments.

The following main inferences can be made. Several attributes significantly influence the choice of both citizens and consumers, noise, solar visibility and recreational land-use. Furthermore, citizens derive significant utility for the two community participations levels that entail the provision that the community has *binding* decision-making power. The current status-quo 'consultation' (without binding decision) is no significant improvement from no participation. The consumer experiment conveys that respondents do not elicit statistical significant higher or lower marginal WTP from noise, solar visibility, agricultural land-use and recreational land-use. However, the average marginal WTP suggests that consumers may have a higher marginal WTP for agricultural and recreational land-use over noise and solar visibility.

Several differences between citizens and consumers are identified. The citizen derives significant utility for wind visibility but the consumer does not. Contrarily, the consumer derives significant utility from agricultural land-use while the citizen does not. Furthermore, the t-ratio test derives differences across experiments for the attributes that are statistically significant in both citizen and consumer experiments. Two major observations are discussed. Citizens derive a higher statistically significant utility for solar visibility hinder reduction, while hinder, while consumer derive a significantly higher utility for solar recreational land-use reductions.

Table 57: Recap model estimation results

Context	4. Citizen experiment				5. Consumer experiment				6. Citizen participation experiment			
Observations:	2844				2616				2328			
Individuals:	237				218				194			
Rho-square:	0,067				0,047				0,075			
Adjusted rho-square:	0,063				0,043				0,069			
	Est	*Std. err*	*t-test*	*p-value*	*Est*	*Std. err*	*t-test*	*p-value*	*Est*	*Std. err*	*t-test*	*p-value*
Estimates												
ASC_ Solar	0,411	0,202	2,040	0,04*	1,440	0,173	8,300	0*	-0,011	0,238	-0,050	0,960
ASC_ Wind	0.00	Fixed	--	--	1,880	1,180	1,600	0,110	0.00	Fixed	--	--
B_WNoise	-0,634	0,072	-8,760	0,00*	-0,507	0,190	-2,680	0,01*	-0,498	0,081	-6,120	0*
B_WLand	0,028	0,362	0,080	0,940	-0,824	1,520	-0,540	0,590	-0,029	0,399	-0,070	0,940
B_WRecr	0,075	0,713	0,110	0,920	-1,300	2,950	-0,440	0,660	-1,320	0,807	-1,630	0,100
B_WVis	-0,128	0,035	-3,640	0,00*	-0,175	0,116	-1,520	0,130	-0,204	0,041	-4,960	0*
B_WTax	--	--	--	--	-1,720	0,459	-3,750	0*	--	--	--	--
B_ZLand	-0,050	0,073	-0,680	0,490	-0,216	0,073	-2,980	0*	-0,062	0,081	-0,760	0,450
B_ZRecr	-0,001	0,001	-1,950	0,05*	-0,209	0,076	-2,750	0,01*	-0,0002	0,001	-0,280	0,780
B_ZVis	-0,269	0,037	-7,330	0,00*	-0,158	0,038	-4,190	0*	-0,197	0,040	-4,950	0*
B_ZTax	--	--	--	--	-0,562	0,227	-2,470	0,01*	--	--	--	--
B_Cons	--	--	--	--	--	--	--	--	0,099	0,079	1,260	0,210
B_Coop	--	--	--	--	--	--	--	--	0,436	0,076	5,740	0*
B_Decis	--	--	--	--	--	--	--	--	0,258	0,077	3,340	0*

Table 58: Recap t-ratio test across experiments

T-ratio test			
	Citizen vs Consumer*	Citizen vs Citizen participation	Consumer vs Citizen participation
ASC Solar	3,88	N/A	N/A
B_WNoise	0,62	1,25	0,04
B_WLand	N/A	N/A	N/A
B_WRecr	N/A	N/A	N/A
B_WVis	N/A	-1,40	N/A
B_ZLand	N/A	N/A	N/A
B_ZRecr	-2,73	N/A	N/A
B_ZVis	2,11	1,33	-0,71

Policy implications are derived from the model estimation results. Most importantly, policy-makers should design effective policy measures to reduce the noise hinder from current and planned wind energy farms. Furthermore, policy-makers may increase research efforts to inform on policies to identify strategic construction sites that naturally mitigate visual and noise hinder. Furthermore, research should give insights into the effectiveness of several design approaches to reduce solar visibility and solar agricultural and recreational land-use.

The reflection on the model identifies several approaches to potentially increase the model fit, such as including unobserved attributes, exclude non-traders, introduce non-linearity and introduce heterogeneity of tastes.

The differences in citizen or consumer preferences has implications for environmental valuation studies of renewable energy technologies and may lead to different policy recommendations. The conceptual differences between citizen and consumer preferences imply that different environmental valuation frameworks should be used. By means of scenario analysis, alternative renewable energy projects were evaluated. The citizen utility evaluation framework concluded that a solar energy farm with minimized visual hinder results in the highest relative citizen utility per tax money budget. The consumer welfare estimation established that the solar energy farm with reduction in agricultural land-use yields the highest increase of welfare expressed in WTP per household. Finally, the

9.1.6 Insights into the citizen and consumer trade-offs

The main research goal is:

> *"To gain insight into how individuals in their role as a citizens and as a consumer make trade-offs between non-market environmental goods and services of wind and solar energy farms, by designing stated choice experiments."*

This study focuses on the role of an individual as a citizen and as a consumer in stated preference methods. A citizen is an individual who reveals preferences in a political setting on the allocation of (previously collected) tax money by the government. A consumer is an individual who reveals preferences on spending their personal budget in a market setting.

This study focuses on two renewable energy technologies: wind energy farms and solar energy farms. These two options are chosen for a reason. The Dutch government has introduced long-term tax-money financing schemes for wind energy farms. Solar energy farms are the most likely alternative.

Factors that may influence citizens and consumers are derived from a literature review and selected through expert sessions. Four technological characteristics were selected as attributes: visibility, noise, agricultural land-use, recreational land-use. Furthermore, one institutional characteristic was selected: level of community participation. Finally, one cost attribute was added to the consumer experiment: tax payment.

The main insights are:

Citizen and consumer preferences:

- Individuals in their role as citizens allocating previously collected tax money between wind and solar energy farms are significantly influenced by non-market environmental impacts noise hinder, solar visual hinder, wind visual hinder and solar recreational land-use.
- Furthermore, citizens derive significant utility for the two community participations levels that entail the provision that the community has *binding* decision-making power. The current status-quo 'consultation' (without binding decision) is no significant improvement from no participation.
- Individuals in their role as consumers spending their (after-tax) private budget are significantly influenced by noise, solar visibility, solar agricultural land-use and solar recreational land-use.
- The consumer model estimates conveys that respondents do not elicit statistical significant higher or lower marginal WTP from noise, solar visibility, agricultural land-use and recreational land-use.

However, the average marginal WTP suggests that consumers may have a higher marginal WTP for agricultural and recreational land-use over noise and solar visibility. Furthermore, the results convey a positive marginal WTP for noise and solar visibility on a 95% confidence interval. However, the marginal WTP of solar agricultural and recreational land-use may be zero or negative on a 95% confidence interval.

Differences between citizen and consumer preferences:

- The comparison of model estimates advances the idea that the role of an individual as a citizen or a consumer may lead to different preferences for wind and solar energy farms. For instance, a citizen significantly cares for the visual hinder of wind energy farms, but the consumer does not. Contrarily, consumers significantly care for the agricultural land-use of solar energy farms, but the citizen does not.
- The statistical analysis of differences of attributes across attributes shows that consumers have a statistically higher preference for solar energy farms when all attribute values are zero. Furthermore, consumers attribute a higher statistically significant utility to solar recreational land-use than citizens, but attribute statistically significant less utility to solar visual hinder than citizens. Interestingly, citizens do not attribute significantly more utility to noise hinder than consumers.

Differences in policy recommendations:

- This research demonstrates that the use of citizen or consumer preferences for the valuation of the environmental impacts of renewable energy technologies may lead to different policy recommendations.
- The comparison conveys that the conceptual difference between citizen and consumers implies that different environmental valuation frameworks are required. A citizen utility evaluation framework assesses a project alternative's 'citizen utility per tax budget' whereas the consumer welfare estimation framework measures a project's alternative welfare in monetary terms.
- A citizen utility evaluation framework is conceptually different to current renewable energy technology environmental valuation studies. Citizen utility frameworks assess project alternatives with consistent tax money allocation, whereas current environmental valuation studies assume consistent electricity production across alternatives.
- Future research efforts can focus on the application of a citizen utility framework in renewable energy technology environmental evaluation studies.

9.2 Discussion

This section discusses several aspects of this research. First, section 9.2.1 discusses the two-staged D-efficient design approach and section 9.2.2 highlights considerations regarding the survey design. Furthermore, section 9.2.3 contemplates on the models used and section 9.2.4 discusses what trends in society may impact the results of this study. Finally, section 9.2.5 discusses some limitations to this research.

9.2.1 Experimental design

A two-staged efficient design approach was adopted in this research. It was assumed that the construction of efficient designs would generate the most information. However, this is not always the case. Studies research the different results generated by different designs. For instance, Walker et al. (2016) research the robustness of experimental designs based on the used priors. Efficient experimental designs are the first choice when one is certain about the prior of the parameter. However, when one is uncertain about the priors used, a Bayesian efficient design is more robust. Since no prior research has conducted research on the citizen preferences for environmental impacts of renewable energy technologies, a Bayesian efficient design would have more wise. However, a Bayesian design requires more time and adds complexity to the model and was therefore omitted.

The pilot study resulted in prior estimates that was input for the design of the d-efficient final experiment. However, the pilot study considered the basic environmental impact attributes: visibility, noise, agricultural land-use and recreational land-use. No priors were estimated for the attributes 'tax payment' and 'level of participation'. For these parameters priors were set to 0.

The range of some of the attribute levels may not have been large enough. The attribute selection was mostly focused on creating realistic trade-off situations for renewable energy farms with equal electricity output. However, a considerable amount of non-traders (around 30%) were identified for every experiment per experiment. Furthermore, the relative difference of land-use by solar energy farm land-use compared to wind energy farms may have been too large. This may explain why wind agricultural land-use and recreational land-use did not affect the choice of respondents in any of the experiments.

In line with this, the results of the attribute land-use may change significantly if a different definition is selected. This research defined land-use as *direct replaced* land-use. While this factor is relatively small compared to solar energy farms, the spatial dimensions are much larger.

9.2.2 Survey

The consumer experiment survey was designed in such a way that respondents needed to make a single contribution for an alternative wind or solar energy farm. Many attributes showed a statistically significant relationship with a consumer's choice. However, this could be different if the survey would have stated such a tax payment could occur for more projects.

Respondents earn points that can be used to pay. There always is a risk that respondents only fill in the survey to obtain this fee. The survey included several mandatory motivation questions. An analysis from the responses showed that some respondents only filled in a '-'for these questions. However, the vast majority of the respondents filled in sensible motivations, which is indication of how serious they took the survey (and how well they understood it).

Despite this, there is a risk that respondents interpret the information and choice situations differently than an analyst intends. Several steps were taken to reduce this so-called hypothetical bias. The respondents could reread the explanation of the attributes in every choice situation; a text-box with all information was added to every choice situation, in case respondents wanted to check specific details. Furthermore, impressions of possible visual impacts from wind and solar energy farms were shown to help respondents visualize this effect. An added benefit is that respondents will have a more consistent image of visual hinder. Beside this, maps were included in every choice situation to help respondents visualize the land-use of wind and solar energy farms.

9.2.3 Model

This research only estimates MNL models to gain insights into the attribute main effects. Train (2003) describes several advantages and disadvantages of MNL models. The MNL is widely adopted amongst scholar due to its ability to efficiently estimate utility parameters. However, there are several limitations to the MNL models. The first limitation of the MNL model is that it assumes homogeneity in preferences. The model is not capable to measure random taste variations between respondents, while it likely that one respondent may find agricultural land-use very important, but another respondent not. Several options are available to get insights into heterogeneity. First, interaction effects between socio-demographic characteristics and main effects can be estimated. Furthermore, advanced models like the Mixed Logit or Latent Class Analysis allow to assess heterogeneity. Introducing heterogeneity may also increase the goodness of fit of the models and thus improve its ability to predict choices for citizens and consumers.

The MNL models assumed linearity for all attributes but the level of community participation. Introducing non-linearity in the model may improve the ability to predict citizen and consumer

MNL models specified linear relations modelling of non-linear effects through estimating dummy variables for attribute levels

9.2.4 Society

This section discusses some societal developments and issues that may affect the results of this study.

Momentum solar energy farms

The results of this study demonstrate statistically significant unobserved preference for the solar energy farms. However, the solar energy technology is relatively unknown compared to wind energy and has had a low environmental impact. Currently, the largest solar energy farm has a capacity of 31 MW and spans over 30 hectares. However, the electricity output of this farm is similar to 5 wind turbines of 3 MW. Therefore, in order for solar energy farms to significantly contribute to the renewable energy targets (14% in 2020), more and larger solar farms need to be developed. Indeed, large-scale grounded solar energy farms are on the rise; more than 200 new projects are planned for construction in the next years, of which four have a capacity of 50+ MW.

The upscale of solar-energy farms complicates fitting in the living environment. A trade-off has to be made between scalability and spatial fitting. The results of this study show that people significantly care for the environmental impacts of solar energy farms. Already, the first signs of conflict show up, where local population protested against the plans to construct a solar energy farm of 41 hectares close to Leeuwarden (Trouw, 2017). If the environmental impacts of large solar energy farms are not properly managed or mitigated, I expect more of this news in the coming years.

Development of cooperative renewable energy farms

The dissatisfaction of the renewable energy deployment has resulted in a bottom-up movement to reach the local sustainability goals. Wind and solar energy cooperatives allow local residents to invest in a part of the renewable energy farms. This way, they help move forward achieving the energy goals against a moderate return on investment. The added benefit is that this movement optimizes the spatial quality, which results in a reasonable business case and electricity production.

Improving business cases

The SDE+ fund is a policy means to overcome the trade-off between costs and renewable energy electricity output. The subsidy scheme intends to temporarily overcome the negative business case of wind and solar energy farms, while driving innovation and learning effects until a positive business case is possible. So far, the government has chosen to optimize the increase in renewable energy capacity by minimizing subsidy costs. Therefore, the construction of onshore and offshore wind energy farms is prioritized.

The business case of the wind and solar energy farms is steadily improving over time. In fact, the business case of solar energy is expected to improve faster than the business case of onshore wind energy. However, it is expected that it will not outperform onshore wind until 2030. Therefore, until then, solar energy farms require more subsidies than wind energy.

Contrarily, offshore wind energy farms are expected to run profitably soon and the Ministry of Economic Affairs saves billions of previously allocated tax money. The government could use optimize for electricity output and designate more offshore wind energy farms or use the free budget to improve the business case of solar energy farms.

9.2.5 Limitations to the research

A stated preference data collection method was used instead of a revealed preference method. The generated data represents choices for hypothetical situations rather than real situations. Therefore, it remains the question if respondents would make the same choices in real life consequences.

The experiments only considered wind or solar energy farms as renewable energy technology options and did not consider other technologies. Respondents could prefer other renewable energy technologies or could prefer a different application of the technology. For instance, one respondent commented that she preferred an increase of rooftop solar pv installations in the Netherlands. Furthermore, electricity producers also experiment with combined wind and solar energy capacity installation on a building site. In line with this, the experiments only assessed a limited amount of attributes.

Furthermore, the citizen-based discrete experiments do not have an opt-out alternative. In reality, people may not want to allocate tax money to renewable energy projects. The lack of an opt-out results in another limitation; the results can only be compared within the research context and cannot be generalized.

The selection of attributes and other factors was based on a literature study and expert discussion sessions. Naturally, a selection of literature was reviewed. Perhaps other scientific contributions propose different attributes and factors that were not included in the surveys. For instance, the electricity output of a renewable energy farm was not included. Several of the selected studies have included this attributes in their discrete choice experiment. However, it appeared to be too difficult to realistically incorporate this in a survey. First of all, the unit of measurement for electricity output was a problem. Amount of MWhs hardly mean anything to respondents. The reviewed studies often adopted 'increase of % renewable energy' in an area. However, the real added value of respondents choosing between a 10-20% increases was criticized. Furthermore, from a technical perspective, electricity generated at a particular site does not really exclusively end up at the residents.

9.3 Recommendations

This section highlights the main scientific (section 9.3.1) and societal (9.3.2) recommendations based on the results of this research.

9.3.1 Science

This section outlines the main recommendations for further scientific research.

Expand research with unobserved alternatives and attributes
The discussion mentioned that a limitation to this research is that only two alternatives are assessed. Future research could study the trade-offs people make between other alternatives. I recommend several research initiatives to build up a body of knowledge on the citizen preferences for non-market environmental impacts of renewable energy technologies:

- Research the trade-offs people make between same technologies to gain more insight in the relative environmental impacts per technology (what are the relative preferences between environmental impacts of the wind energy park that is build)
- Research the trade-offs people make between variations of the same technology to gain more insight into the preferences per technology variation (what are the relative preferences for the environmental impacts of for instance, onshore vs offshore wind or grounded and roof-mounted solar)
- Research the trade-offs people make between different technologies. In addition to wind and solar, the environmental impacts of other renewable energy technologies, such as biomass or geothermal, can be studied.

Furthermore, the discussion denoted that only 4-5 attributes are incorporated in the experiments. I recommend to assess other environmental impacts of renewable energy technologies. For instance the environmental impacts 'turbine shade hinder' and wildlife impacts can be studied. Another recommendation is to research the effect of differences between electricity yield for projects funded by the same amount of tax money.

Research different ways to compare citizen and consumer preferences for renewable energy technologies.
Research could focus on the design of citizen and consumer experiments more in line with the transport citizen experiments to gain insights into a person's willingness to pay for renewable energy technology capacity expansion depending on public or private budget. This allows for a closer analysis of a person's preference to finance renewable energy from different budgets, rather than finding the relative trade-offs between environmental effects.

Vary the attribute levels

This study intends to compare the environmental impacts of large wind and solar energy farms with a similar electricity yield. The added benefit of this approach is that the environmental impacts can be compared to the financial analysis (like CBA and CEA) of renewable energy technologies. The focus was put on large wind energy farms (100+ MW) in line with the 'Structuurvisie Wind op Land' (2017). The consequence of this focus is that both wind and solar energy farms will have to be fitted in hundreds of hectares of living space affecting hundreds of residents. However, on a provincial level, the siting of smaller wind and solar energy farms will increase. Smaller energy farms may be fitted easier within the living environment. I recommend to research the environmental impacts of smaller wind and solar energy farms to get a more *precise* insight into the trade-offs. This will give insight into the utility differences with large renewable energy farms and informs us about possible minimum amount of hindered residents for a statistical significant effect.

Vary the context of the decision

This study finds intuitively large WTP values for reductions in noise hinder, solar visibility hinder, agricultural land-use and recreational land-use. One of the causes may be that respondents were asked for a *single* tax increase, to reduce hinder from a *single* renewable energy farm. My hypothesis is that the WTP will drop significantly when households are asked for *multiple* tax payments, for instance on a yearly basis or per planned wind energy farm. I recommend researching the willingness to pay for a reduction of hinder from a portfolio of renewable energy farms. This way, the aggregated willingness to pay from this study can be compared.

Heterogeneity of preferences

This research provides is a first attempt to gain insights into citizen preferences for the environmental impacts of renewable energy technologies. Therefore, the research focused on getting insights into the relative importance of the main effects by estimating relative simple MNL models. I recommend to build on this research and elicit more specific preferences by conducting a Latent Class Analysis. This will give a more specific insights into the preferences of the population, by assessing the effect of age, income, personal living environment and prior experience with hinder.

Citizen environmental evaluation frameworks

Future research efforts can focus on the lack of knowledge on how citizen preferences can be used in current renewable energy technology environmental evaluation studies. Such insights are necessary before the position of environmental impacts can be alleviated compared to financial impacts.

9.3.2 Society

This section outlines the main recommendations for promising renewable energy policy, when dealing with the environmental impacts of wind and solar energy farms.

Alleviate the position of non-market environmental impacts in the decision-making process

This research focused on getting insights into trade-offs between non-market environmental impacts of wind and solar energy farms, for which a citizen and consumer approach was used. The results emphasize the importance of several of these environmental impacts and show that the type of approach results in several different insights. Furthermore, studies show the relation between environmental impacts and public acceptance (Langer et al, 2017).

Currently, the mandatory CBA and CEA studies of renewable energy projects attempt to monetize and incorporate these environmental effects. However, often, environmental impacts are omitted or not monetized in such studies. As a result they are often not included in CBA conclusions which leads to a relative weak position in the decision-making process. Attempting to monetize these impacts may not do justice to the *non-market* character of these impacts.

In line with the results of this study, I therefore recommend to alleviate the relative importance of the environmental impacts of renewable energy technologies compared to the business case. This may lead to different designs and possibly help to reduce local resistance/public acceptance.

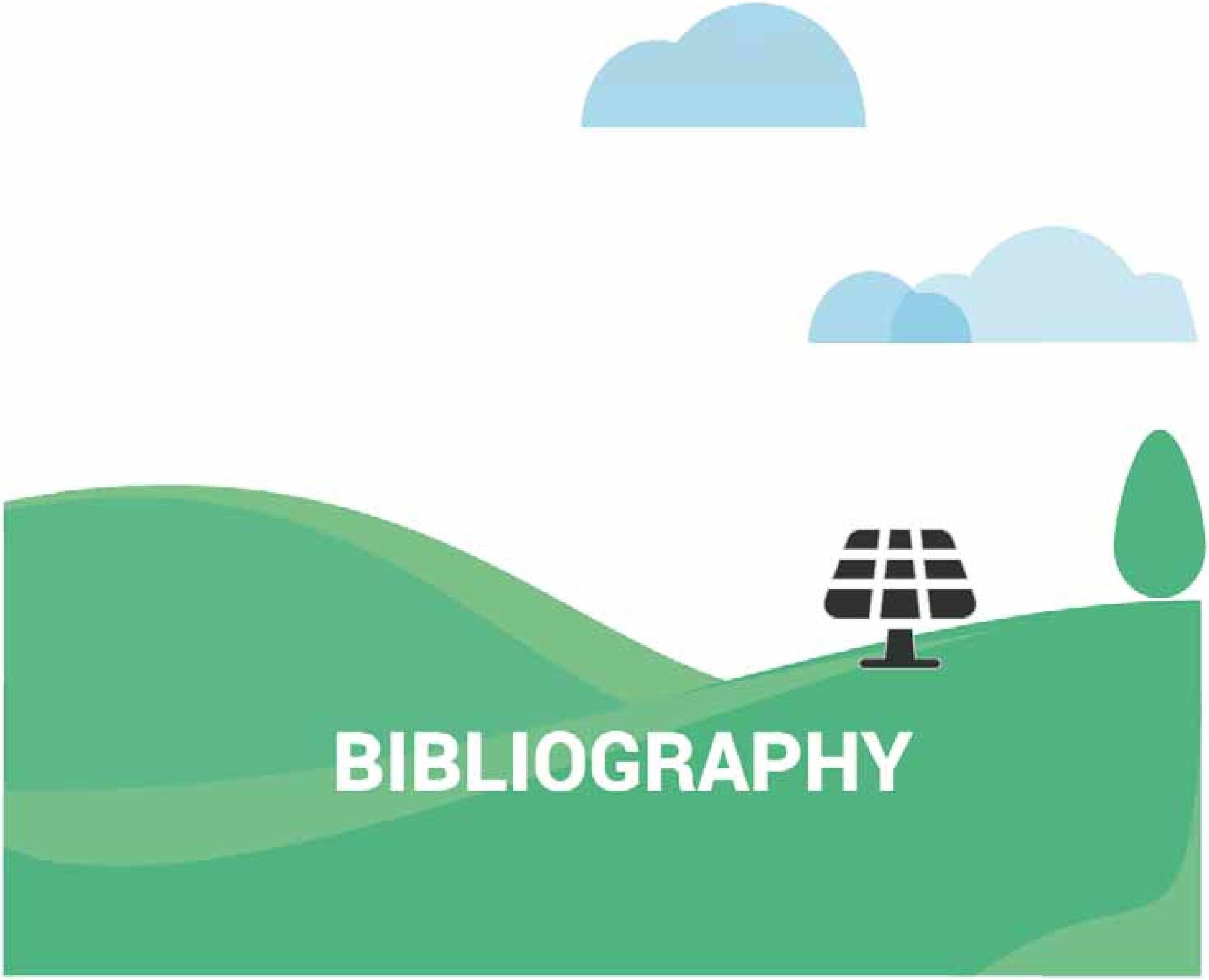
Design solar energy farm policy
The construction of grounded solar energy farms is gaining momentum, despite being relatively unknown. The installed capacity will increase exponentially over the next years. Moreover, in order to compete with onshore wind energy farms in terms of electricity production, the size of solar energy farms will be scaled up. At this point, 200 new solar energy farms are planned, of which the largest is more than 100 hectares. The environmental impacts of such large scale energy farms may be considerate. Therefore, I deem it wise to anticipate to this trend and set-up guidelines as an incentive to manage/avoid/mitigation the environmental impacts of solar energy farms. On a provincial level, provinces may avoid environmental impact by strategically designating solar energy construction sites (next to road and rail infrastructure, on public roofs etc.). Furthermore, clear policy on minimizing environmental impacts of solar energy farms may fuel feasible design options (economically and environmentally) and help avoid conflicts on a local level.

Noise regulations
The results of this study highlighted the relative importance of noise compared to other environmental impacts. Langer et al (2017) concludes the same and links this to a reason for low public acceptance. Given the fact that the Wind Monitor 2017 indicates delay or no-go for planned wind energy farms possibly caused by the low public acceptance, I recommend to actively reduce the noise hinder from current and future wind energy farms. In line with section 6.4, I recommend to explore possible technical alterations to current wind turbines or a case-by-case evaluation of noise hinder in recently build wind energy farms. Furthermore, I recommend to amend the current noise regulations. The definition of yearly average noise limit most likely leads to higher noise hinder. Moreover, the study from Nieuwenhuizen and Köhl (2015) demonstrates that this definition induces lower minimum distances.

Experiment with cooperative decision-making processes
The results from this study show that people significantly care about the level of community participation in the development of renewable energy farms. Furthermore, the respondents are able to trade-off community participation with environmental impacts. The results show that increasing the level of participation from the current status-quo ‘consultation’ to ‘cooperation’ results in a significant improvement of people’s perceived utility.

The fundamental difference between these levels is that the community has **binding** decision-making power; the community has binding power to approve or obstruct renewable energy farm construction. In line with the findings from Langal et al (2017), designating the ‘right’ level of participation may increase the public acceptance of renewable energy farms. Therefore, I recommend to start experimenting (learning by doing) with various forms of cooperative design and planning. One way is posed by Koers (2017) to organize a (as good as possible) representative voluntary citizen parliament by lottery selection, who are actively involved in the spatial planning of a renewable energy farm. This process can be managed by independent companies facilitating the cooperative decision-making approach. The citizen parliament needs to be provided with the relevant knowledge and information. The exchange of community attitudes and ideas and government/electricity company should lead to a cooperation that respects and meets the criteria for required electricity production, business case and impact on the living environment.

Mind that cooperation is only truly possible when both parties are formally equal. If there is no lawful requirement that formalize the binding nature of community approval for renewable energy farms, there is a risk that participation remains a form of tokenism. If the Ministry of Economic Affairs intents to explore the possibilities to work with community participation with binding decision-making, I recommend to lawfully enforce this requirement. Ultimately this strengthens the position of the community in the decision-making process and increases trust in the sincerity of the role of the participants.



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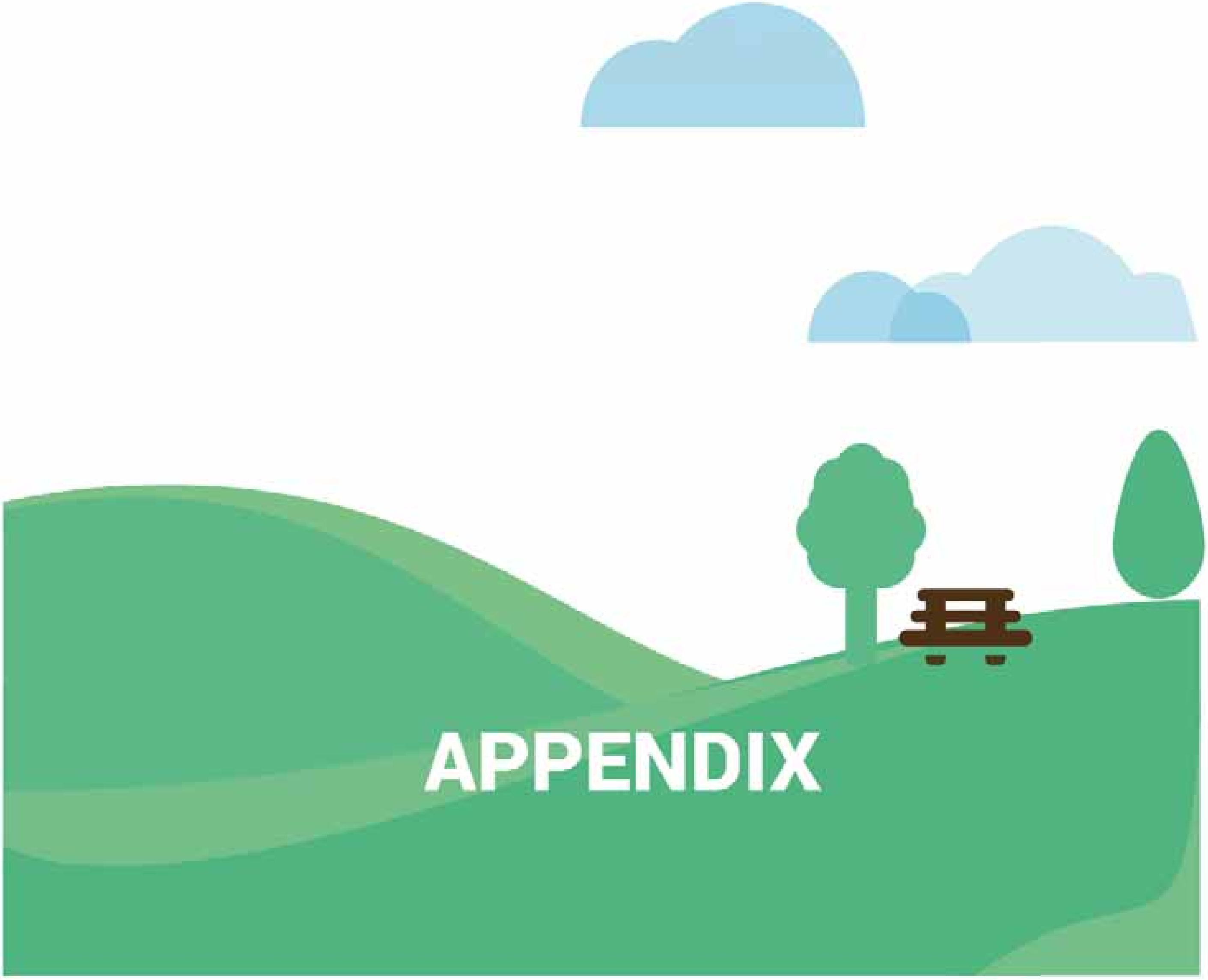


APPENDIX

A: **Attribute selection expert consults**
B: **Pilot Survey**
C: **Final Survey**
D: **MNL Model Results**
E: **MNL model without non-traders**

Appendix A: Attribute selection expert consults

The list of selected relevant factors from the literature review in section 4.2 was discussed extensive with expert. The following paragraphs highlight some of the main discussion points.

The main technological factors proposed in the literature were discussed in several rounds. The importance of visibility and land-use was stressed and confirmed. The relevance of security of supply was omitted, because according to the expert from Decisio BV, it is unknown if this will ever be a relevant factor. Finally, the amount electricity output was considered interesting from a spatial planning perspective. However, the operationalization of this factor was considered problematic for respondents to understand. The research experts from the TU Delft expected that respondents would find it difficult to choose between different levels of '% increase in renewable energy generation' or 'number of households with renewable energy that can be supplied with renewable energy'.

Another clear result from the discussion was the relevance of noise from wind turbines. Many residents complain about the noise from wind turbines and criticize the lawfully acceptable minimum noise levels of a yearly averaged 47 dB L_{den}. They argue that real noise levels are higher, since it concerns a yearly average (50 days no winds allows for other days more noise). Furthermore, citizens argue that the Netherlands positions wind turbines too close to residential areas.

Therefore, noise was preferred over wildlife attributes, despite the latter's significant contributions to an individual's willingness to pay in stated choice studies (e.g. Vecchiato & Tempesta, 2015). The impacts of wind farms on bird population have been researched, but remain complex to monitor (Marques et al, 2014). However, the impact of solar farms on birds appears is limited if utility scale solar pv power plants are build outside breeding season (Guerin, 2017). Only security fences may block animal passage ways.

Besides the environmental impacts, the importance of institutional and process attributes was discussed with spatial planning experts from the Ministry of Economic Affairs. The input for the discussions were the identified characteristics from section 4.2.2.: compensation, ownership, employment and community influence in development. The experts were skeptical about employment effects were criticized. Employment is frequently used in CEs and has shown to be a significant factor in rural areas (Bergmann, 2008). However, CE Delft (2016) also denotes that the development of wind or solar farms does not yield a real net employment effect. Instead, it is argued that it just a redistribution of jobs from one area to the other. This was confirmed in expert consults with Economic Affairs. Typically, the redistribution of jobs does not yield new jobs for people in the region. It just moves original workers to another area. All other factors were regarded as interesting and socially relevant. Citizen influence was regarded the most elegant attribute, since ownership (shares) and compensation impact an individual's after-tax income. This is not in line with the definition of citizen preferences used in this research and may lead to confusion for respondents.

Finally, a division of the attributes over the three surveys was made. The first survey forms the basis and aims to induce data on citizen based preferences for the trade-off of non-market environmental impacts of wind and solar energy farms. The second survey is a consumer based survey and therefore adds a cost component to an individual's willingness to pay to reduce the amount of hinder or land-use. Finally, a third survey is designed to research the importance of community influence in the planning and design process. The ordinal attribute 'level of community participation' is added to see how this influences the trade-offs citizens make.

Appendix B: Pilot Survey

Ngene design generation:

The syntax that is required to generate the choice sets with Ngene is shown in the textbox below.

```
design
; alts = wind, zon
; rows = 18
; orth = sim
; model:

U(wind) = b0+ b1*Wzicht[0,300,600]+ b2*Wgeluid[0,300,600] +
b3*Wlandb[5,25,45] + b4*Wrecrea[5,25,45]/
U(zon) = b5*ZZicht[0,300,600] + b6*Zlandb[100,300,500] +
b7*Zrecrea[100,300,500]
$
```

The code defines two attributes, 18 choice sets, a simultaneous orthogonal design and the two utility functions for wind and solar.

Model file:

The model file specification is depicted in the figure below.

```
// Author : Jori Corbié
// Date : Mon June 19
//
// MNL model
// Two alternatives : Wind, Solar
// SP data


// Declare model parameters
// Name          Value    Lower Bound    Upper Bound     status (0= variable, 1=fixed)

[Beta]
ASC_Wind        0       -10000         10000           1
ASC_Solar       0       -10000         10000           0
B_WZicht        0       -10000         10000           0
B_WGeluid       0       -10000         10000           0
B_WLand         0       -10000         10000           0
B_WRecr         0       -10000         10000           0
B_ZZicht        0       -10000         10000           0
B_ZLand         0       -10000         10000           0
B_ZRecr         0       -10000         10000           0

// Utility specification
//ID     Name    Avail     Linear-in-parameter

[Utilities]
  1      A        AV_A    ASC_Wind * one + B_WZicht * WZicht_SCALED + B_WGeluid * WGeluid_SCALED + B_WLand * WLand_SCALED + B_WRecr * WRecr_SCALED
  2      B        AV_B    ASC_Solar * one + B_ZZicht * ZZicht_SCALED + B_ZLand * ZLand_SCALED +B_ZRecr * ZRecr_SCALED

[Choice]
CHOICE

// Set one to 1

[Expressions]
one = 1
// For numerical reasons it is good practice to scale the data to values around 1.0
// A previous run with unscaled data generated parameters around 0.002-0.009
// Therefore, parameters are scaled by dividing by 100
WZicht_SCALED = WZicht / 100
WGeluid_SCALED = WGeluid / 100
WLand_SCALED = WLand / 100
WRecr_SCALED = WRecr / 100
ZZicht_SCALED = ZZicht / 100
ZLand_SCALED = ZLand / 100
ZRecr_SCALED = ZRecr / 100


// Specify which model to estimate

[Model]
$MNL
```

Appendix C: Final Survey

Experimental design:

Table 59: Choice sets citizen experiment

Design	Wind				Solar		
Choice situation	*Visibility*	*Noise*	*Agricultural land-use*	*Recreational land-use*	*Visibility*	*Agricultural land-use*	*Recreational land-use*
1	200	0	40	15	100	100	50
2	200	150	10	5	300	100	100
3	0	100	20	15	200	150	100
4	100	100	10	20	0	200	150
5	300	0	10	20	200	50	200
6	300	50	20	5	0	150	50
7	300	150	40	20	300	200	100
8	0	50	30	10	300	100	150
9	100	50	30	5	100	200	200
10	200	150	40	10	0	50	200
11	100	0	30	10	200	150	150
12	0	100	20	15	100	50	50

Table 60: Choice sets consumer experiment

Design	*Wind*					*Solar*			
Choice	*Visibility*	*Noise*	*Agricultural land-use*	*Recreational land-use*	*Tax*	*Visibility*	*Agricultural land-use*	*Recreational land-use*	*Tax*
1	300	100	10	15	25	300	50	50	45
2	200	50	20	10	65	0	50	50	5
3	300	50	30	10	25	300	150	100	45
4	0	0	40	20	5	200	100	100	65
5	100	0	30	15	45	200	150	150	25
6	100	150	20	15	5	100	200	100	65
7	200	150	20	10	45	0	200	50	25
8	0	100	10	20	65	100	150	200	5
9	0	100	40	5	65	300	100	150	5
10	300	0	30	5	45	200	200	150	25
11	200	50	10	20	25	100	100	200	45
12	100	150	40	5	5	0	50	200	65

Table 61: Choice sets citizen participation experiment

Design	*Wind*					*Solar*			
Choice	*Visibility*	*Noise*	*Agr. land use*	*Recr. land use*	*Participation*	*Visibility*	*Agr. land-use*	*Recr. land-use*	*Participation*
1	300	100	20	5	Decision-maker	300	200	100	No participation
2	300	150	30	15	No participation	200	50	150	Consultation
3	300	0	20	5	No participation	0	150	50	Decision-maker
4	200	100	10	20	Consultation	100	50	50	No participation
5	100	50	10	15	No participation	300	100	150	Cooperation
6	0	0	30	20	Cooperation	300	150	50	Consultation
7	100	150	40	15	Consultation	200	200	100	Decision-maker
8	200	0	40	10	Decision-maker	100	100	200	No participation
9	100	50	20	10	Consultation	200	100	200	Decision-maker
10	0	150	10	10	Cooperation	0	150	150	Consultation
11	200	50	30	20	Decision-maker	0	200	200	Cooperation
12	0	100	40	5	Decision-maker	100	50	100	Cooperation

Survey:

VOORKEUREN DUURZAME ENERGIE 1

Welkom

Geachte heer / mevrouw,
Dank voor uw deelname aan dit onderzoek. Het onderzoek bestaat uit 12 vragen. Het invullen van de vragen kost u ongeveer 8 minuten (3 minuten voor het doorlezen van de introducerende tekst en 5 minuten voor het beantwoorden van de vragen)

Klik op "next" om met het onderzoek te starten.

Inleiding

Het uitbreiden van stroomproductie door wind en/of- zonne-energie is een centraal onderdeel van het Nederlandse energie- en klimaatbeleid, om in 2050 een volledig duurzame energievoorziening te realiseren. Daarom zet de overheid belastinggeld in om de aanleg van wind- of zonneparken te financieren.

De bouw van een wind-of zonnepark verandert de directe leefomgeving van omwonenden. Zo kan het uitzicht vanuit de huizen van mensen veranderen of verdwijnt er recreatiegrond. Daarom wil de overheid graag weten wat u belangrijk vindt bij de aanleg van een wind- of zonnepark in Nederland. Om daar inzicht in te krijgen leggen wij u twaalf keer een variant van een windpark en een zonnepark voor en wij vragen u of uw voorkeur uitgaat naar het windpark of het zonnepark.

Beschrijving van de omgevingseffecten

De overheid wil graag weten onder welke voorwaarden Nederlanders een voorkeur hebben voor windparken of zonneparken.

Gaat u van het volgende uit:

- Het wind-of zonnepark wordt vanuit reeds gereserveerd belastinggeld betaald. Voor dit onderzoek kunt u ervan uitgaan dat uw besteedbaar inkomen onveranderd blijft (bijv. uw energierekening blijft onveranderd).
- Het wind-of zonnepark verschilt **alleen** op de volgende vier aspecten, verdeeld over twee typen hinder en twee typen grondgebruik.

Hinder:
Het wind-of zonnepark wordt in de buurt van woningen gebouwd en beïnvloedt de directe leefomgeving van huishoudens via zicht- en geluidshinder.

1. Het aantal huishoudens dat zichthinder ondervindt: Het wind-of zonnepark verandert het vrije zicht van huishoudens die aan de rand van een windpark (op de minimale afstand van 500 meter) of een zonnepark wonen.
2. Het aantal huishoudens dat geluidsoverlast ondervindt: Een zonnepark produceert geen geluid, een windmolenpark wel. Het geluidsvolume van een windmolen op de minimale wettelijke afstand (van 500 meter) van huizen bedraagt jaarlijks gemiddeld 42 decibel, gemeten op de gevel. Als het raam dicht is, is het geluid binnenshuis niet hoorbaar. Met een open raam is dit geluidsvolume te vergelijken met het geluid van een koelkast op een meter afstand. Het type geluid is wel anders: elektrische apparaten produceren een monotoon geluid, terwijl het geluid van een windmolen licht zoevend is.

Grondgebruik:
De bouw van een wind- of zonnepark vervangt grond dat gebruikt wordt voor landbouw of recreatie.

Het oppervlak vervangen grond wordt gemeten in hectare. Een hectare staat gelijk aan ongeveer twee voetbalvelden, terwijl honderd hectare (een kilometer bij een kilometer) gelijk staat aan de grootte van een klein dorp.

3. Aantal hectare vervangen landbouwgrond: Het wind-of zonnepark vervangt landbouwgrond. Deze grond bevindt zich op afgesloten (privé) boerenterrein.

4. Aantal hectare vervangen recreatiegrond: Het wind-of zonnepark vervangt recreatiegrond. Recreatiegrond wordt gebruikt voor diverse activiteiten, variërend van hardlopen tot natuurrecreatie. Een omheind zonnepark vormt een duidelijke barrière tussen woonwijken en recreatiegebied, waardoor aantrekkelijke gebieden slechter te bereiken zijn.

Impressie van het zijaanzicht

Om u een beter beeld te geven van het type zichthinder van huishoudens aan de rand van een wind-of zonnepark tonen wij twee impressies van een zijaanzicht.

Impressies zijaanzicht

Windmolens op de minimale afstand van 500 meter

Omheind grondgebonden zonnepark

Impressie van het grondgebruik

Om u een beter beeld te geven van het grondgebruik van wind- en zonneparken tonen wij u bij elke keuze een corresponderende plattegrond. De windmolens vervangen stukken grond op de plek waar ze gebouwd worden, verspreid over een gebied. Dit is bij elke keuze aangegeven met roze stippen. Bij een zonnepark staan zonnepanelen in rijen achter elkaar en vervangen ze een aaneengesloten stuk grond. Het blauw gearceerde vlak op de plattegrond is hiervan een voorbeeld. De grootte van het vlak komt overeen met het aangegeven oppervlak in de keuze. Daarnaast zijn er ter ondersteuning lengte- en breedtematen toegevoegd

Opmerkingen

We vragen u in dit onderzoek 12 keer welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de verschillende effecten op de leefomgeving (Project A: Windpark op Land, Project B: Grondgebonden zonnepark).

De overheid wil de resultaten van het experiment gebruiken om een beslissing te nemen over de bouw van wind-en zonneparken in Nederland, waarbij de varianten alleen verschillen op de vier bovengenoemde aspecten. Daarom is het belangrijk dat u aanneemt dat de projecten niet verschillen op andere aspecten (bijvoorbeeld: stroomproductie, energiezekerheid, energierekening).

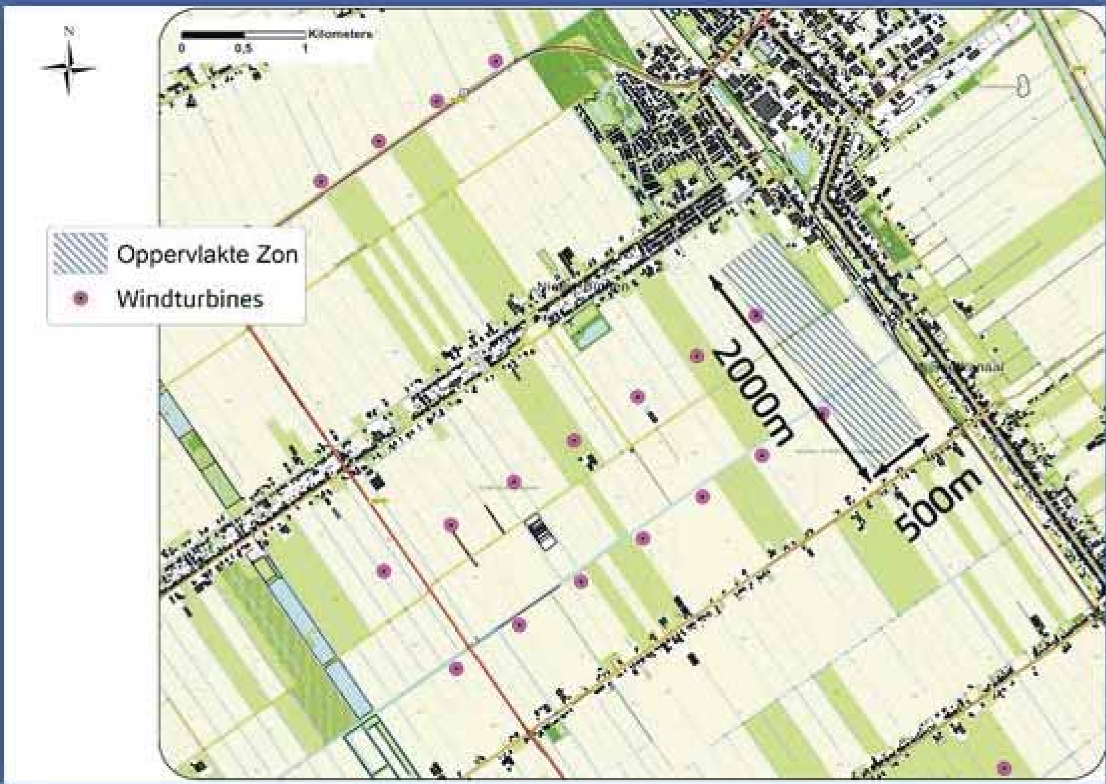
De overheid is geïnteresseerd in de algemene voorkeuren van Nederlanders voor de ontwikkeling van wind- en zonneparken. Daarom geven we niet aan of de verandering in uw leefomgeving plaatsvindt. Als combinaties van effecten u onlogisch lijken, vragen wij u vriendelijk toch uw keuze te maken op basis van de omgevingseffecten.

Succes met het invullen van dit onderzoek!

1. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	15 hectare	50 hectare

Ik adviseer de overheid het volgende project:

*This question is required.

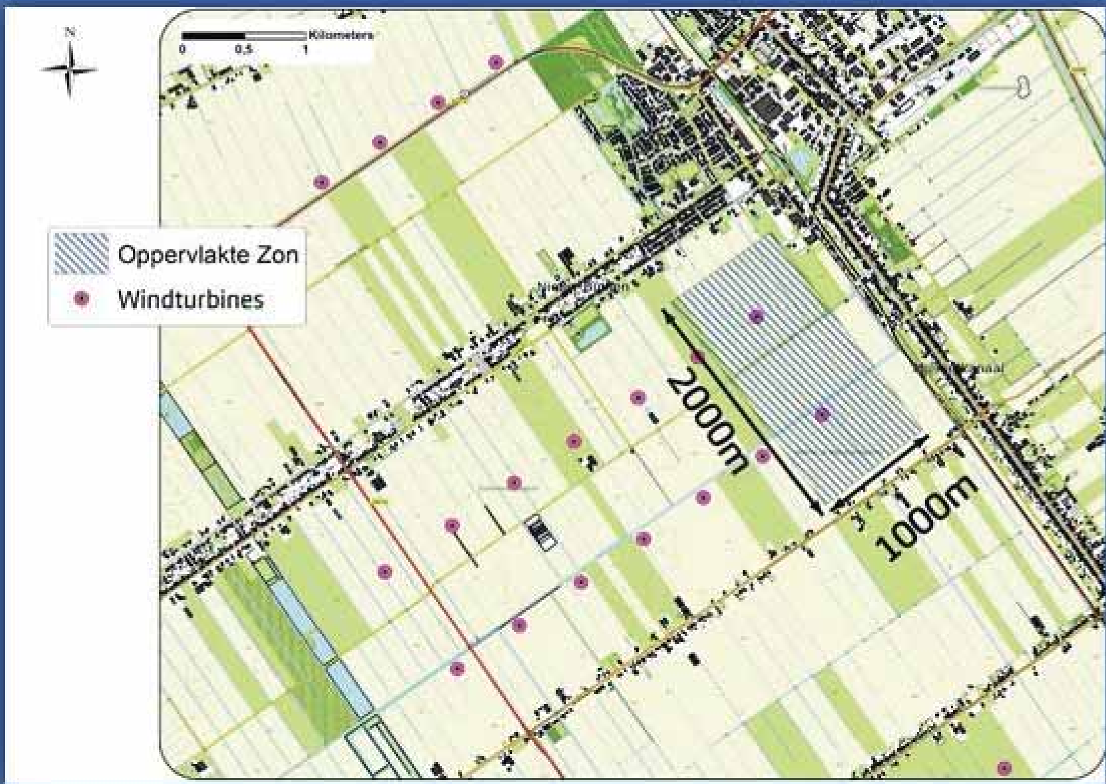
○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

2. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	200 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	100 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	100 hectare

Ik adviseer de overheid het volgende project:
*

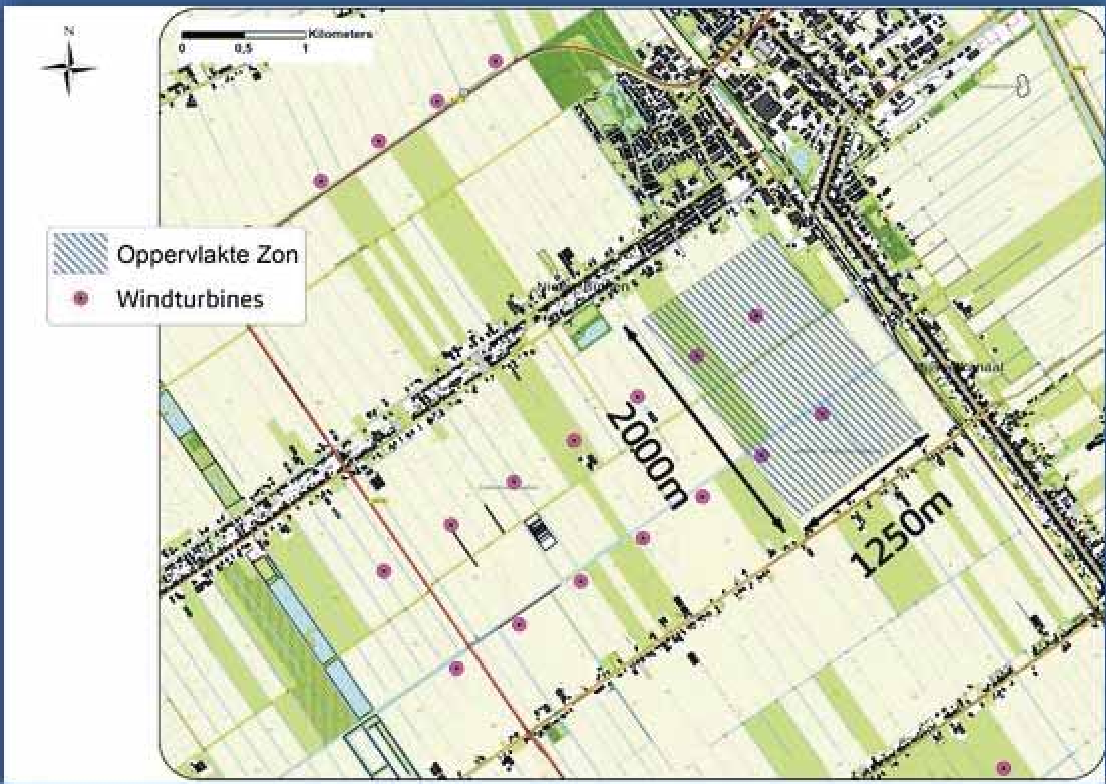
○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

3. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	15 hectare	100 hectare

Ik adviseer de overheid het volgende project:
*

○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

4. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon

	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	100 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	200 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	150 hectare

Ik adviseer de overheid het volgende project:
*

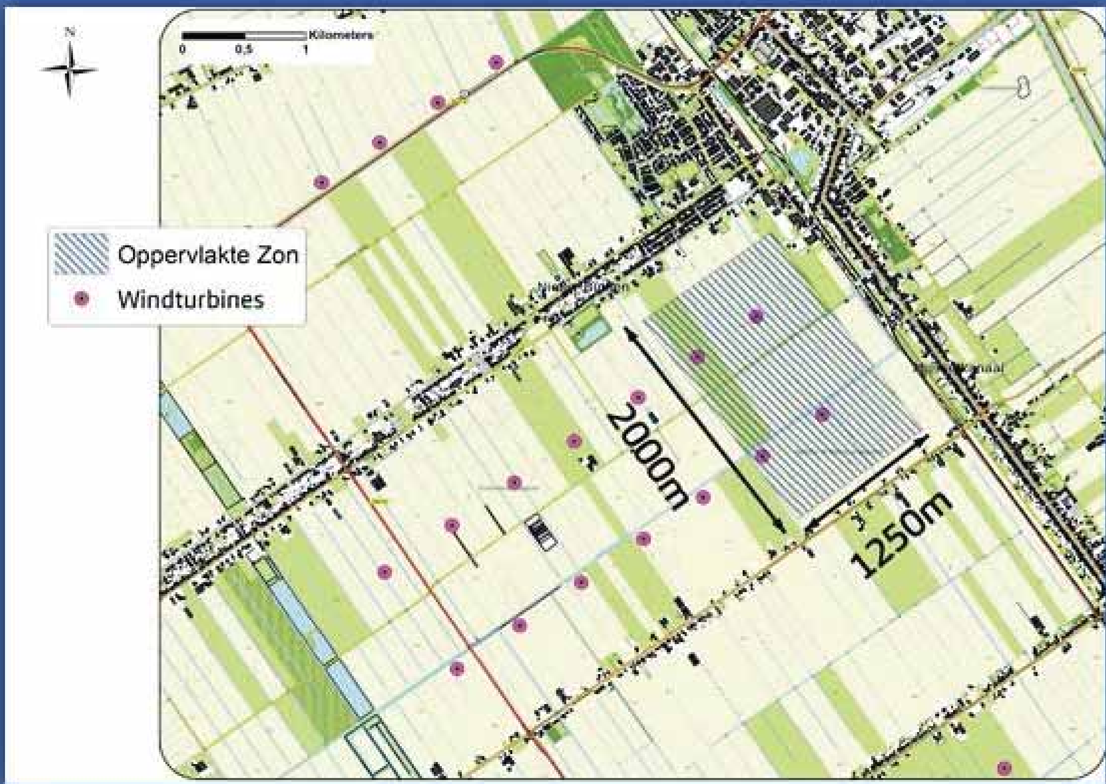
○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

5. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	200 hectare

Ik adviseer de overheid het volgende project:
*

Project A: Wind op Land

Project B: Grondgebonden zonnepark

6. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon

	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	50 hectare

Ik adviseer de overheid het volgende project:
*

Project A: Wind op Land

Project B: Grondgebonden zonnepark

7. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon

	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	200 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	100 hectare

Ik adviseer de overheid het volgende project:
*

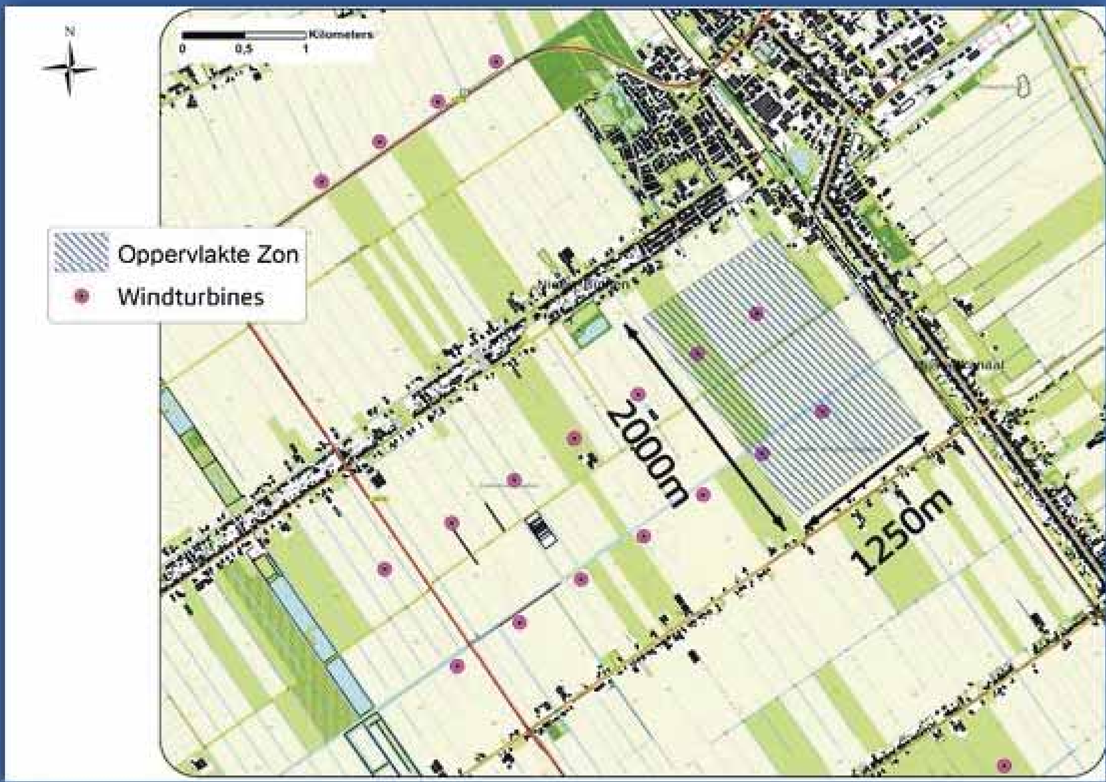
Project A: Wind op Land

Project B: Grondgebonden zonnepark

8. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	100 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	150 hectare

Ik adviseer de overheid het volgende project:
*

○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

9. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon

	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	100 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	200 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	200 hectare

Ik adviseer de overheid het volgende project:
*

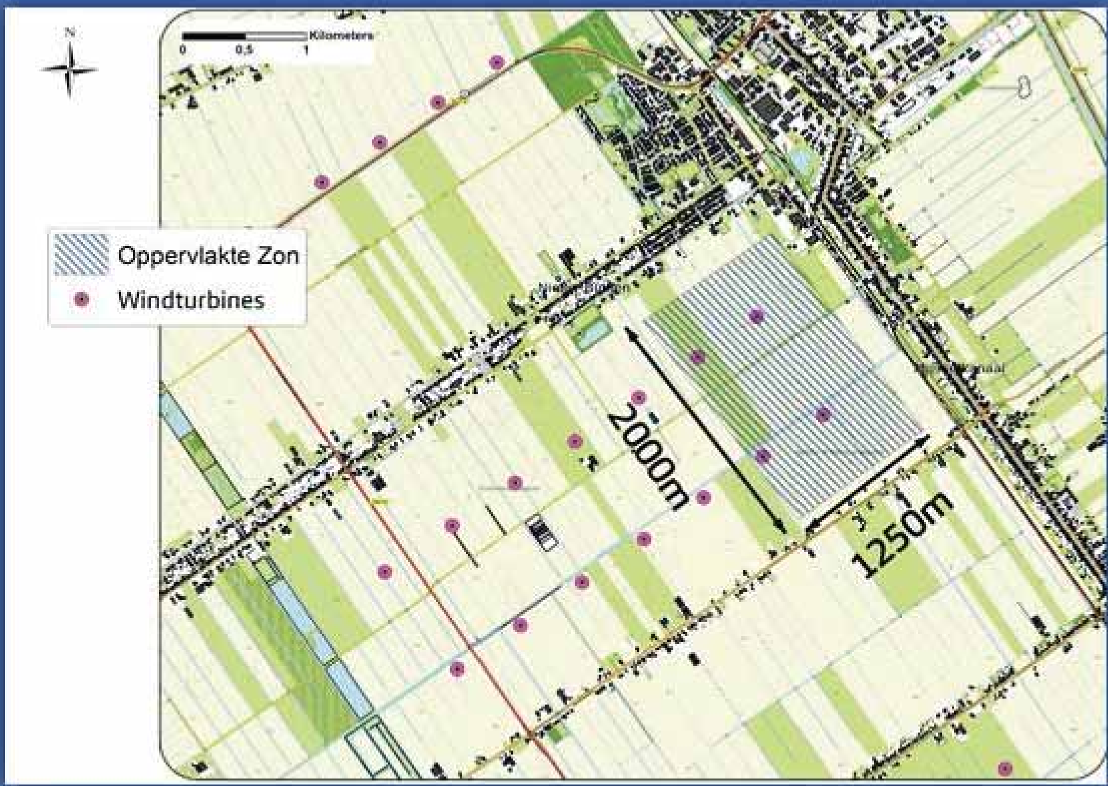
○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

10. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	200 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	200 hectare

Ik adviseer de overheid het volgende project:
*

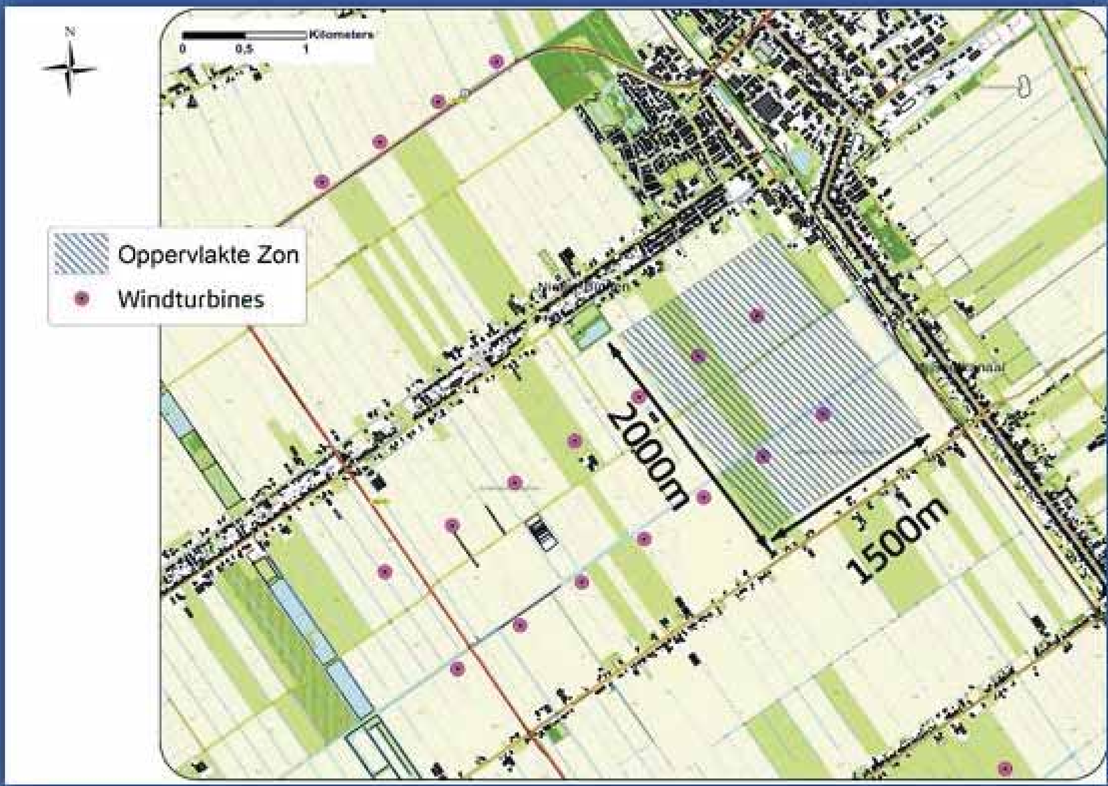
○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

11. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	100 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	150 hectare

Ik adviseer de overheid het volgende project:
*

○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

12. Wij vragen u welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de effecten op de leefomgeving.

Impressie bovenaanzicht

Wind en Zon

	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	15 hectare	50 hectare

Ik adviseer de overheid het volgende project:
*

○ Project A: Wind op Land

○ Project B: Grondgebonden zonnepark

Belangrijkste criterium

13) Wat was voor u het <u>belangrijkste</u> criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare vervangen landbouwgrond
( ) Aantal hectare vervangen recreatiegrond

Motivatie belangrijkste criterium

14) Kunt u aangeven waarom dit het belangrijkste criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Minst belangrijke criterium

15) Wat was voor u het <u>minst belangrijke</u> criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare ruimtebeslag landbouwgrond
( ) Aantal hectare ruimtebeslag recreatiegrond

Motivatie minst belangrijke criterium

16) Kunt u aangeven waarom dit het minst belangrijke criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Stellingen over de keuzes

17) Hieronder volgen een aantal stellingen. Kunt u per stelling aangeven in welke mate u het er mee eens bent?*

	Helemaal mee eens	Mee eens	Neutraal	Mee oneens	Helemaal mee oneens
Ik was regelmatig overtuigd van mijn keuze	○	○	○	○	○
Ik vond de keuzesituaties realistisch	○	○	○	○	○
Dit experiment biedt de overheid relevante informatie bij het maken van keuzes	○	○	○	○	○

Type leefomgeving

18) Welk van de volgende omschrijvingen past het best bij uw leefomgeving?*
( ) Sterk stedelijk gebied
( ) Matig stedelijk gebied
( ) Landelijk gebied

Eigen omgeving

19) Ervaart u thuis zichthinder van een windpark?*
( ) Ja
( ) Nee

20) Ervaart u thuis zichthinder van een zonnepark?*
( ) Ja
( ) Nee

21) Ervaart u thuis geluidsoverlast van een windpark?*
( ) Ik ervaar thuis zeer veel geluidsoverlast van een windpark
( ) Ik ervaar thuis veel geluidsoverlast van een windpark
( ) Ik ervaar thuis regelmatig geluidsoverlast van een windpark
( ) Ik ervaar thuis nauwelijks geluidsoverlast van een windpark
( ) Ik ervaar thuis geen geluidsoverlast van een windpark

22) Hoe vaak recreëert u in een recreatiegebied?*
( ) Dagelijks
( ) Meerdere keren per week
( ) 1 keer per week
( ) Meerdere keren per maand
( ) 1 keer per maand
( ) 1 of meerdere keren per jaar
( ) Nooit

Politieke voorkeur

23) Op welke politieke partij heeft u gestemd bij de vorige verkiezingen?*
( ) VVD
( ) Partij van de Arbeid
( ) CDA
( ) PVV
( ) GroenLinks
( ) SP
( ) D66
( ) ChristenUnie
( ) SGP
( ) Partij voor de Dieren
( ) Een andere politieke partij
( ) Ik heb niet gestemd
( ) Ik wil deze vraag niet invullen

NIPOpunten

24) Hartelijk dank voor uw medewerking!

Voor het invullen van deze vragenlijst ontvangt u NIPOpunten. Om u uw NIPOpunten te kunnen sturen, is het noodzakelijk dat u uw code hieronder invult. Deze code staat in de uitnodigingsmail.

Vul uw code hieronder nauwkeurig in.

Thank You!

Dank voor uw deelname aan dit onderzoek.

Uw antwoorden zijn verzonden en u kunt de pagina nu afsluiten.

VOORKEUREN DUURZAME ENERGIE 2

Geachte heer / mevrouw,

Dank voor uw deelname aan dit onderzoek. Het onderzoek bestaat uit 12 vragen. Het invullen van de vragen kost u ongeveer 8 minuten (3 minuten voor het doorlezen van de introducerende tekst en 5 minuten voor het beantwoorden van de vragen)

Klik op "next" om met het onderzoek te starten.

Inleiding

Het uitbreiden van stroomproductie door wind en/of- zonne-energie is een centraal onderdeel van het Nederlandse energie- en klimaatbeleid, om in 2050 een volledig duurzame energievoorziening te realiseren. Dit experiment gaat over een plan van de overheid om een windpark aan te leggen, dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet.

De bouw van een windpark verandert de directe leefomgeving van omwonenden. Zo kan het uitzicht vanuit de huizen van mensen veranderen of verdwijnt er recreatiegrond. Dit geplande windpark is echter niet de enige optie. Het is mogelijk om een ander type windpark te bouwen, met minder gevolgen voor de leefomgeving. Daarnaast is het mogelijk om een zonnepark te bouwen. Echter, deze alternatieven zijn duurder en er is onvoldoende regulier overheidsbudget om de aanlegkosten en onderhoudskosten van deze duurdere alternatieven te dekken.

De overheid wil graag weten wat u belangrijk vindt bij de aanleg van een duurzaam energiepark in Nederland. Om daar inzicht in te krijgen vragen wij u twaalf keer een keuze te maken tussen drie opties voor een duurzaam energiepark: 1) een gepland windpark; 2) een alternatief windpark; 3) een alternatief zonnepark.

Beschrijving omgevingseffecten

De overheid wil graag weten onder welke voorwaarden Nederlanders een voorkeur hebben voor windparken of zonneparken.

Gaat u van het volgende uit:

- De twee windparken en het zonnepark verschillen **alleen** op de volgende vijf aspecten, verdeeld over twee typen hinder, twee typen grondgebruik en een belastingverhoging.

Hinder:
Het wind-of zonnepark wordt in de buurt van woningen gebouwd en beïnvloedt de directe leefomgeving van huishoudens via zicht- en geluidshinder.

1. Het aantal huishoudens dat zichthinder ondervindt: Het wind-of zonnepark verandert het vrije zicht van huishoudens die aan de rand van een windpark (op de minimale afstand van 500 meter) of een zonnepark wonen.
2. Het aantal huishoudens dat geluidsoverlast ondervindt: Een zonnepark produceert geen geluid, een windmolenpark wel. Het geluidsvolume van een windmolen op de minimale wettelijke afstand (van 500 meter) van huizen bedraagt jaarlijks gemiddeld 42 decibel, gemeten op de gevel. Als het raam dicht is, is het geluid binnenshuis niet hoorbaar. Met een open raam is dit geluidsvolume te vergelijken met het geluid

van een koelkast op een meter afstand. Het type geluid is wel anders: elektrische apparaten produceren een monotoon geluid, terwijl het geluid van een windmolen licht zoevend is.

Grondgebruik:
De bouw van een wind- of zonnepark vervangt grond dat gebruikt wordt voor landbouw of recreatie. Het oppervlak vervangen grond wordt gemeten in hectare. Een hectare staat gelijk aan ongeveer twee voetbalvelden, terwijl honderd hectare (een kilometer bij een kilometer) gelijk staat aan de grootte van een klein dorp.

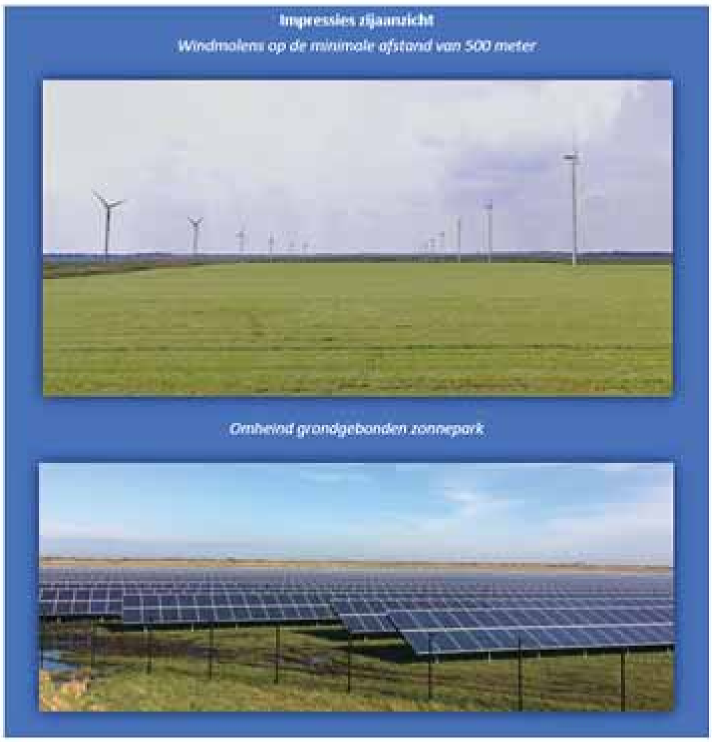
3. <u>Aantal hectare vervangen landbouwgrond</u>: Het duurzame energiepark vervangt landbouwgrond. Deze grond bevindt zich op afgesloten (privé) boerenterrein.
4. <u>Aantal hectare vervangen recreatiegrond</u>: Het duurzame energiepark vervangt recreatiegrond. Recreatiegrond wordt gebruikt voor diverse activiteiten, variërend van hardlopen tot natuurrecreatie. Een omheind zonnepark vormt een duidelijke barrière tussen woonwijken en recreatiegebied, waardoor aantrekkelijke gebieden slechter te bereiken zijn.

Belastingverhoging:

5. <u>Eenmalige verhoging energiebelasting Nederlandse huishoudens:</u> Het alternatieve windpark en het alternatieve zonnepark hebben hogere kosten dan het geplande windpark. Dit komt bijvoorbeeld doordat de stillere windmolens van het alternatieve windpark duurder zijn. Omdat er onvoldoende regulier overheidsbudget is om deze extra kosten te dekken, vraag de overheid of u instemt met een eenmalige verhoging van de energiebelasting in 2018 om deze kosten te kunnen dekken. De eenmalige belastingverhoging geldt alleen voor 2018 en heeft geen invloed op andere jaren (niet voor 2017 en 2019 en later). Het duurzame energiepark dat door de meeste Nederlanders wordt geadviseerd, zal worden aangelegd.

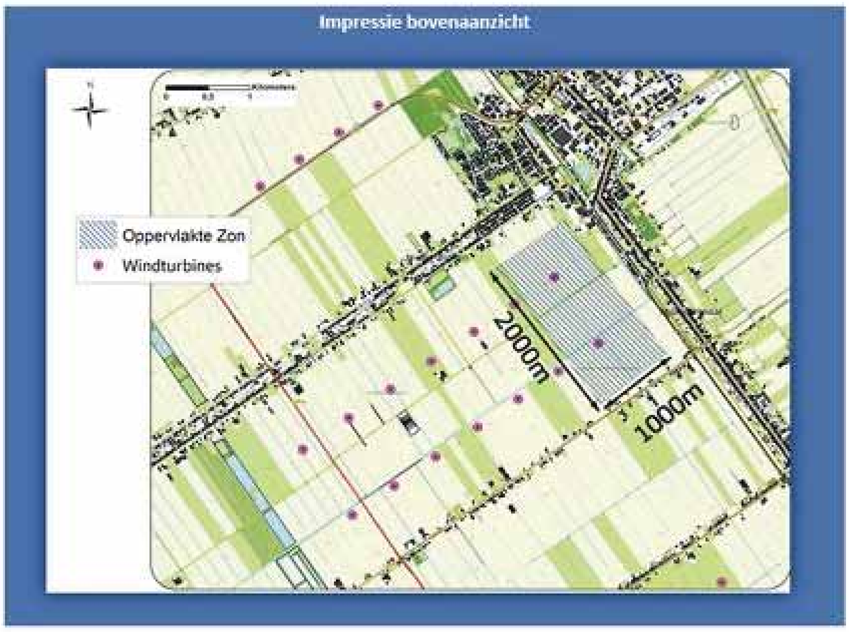
Impressie van het zijaanzicht

Om u een beter beeld te geven van het type zichthinder van huishoudens aan de rand van een wind- of zonnepark tonen wij twee impressies van een zijaanzicht



Impressie van het grondgebruik

Om u een beter beeld te geven van het grondgebruik van wind- en zonneparken tonen wij u bij elke keuze een corresponderende plattegrond. De windmolens vervangen stukken grond op de plek waar ze gebouwd worden, verspreid over een gebied. Dit is bij elke keuze aangegeven met roze stippen. Bij een zonnepark staan zonnepanelen in rijen achter elkaar en vervangen ze een aaneengesloten stuk grond. Het blauw gearceerde vlak op de plattegrond is hiervan een voorbeeld. De grootte van het vlak komt overeen met het aangegeven oppervlak in de keuze. Daarnaast zijn er ter ondersteuning lengte- en breedtematen toegevoegd



Opmerkingen

We vragen u in dit onderzoek 12 keer welk project u de overheid zou adviseren op basis van de verschillende effecten op de leefomgeving (Gepland Windpark, Alternatief Windpark, Alternatief Zonnepark)

De overheid wil de resultaten van het experiment gebruiken om een beslissing te nemen over de bouw van wind- en zonneparken in Nederland, waarbij de varianten alleen verschillen op de vijf bovengenoemde aspecten. Daarom is het belangrijk dat u aanneemt dat de projecten **niet** verschillen op andere aspecten (bijvoorbeeld: stroomproductie, energiezekerheid).

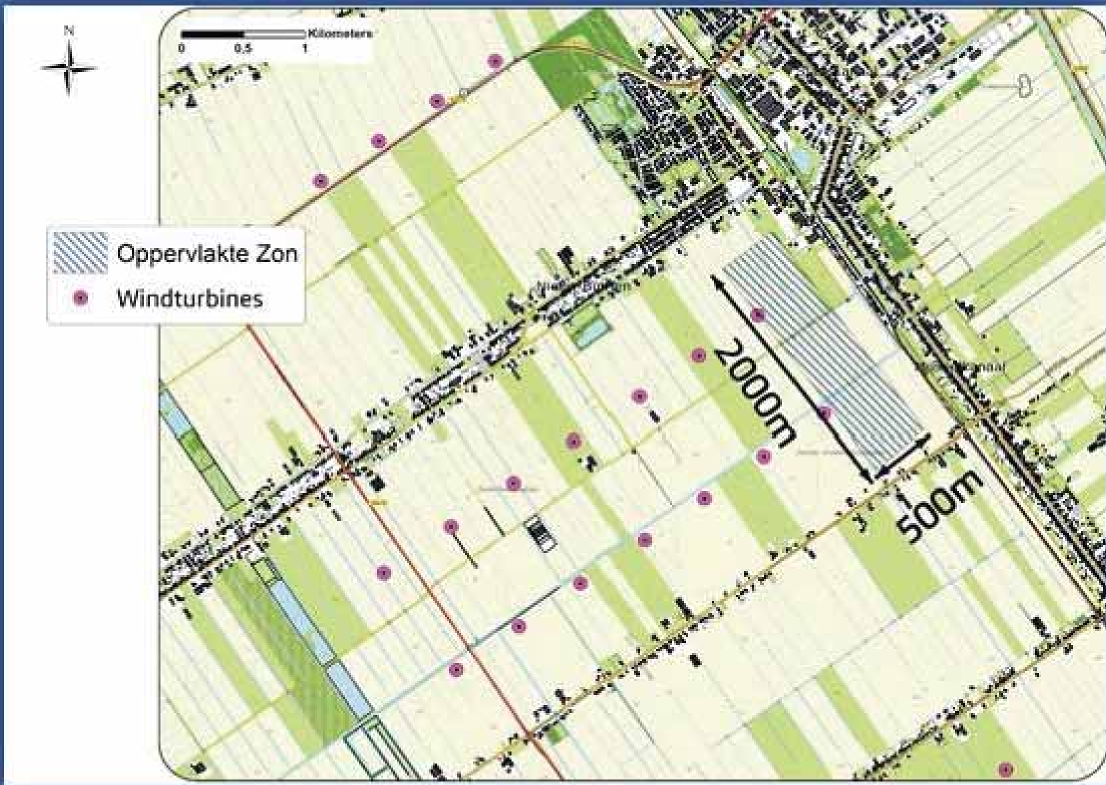
De overheid is geïnteresseerd in de algemene voorkeuren van Nederlanders voor de ontwikkeling van wind- en zonneparken. Daarom geven we niet aan of de verandering in uw leefomgeving plaatsvindt. Als combinaties van effecten u onlogisch lijken, vragen wij u vriendelijk toch uw keuze te maken op basis van de omgevingseffecten.

Succes met het invullen van dit onderzoek!

1) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	300 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	10 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	15 hectare	50 hectare
Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	25 euro	45 euro

Ik adviseer de overheid het volgende project:

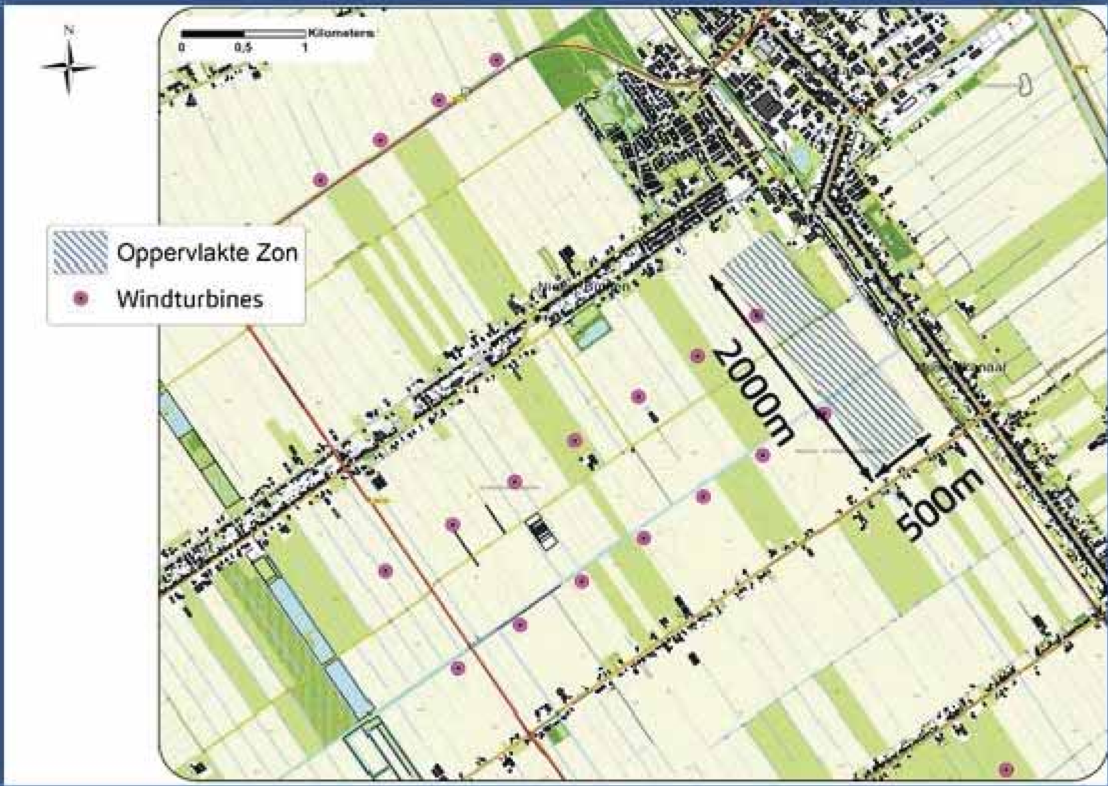
*

- ◯ Gepland Windpark
- ◯ Alternatief Windpark
- ◯ Alternatief Zonnepark

2) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	200 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	50 huishoudens	0 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	65 euro	5 euro

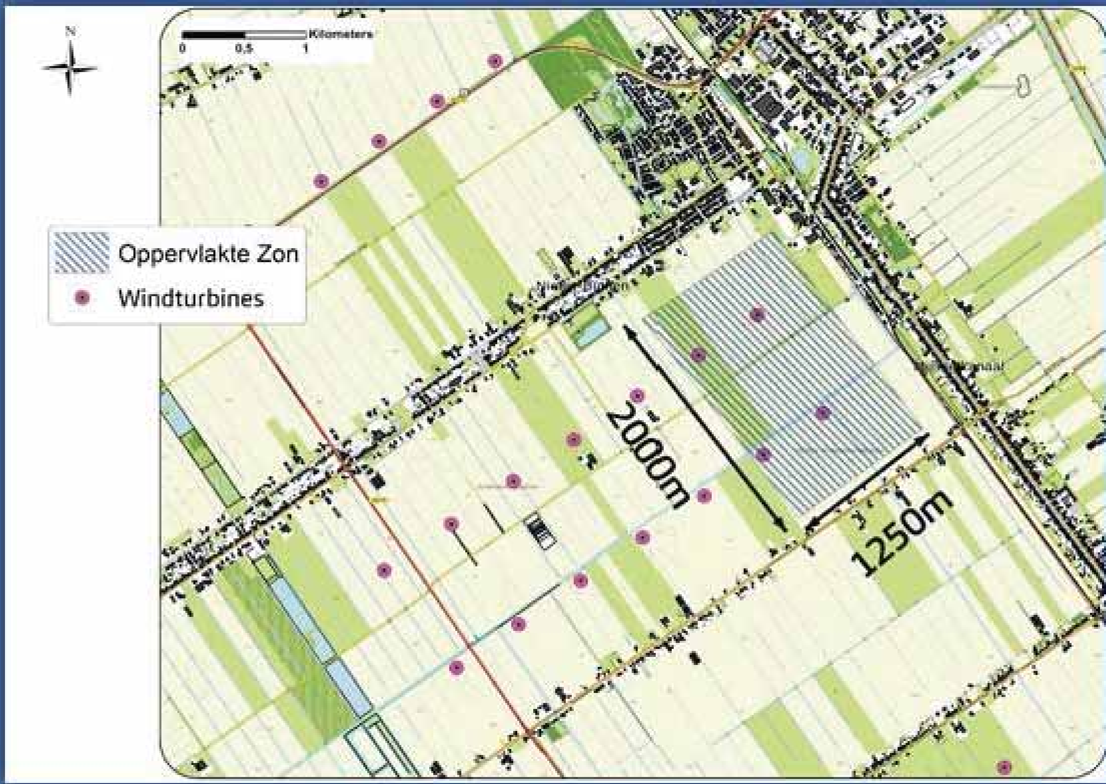
Ik adviseer de overheid het volgende project:
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

3) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	300 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	30 hectare	150 hectare
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	25 euro	45 euro

Ik adviseer de overheid het volgende project:
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

4) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon

	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	0 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens	0 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	5 euro	65 euro

Ik adviseer de overheid het volgende project:

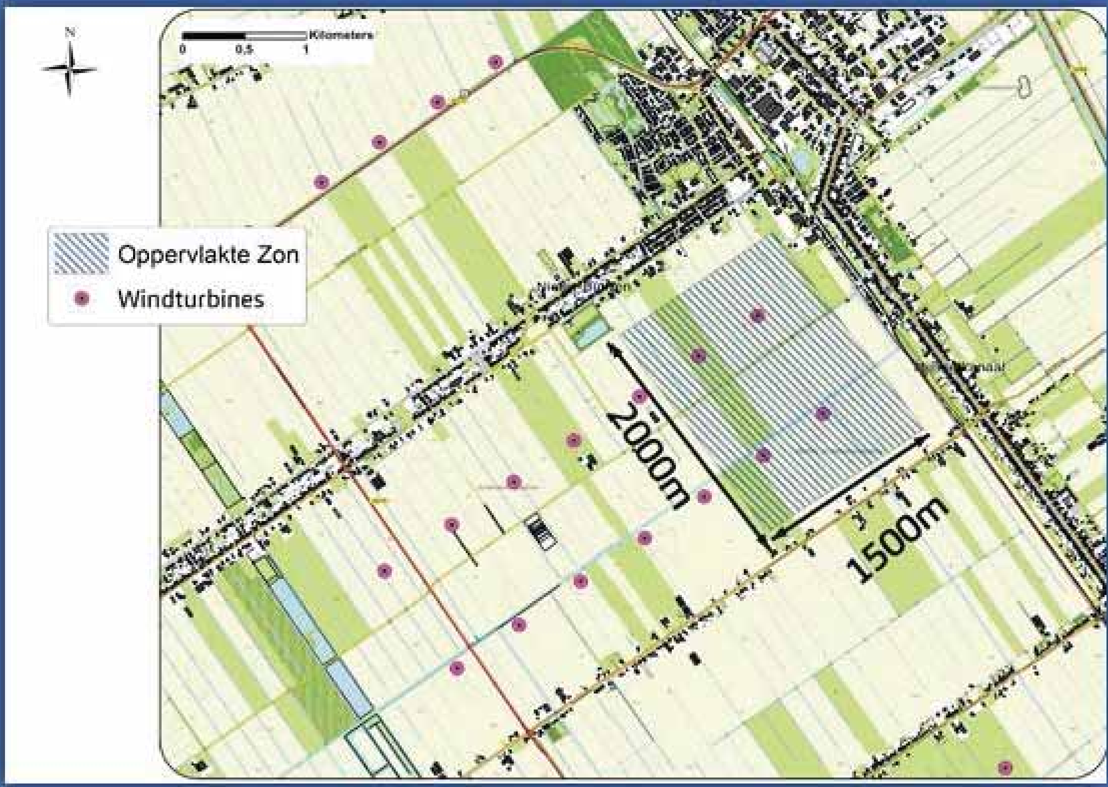
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

5) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	100 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens	0 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	45 euro	25 euro

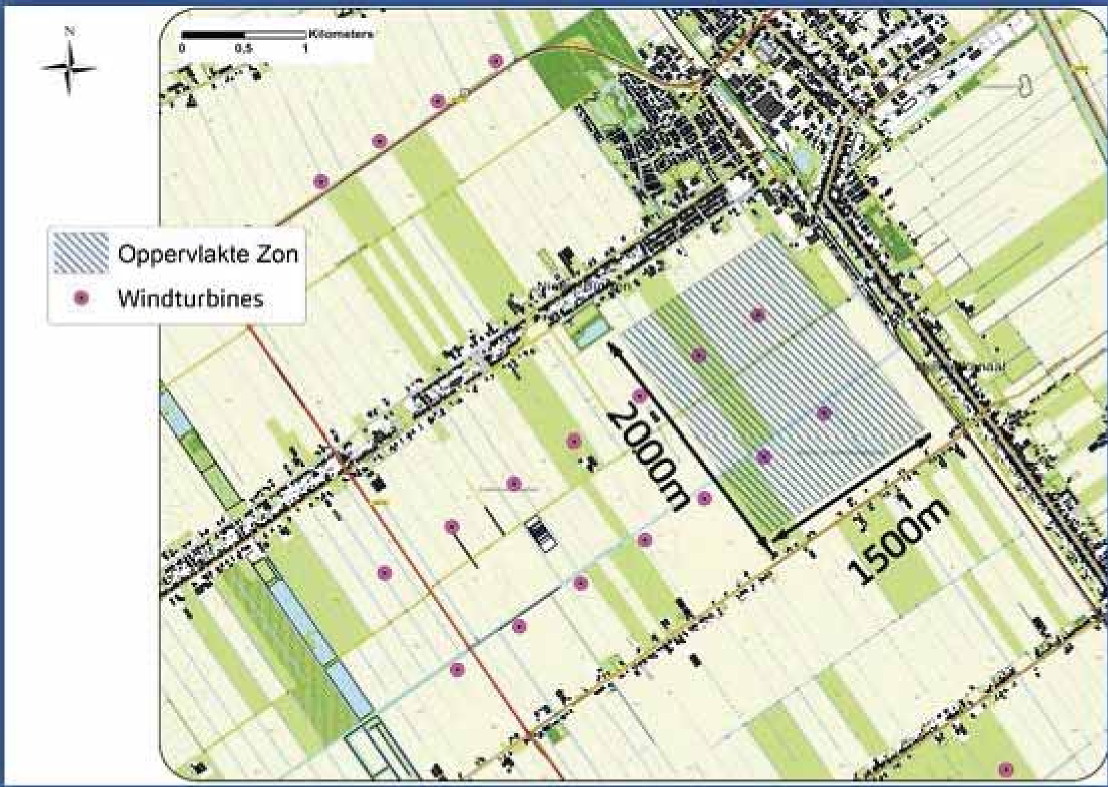
Ik adviseer de overheid het volgende project:
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

6) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	100 huishoudens	100 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	5 euro	65 euro

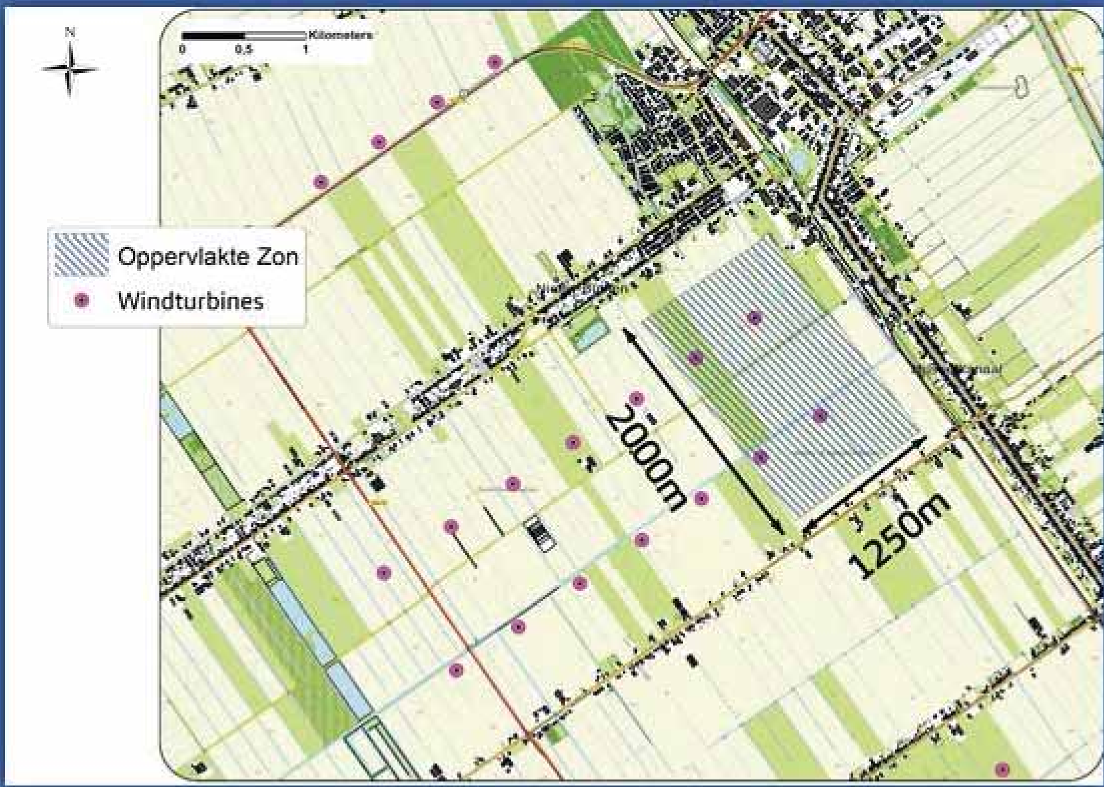
Ik adviseer de overheid het volgende project:
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

7) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	200 huishoudens	0 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	45 euro	25 euro

Ik adviseer de overheid het volgende project:

*

◯ Gepland Windpark

◯ Alternatief Windpark

◯ Alternatief Zonnepark

8) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon

	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	0 huishoudens	100 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	65 euro	5 euro

Ik adviseer de overheid het volgende project:

*

◯ Gepland Windpark

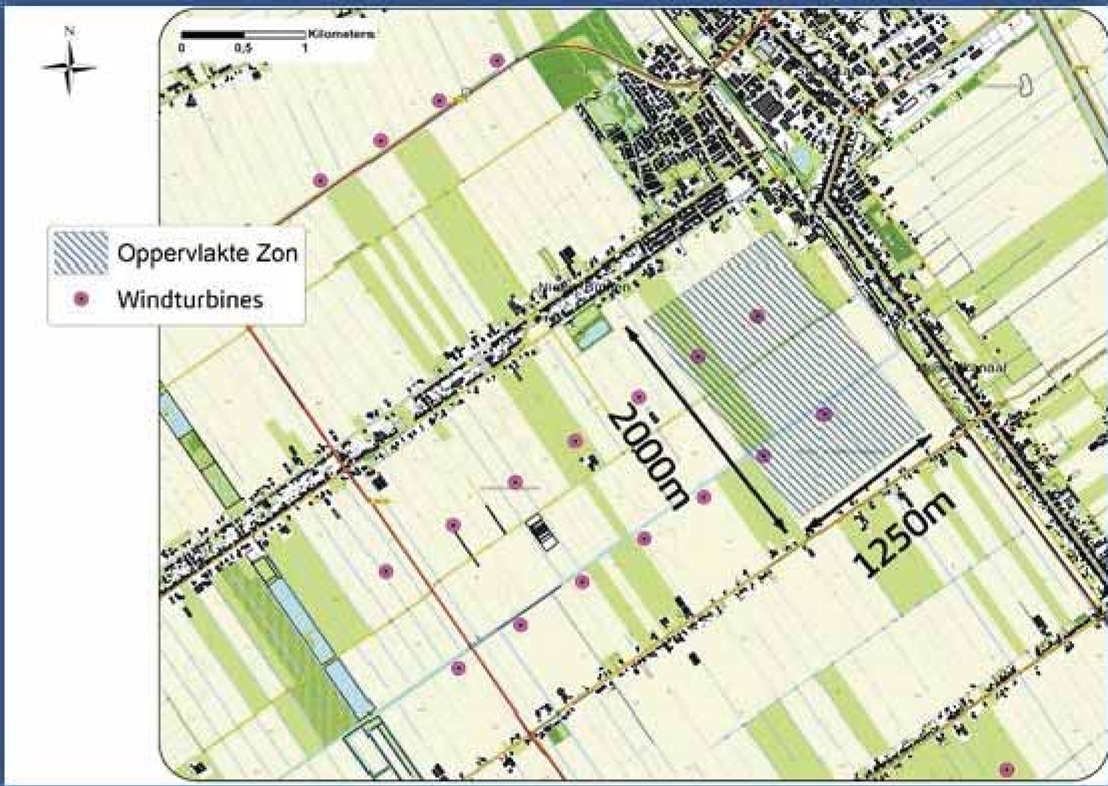
◯ Alternatief Windpark

◯ Alternatief Zonnepark

9) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	0 huishoudens	300 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	65 euro	5 euro

Ik adviseer de overheid het volgende project:
*

◯ Gepland Windpark
◯ Alternatief Windpark
◯ Alternatief Zonnepark

10) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon

	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	300 huishoudens	200 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	45 euro	25 euro

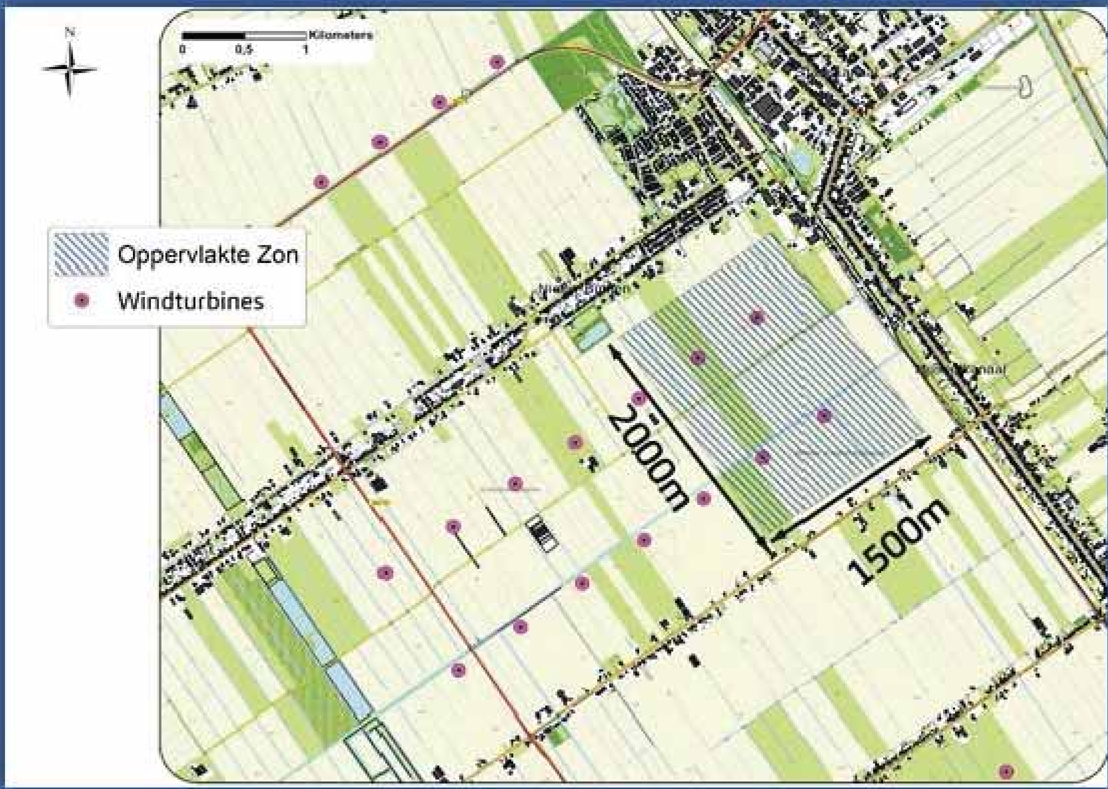
Ik adviseer de overheid het volgende project:
*

- ◯ Gepland Windpark
- ◯ Alternatief Windpark
- ◯ Alternatief Zonnepark

11) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	200 huishoudens	100 huishoudens
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Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	25 euro	45 euro

Ik adviseer de overheid het volgende project:

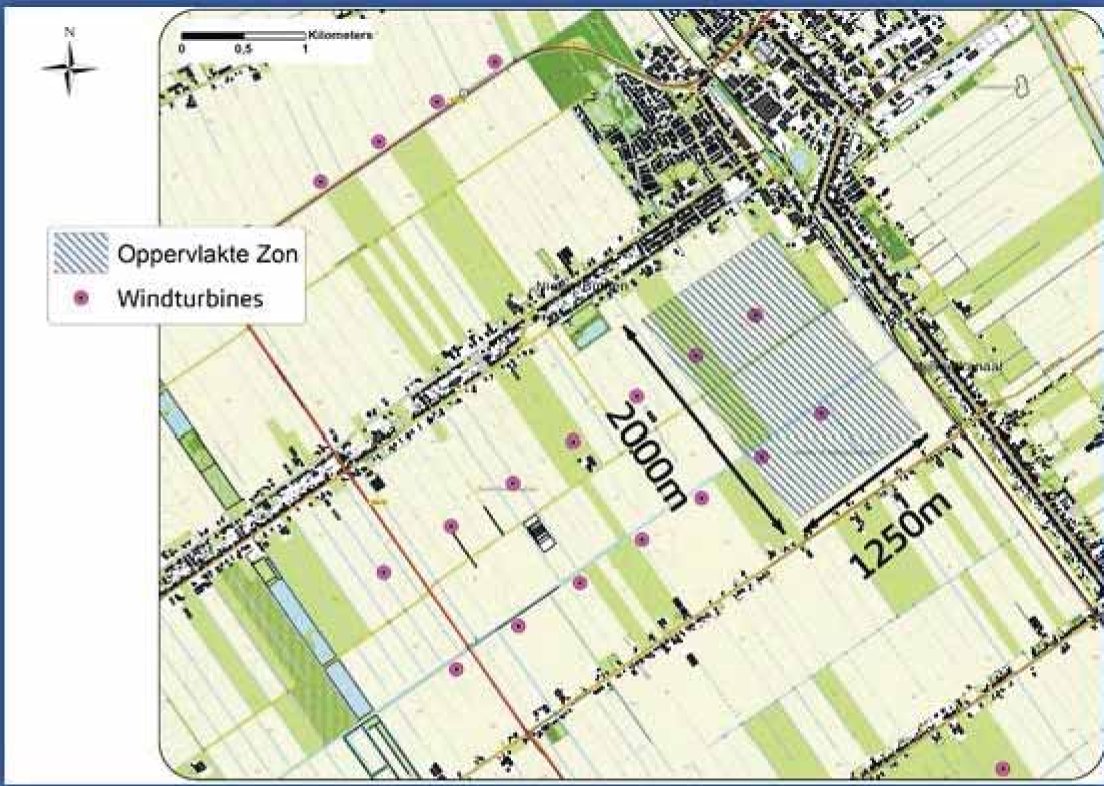
*

- ◯ Gepland Windpark
- ◯ Alternatief Windpark
- ◯ Alternatief Zonnepark

12) De overheid is van plan een windpark aan te leggen dat tegen relatief lage kosten huishoudens van duurzame stroom voorziet. Dit geplande windpark is echter niet de enige optie. Het is ook mogelijk te kiezen voor varianten van een wind- of zonnepark met andere omgevingseffecten. Dit leidt wel tot een eenmalige belastingverhoging voor Nederlandse huishoudens in 2018.

Impressie bovenaanzicht

Wind en Zon



	Gepland Windpark	Alternatief Windpark	Alternatief Zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	100 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	150 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	40 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	5 hectare	200 hectare
Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018 om de aanlegkosten en onderhoudskosten te financieren	Niet van toepassing	5 euro	65 euro

Ik adviseer de overheid het volgende project:
*

- ◯ Gepland Windpark
- ◯ Alternatief Windpark
- ◯ Alternatief Zonnepark

Belangrijkste criterium

13) Wat was voor u het belangrijkste criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare vervangen landbouwgrond
( ) Aantal hectare vervangen recreatiegrond
( ) Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018

Motivatie belangrijkste criterium

14) Kunt u aangeven waarom dit het belangrijkste criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Minst belangrijke criterium

15) Wat was voor u het minst belangrijke criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare vervangen landbouwgrond
( ) Aantal hectare vervangen recreatiegrond
( ) Eenmalige verhoging energiebelasting voor Nederlandse huishoudens in 2018

Motivatie minst belangrijke criterium

16) Kunt u aangeven waarom dit het minst belangrijke criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Stellingen over de keuzes

17) Hieronder volgen een aantal stellingen. Kunt u per stelling aangeven in welke mate u het er mee eens bent?*

	Helemaal mee eens	Mee eens	Neutraal	Mee oneens	Helemaal mee oneens
Ik was regelmatig overtuigd van mijn keuze	○	○	○	○	○
Ik vond de keuzesituaties realistisch	○	○	○	○	○
Dit experiment biedt de overheid relevante informatie bij het maken van keuzes	○	○	○	○	○

Type leefomgeving

18) Welk van de volgende omschrijvingen past het best bij uw leefomgeving?*
( ) Sterk stedelijk gebied
( ) Matig stedelijk gebied
( ) Landelijk gebied

Eigen omgeving

19) Ervaart u thuis zichthinder van een windpark?*
( ) Ja
( ) Nee

20) Ervaart u thuis zichthinder van een zonnepark?*
( ) Ja
( ) Nee

21) Ervaart u thuis geluidsoverlast van een windpark?*
( ) Ik ervaar thuis zeer veel geluidsoverlast van een windpark
( ) Ik ervaar thuis veel geluidsoverlast van een windpark
( ) Ik ervaar thuis regelmatig geluidsoverlast van een windpark
( ) Ik ervaar thuis nauwelijks geluidsoverlast van een windpark
( ) Ik ervaar thuis geen geluidsoverlast van een windpark

22) Hoe vaak recreëert u in een recreatiegebied?*
( ) Dagelijks
( ) Meerdere keren per week
( ) 1 keer per week
( ) Meerdere keren per maand
( ) 1 keer per maand
( ) 1 of meerdere keren per jaar
( ) Nooit

Politieke voorkeur

23) Op welke politieke partij heeft u gestemd bij de vorige verkiezingen?*
( ) VVD
( ) Partij van de Arbeid
( ) CDA
( ) PVV
( ) GroenLinks
( ) SP
( ) D66
( ) ChristenUnie
( ) SGP
( ) Partij voor de Dieren
( ) Een andere politieke partij
( ) Ik heb niet gestemd
( ) Ik wil deze vraag niet invullen

NIPOpunten

24) Hartelijk dank voor uw medewerking!

Voor het invullen van deze vragenlijst ontvangt u NIPOpunten. Om u uw NIPOpunten te kunnen sturen, is het noodzakelijk dat u uw code hieronder invult. Deze code staat in de uitnodigingsmail.

Vul uw code hieronder nauwkeurig in.

Thank You!

VOORKEUREN DUURZAME ENERGIE 3

Welkom

Geachte heer / mevrouw,
Dank voor uw deelname aan dit onderzoek. Het onderzoek bestaat uit 12 vragen. Het invullen van de vragen kost u ongeveer 8 minuten (3 minuten voor het doorlezen van de introducerende tekst en 5 minuten voor het beantwoorden van de vragen)

Klik op "next" om met het onderzoek te starten.

Inleiding

Het uitbreiden van stroomproductie door wind en/of- zonne-energie is een centraal onderdeel van het Nederlandse energie- en klimaatbeleid, om in 2050 een volledig duurzame energievoorziening te realiseren. Daarom zet de overheid belastinggeld in om de aanleg van een wind- of zonnepark te financieren.

De bouw van een wind-of zonnepark verandert de directe leefomgeving van omwonenden. Zo kan het uitzicht vanuit de huizen van mensen veranderen of verdwijnt er recreatiegrond. Daarnaast nemen omwonenden in verschillende mate deel aan de ontwikkeling van een wind- en zonnepark (participatie). Daarom wil de overheid graag weten wat u belangrijk vindt bij de aanleg van een wind- of zonnepark in Nederland. Om daar inzicht in te krijgen leggen wij u twaalf keer een variant van een windpark en een zonnepark voor en wij vragen u of uw voorkeur uitgaat naar het windpark of het zonnepark.

Beschrijving van de omgevingseffecten

De overheid wil graag weten onder welke voorwaarden Nederlanders een voorkeur hebben voor windparken of zonneparken.

Gaat u van het volgende uit:

- Het windpark en het zonnepark zijn op twee verschillende locaties gebouwd (Dorp A en Dorp B) met verschillende omwonenden/recreanten etc.
- U spreekt uw voorkeur uit voor het park dat volgens u met gereserveerd belastinggeld gefinancierd moet worden. Voor dit onderzoek kunt u ervan uitgaan dat uw besteedbaar inkomen onveranderd blijft (bijv. uw energierekening blijft onveranderd).
- Het wind-of zonnepark verschilt **alleen** op de volgende vijf aspecten, verdeeld over twee typen hinder, twee typen grondgebruik en de mate van participatie van omwonenden bij de ontwikkeling van een wind- of zonnepark .

Hinder:
Het wind- en zonnepark is in de buurt van woningen gebouwd en beïnvloedt de directe leefomgeving van huishoudens via zicht- en geluidshinder.

1. Het aantal huishoudens dat zichthinder ondervindt: Een wind-of zonnepark verandert het vrije zicht van huishoudens die aan de rand van het windpark (op de minimale afstand van 500 meter) of het zonnepark wonen.
2. Het aantal huishoudens dat geluidsoverlast ondervindt: Een zonnepark produceert geen geluid, een windmolenpark wel. Het geluidsvolume van een windmolen op de minimale wettelijke afstand (van 500 meter) van huizen bedraagt jaarlijks gemiddeld 42 decibel, gemeten op de gevel. Als het raam dicht is, is

het geluid binnenshuis niet hoorbaar. Met een open raam is dit geluidsvolume te vergelijken met het geluid van een koelkast op een meter afstand. Het type geluid is wel anders: elektrische apparaten produceren een monotoon geluid, terwijl het geluid van een windmolen licht zoevend is.

Grondgebruik:

De bouw van een wind- of zonnepark vervangt grond dat gebruikt wordt voor landbouw of recreatie.
Het oppervlak vervangen grond wordt gemeten in hectare. Een hectare staat gelijk aan ongeveer twee voetbalvelden, terwijl honderd hectare (een kilometer bij een kilometer) gelijk staat aan de grootte van een klein dorp.

3. Aantal hectare vervangen landbouwgrond: Het windpark en het zonnepark vervangen landbouwgrond. Deze grond bevindt zich op afgesloten (privé) boerenterrein.
4. Aantal hectare vervangen recreatiegrond: Het windpark en het zonnepark vervangen recreatiegrond. Recreatiegrond wordt gebruikt voor diverse activiteiten, variërend van hardlopen tot natuurrecreatie. Een omheind zonnepark vormt een duidelijke barrière tussen woonwijken en recreatiegebied, waardoor aantrekkelijke gebieden slechter te bereiken zijn.

Participatie omwonenden:

5. Mate van participatie omwonenden: Tijdens de ontwikkeling van het wind-en zonnepark zijn beslissingen genomen over de bouw van het windpark en het zonnepark. Zo is er gekeken naar de exacte locatie en indeling van het park. Hierin hebben omwonenden per dorp in verschillende mate geparticipeerd. Hieronder volgt een omschrijving van de verschillende mate van participatie in dit proces.

Rol van de omwonenden	Omschrijving
Geen participatie	De overheid heeft **zelf** beslist over de bouw van het wind-of zonnepark, zonder de omwonenden hierover te informeren
Raadgeven	De overheid heeft zelf beslist over de bouw van het wind-of zonnepark, maar heeft de omwonenden de gelegenheid gegeven **problemen aan te dragen en oplossingen te formuleren**. Hoewel deze ideeen niet bindend zijn, hebben ze wel een volwaardige rol gehad in de ontwikkeling van het duurzame energiepark.
Samenwerken	De overheid en de omwonenden hebben **gezamelijk** beslist over de bouw van het wind-of zonnepark. Alle partijen hebben zich verbonden aan dit overeengekomen plan.
Beslissen	**De omwonenden hebben beslist** over de bouw van het wind-of zonnepark. De overheid heeft vooraf de randvoorwaarden getoetst, vervolgens de omwonenden geadviseerd en het proces begeleid.

Impressie van het zijaanzicht

Om u een beter beeld te geven van het type zichthinder van huishoudens aan de rand van een wind-of zonnepark tonen wij twee impressies van een zijaanzicht.

Impressies zijaanzicht

Windmolens op de minimale afstand van 500 meter

Omheind grondgebonden zonnepark

Impressie van het grondgebruik

Om u een beter beeld te geven van het grondgebruik van het gebouwde wind- en zonnepark tonen wij ze in dezelfde afbeelding. Ga er echter wel vanuit dat het windpark en zonnepark in verschillende dorpen zijn gebouwd, met verschillende omwonenden en recreanten etc.

De windmolens vervangen stukken grond op de plek waar ze gebouwd worden, verspreid over een gebied. Dit is bij elke keuze aangegeven met roze stippen. Bij een zonnepark staan zonnepanelen in rijen achter elkaar en vervangen ze een aaneengesloten stuk grond. Het blauw gearceerde vlak op de plattegrond is hiervan een voorbeeld. De grootte van het vlak komt overeen met het aangegeven oppervlak in de keuze. Daarnaast zijn er ter ondersteuning lengte- en breedtematen toegevoegd.

Opmerkingen

We vragen u in dit onderzoek 12 keer welk project u de overheid zou adviseren te financieren met belastinggeld, op basis van de verschillende effecten op de leefomgeving (Project A: Windpark op Land, Project B: Grondgebonden zonnepark).

De overheid wil de resultaten van het experiment gebruiken om een beslissing te nemen over de bouw van wind-en zonneparken in Nederland, waarbij de varianten alleen verschillen op de vier bovengenoemde aspecten. Daarom is het belangrijk dat u aanneemt dat de projecten **niet** verschillen op andere aspecten (bijvoorbeeld: stroomproductie, energiezekerheid, energierekening).

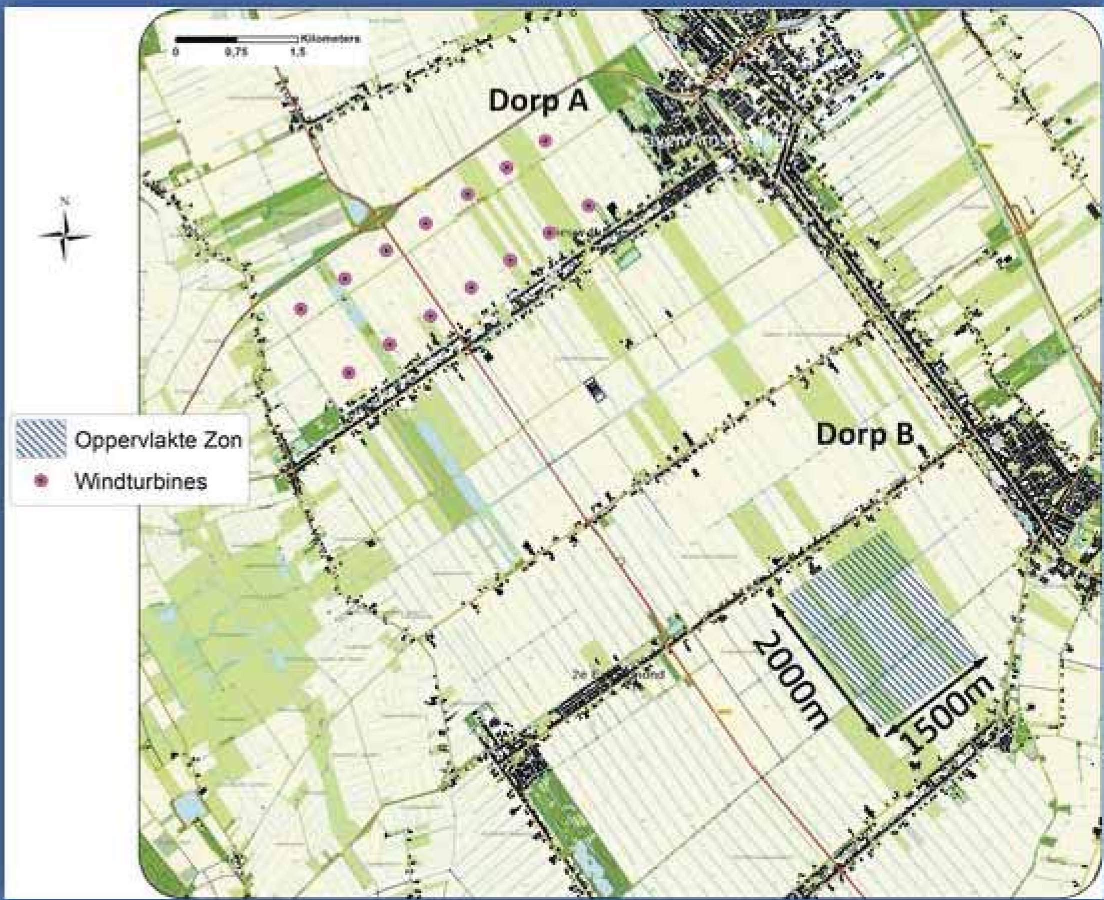
De overheid is geïnteresseerd in de algemene voorkeuren van Nederlanders voor de ontwikkeling van wind- en zonneparken. Daarom geven we niet aan of de verandering in uw leefomgeving plaatsvindt. Als combinaties van effecten u onlogisch lijken, vragen wij u vriendelijk toch uw keuze te maken op basis van de omgevingseffecten.

Succes met het invullen van dit onderzoek!

1. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	200 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	100 hectare
Mate van participatie omwonenden	Beslissen	Geen participatie

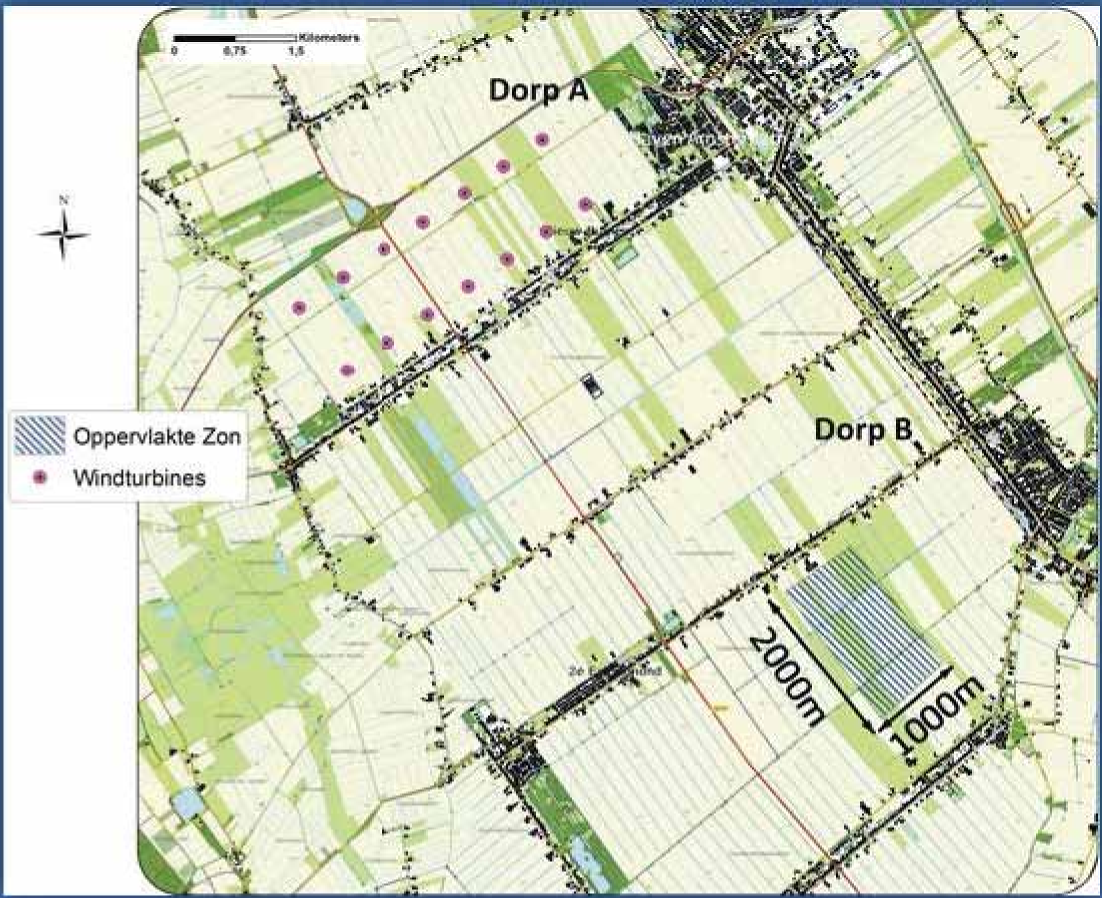
Ik adviseer de overheid het volgende project:*

- ○ Project A: Wind op Land
- ○ Project B: Grondgebonden zonnepark

2. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	50 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	15 hectare	150 hectare
Mate van participatie omwonenden	Geen participatie	Raadgeven

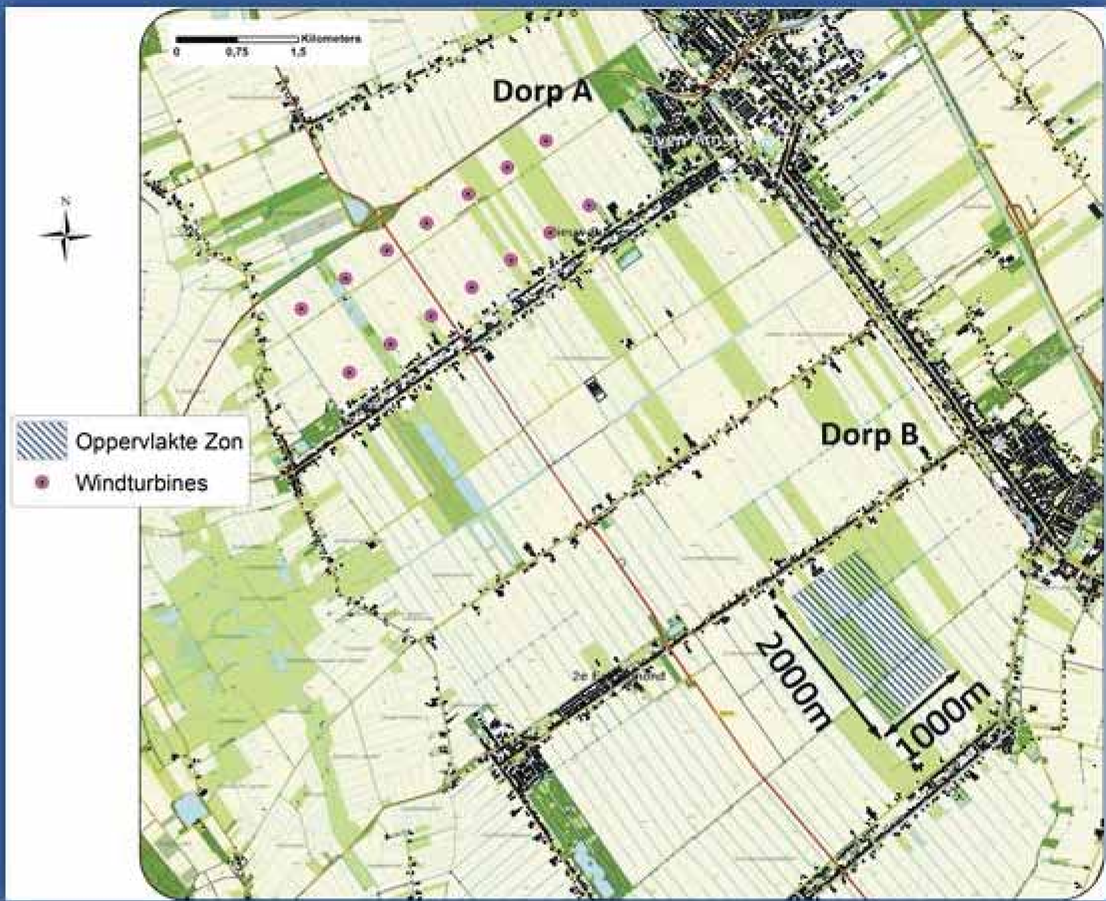
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

3. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	300 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	50 hectare
Mate van participatie omwonenden	Geen participatie	Beslissen

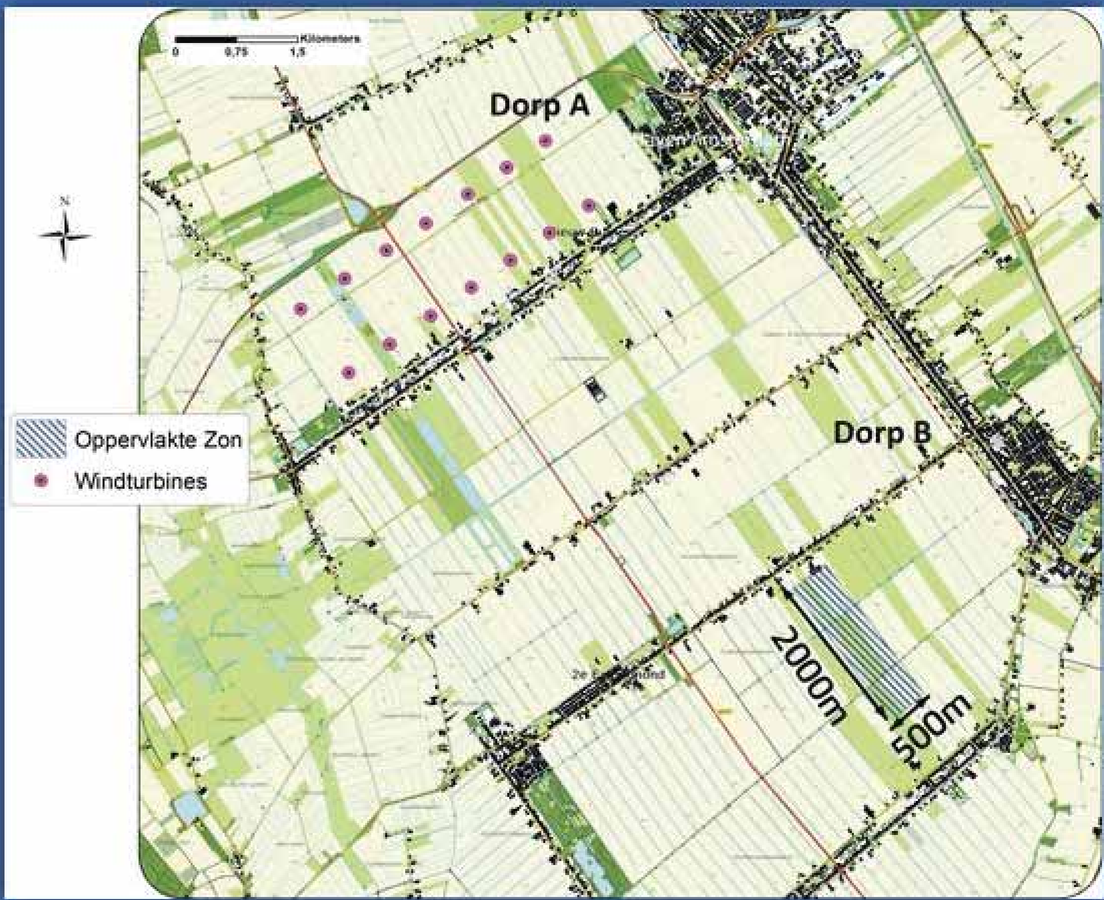
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

4. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	200 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	50 hectare
Mate van participatie omwonenden	Raadgeven	Geen participatie

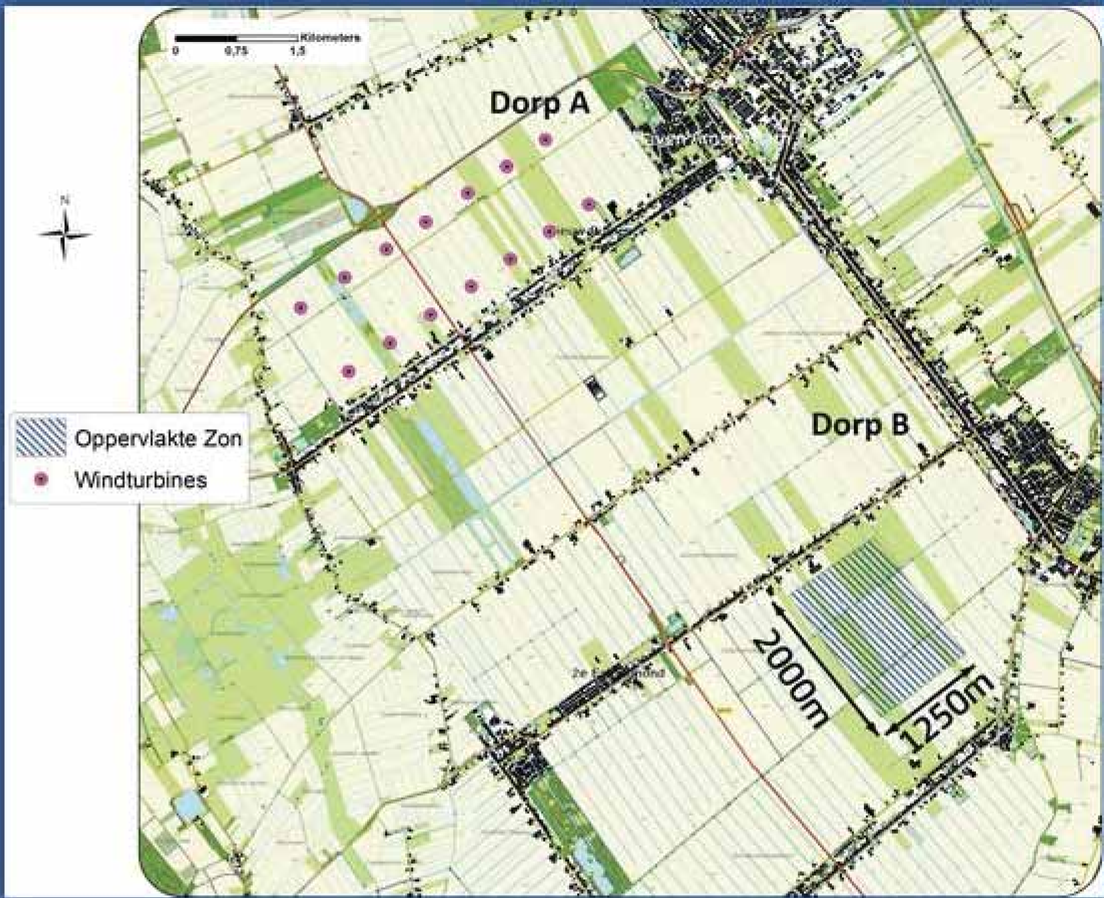
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

5. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	100 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	100 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	15 hectare	150 hectare
Mate van participatie omwonenden	Geen participatie	Samenwerken

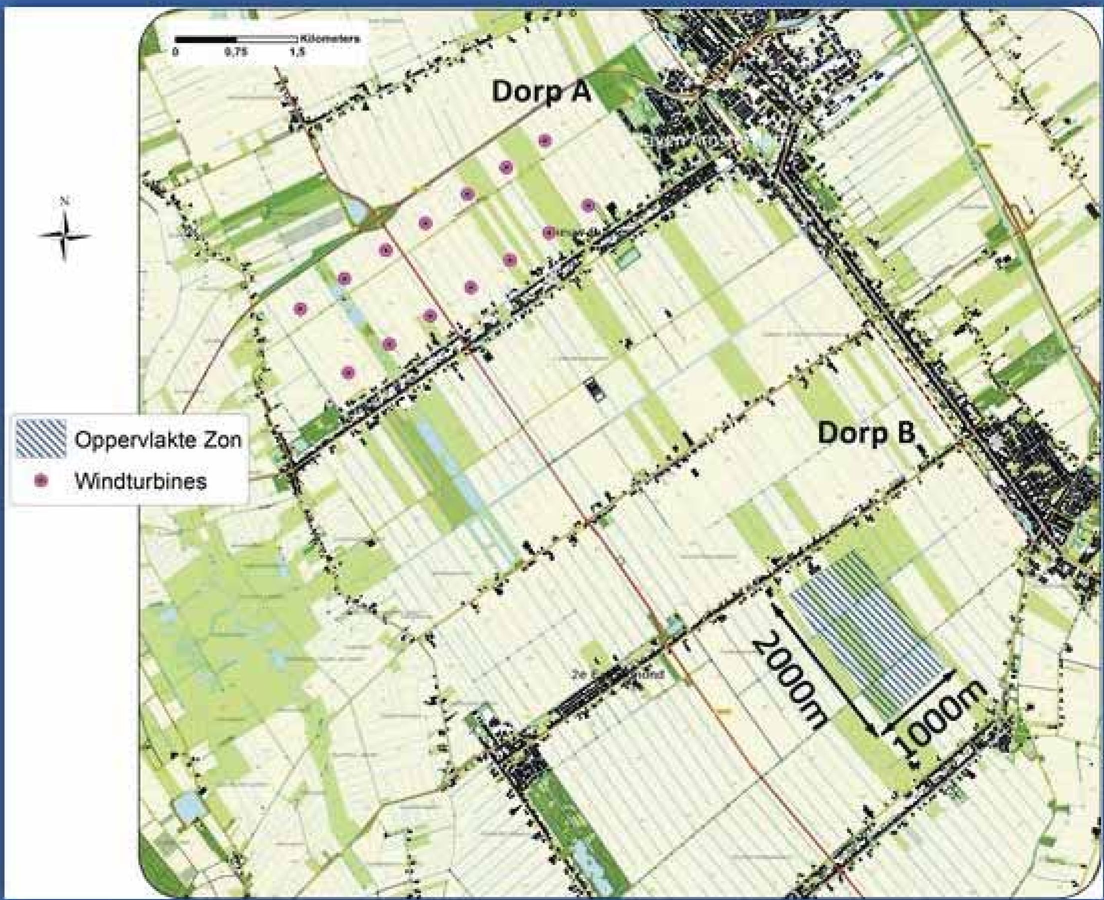
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

6. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	50 hectare
Mate van participatie omwonenden	Samenwerken	Raadgeven

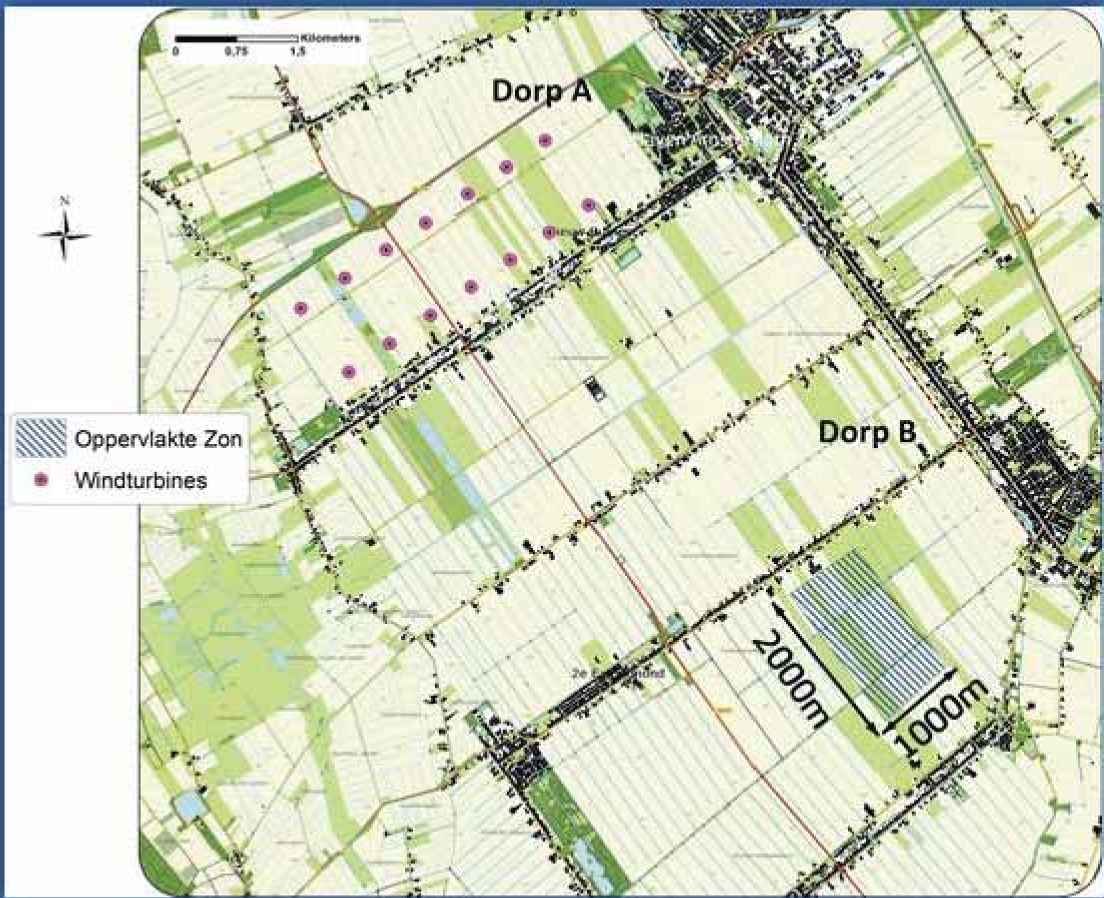
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

7. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	300 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	50 hectare
Mate van participatie omwonenden	Samenwerken	Raadgeven

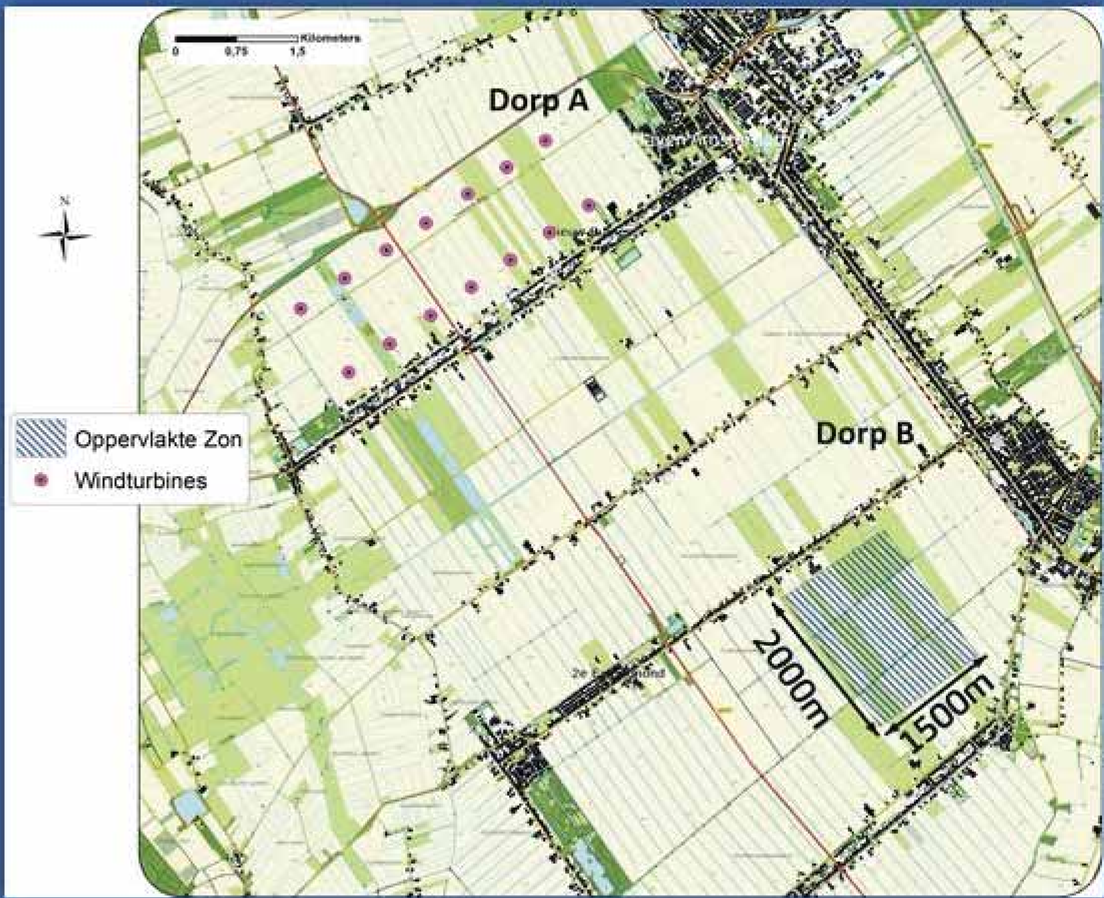
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

8. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	200 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	0 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	100 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	200 hectare
Mate van participatie omwonenden	Samenwerken	Geen participatie

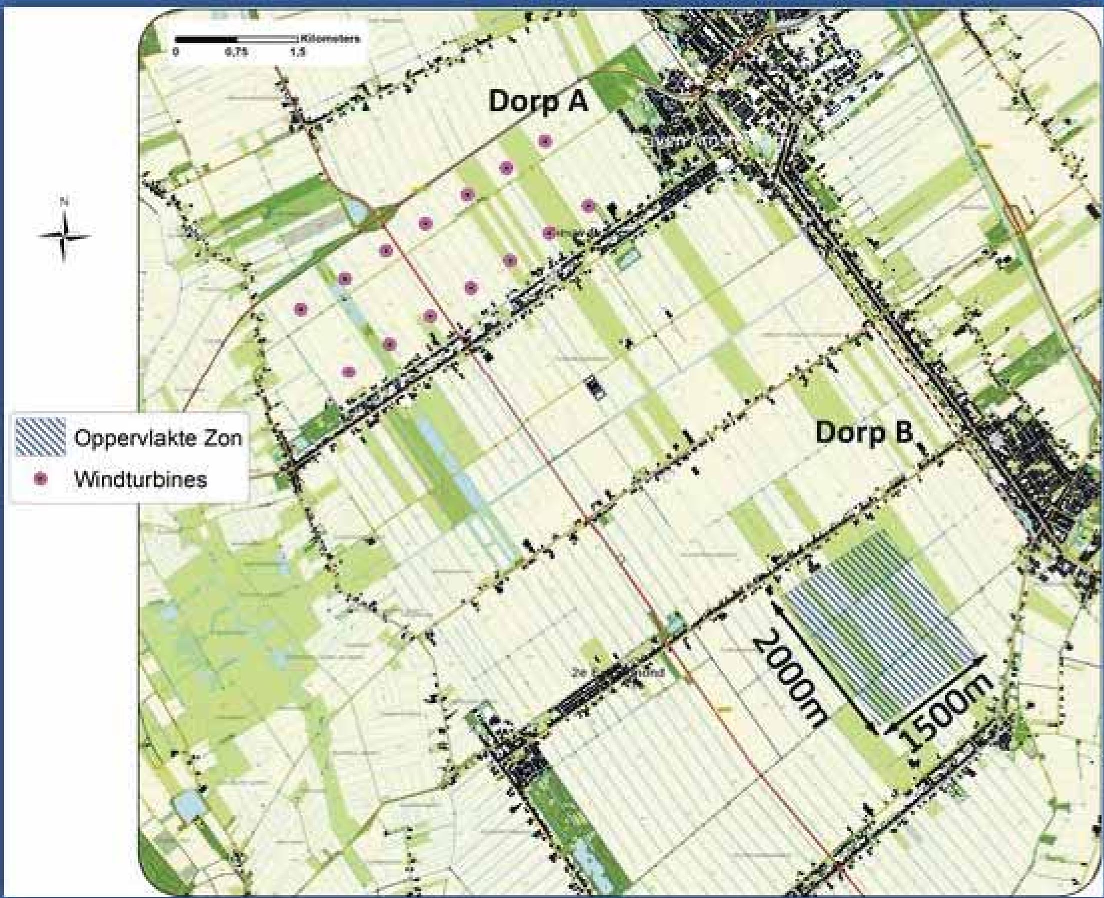
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

9. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	**Project B: Grondgebonden zonnepark**
Aantal huishoudens dat zichthinder ondervindt	100 huishoudens	200 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	20 hectare	100 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	200 hectare
Mate van participatie omwonenden	Raadgeven	Beslissen

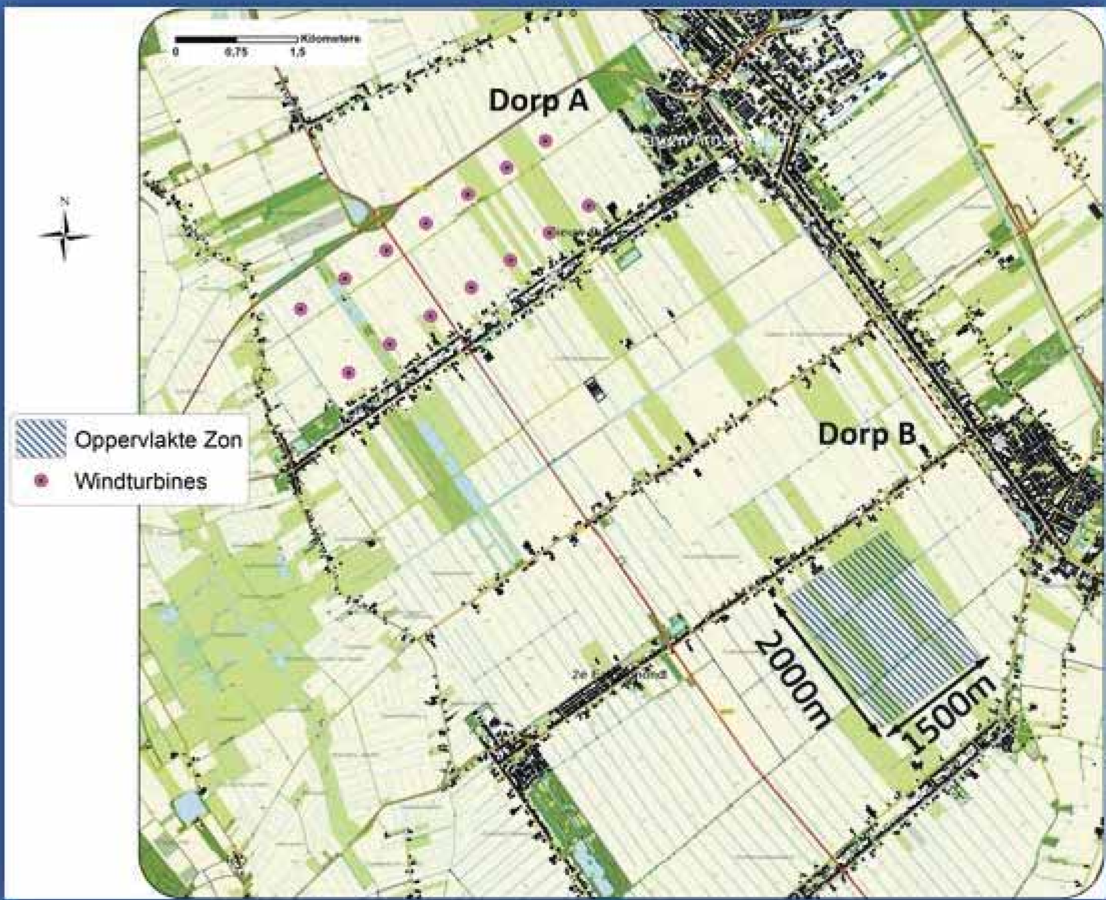
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

10. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



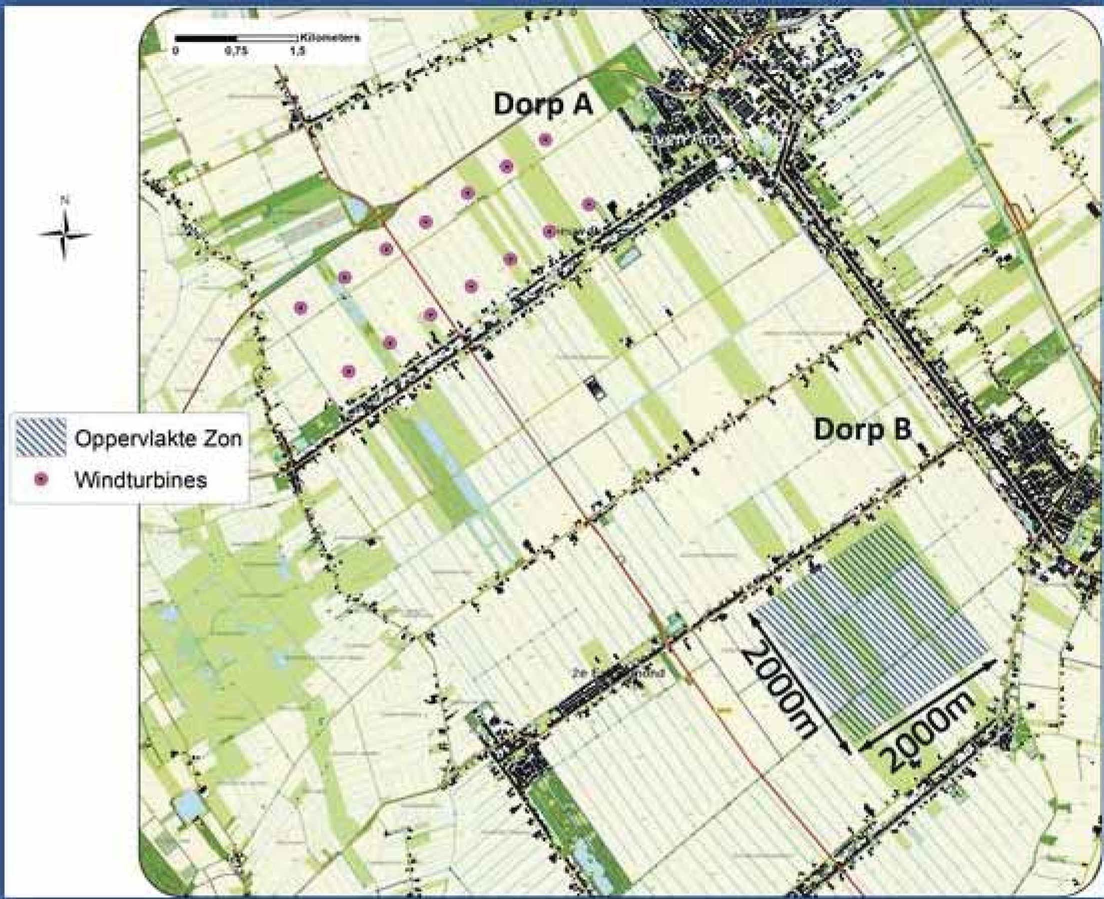
	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	150 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	10 hectare	150 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	10 hectare	150 hectare
Mate van participatie omwonenden	Samenwerken	Raadgeven

Ik adviseer de overheid het volgende project:*

- ○ Project A: Wind op Land
- ○ Project B: Grondgebonden zonnepark

11. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht
Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	200 huishoudens	0 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	50 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	30 hectare	200 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	20 hectare	200 hectare
Mate van participatie omwonenden	Beslissen	Samenwerken

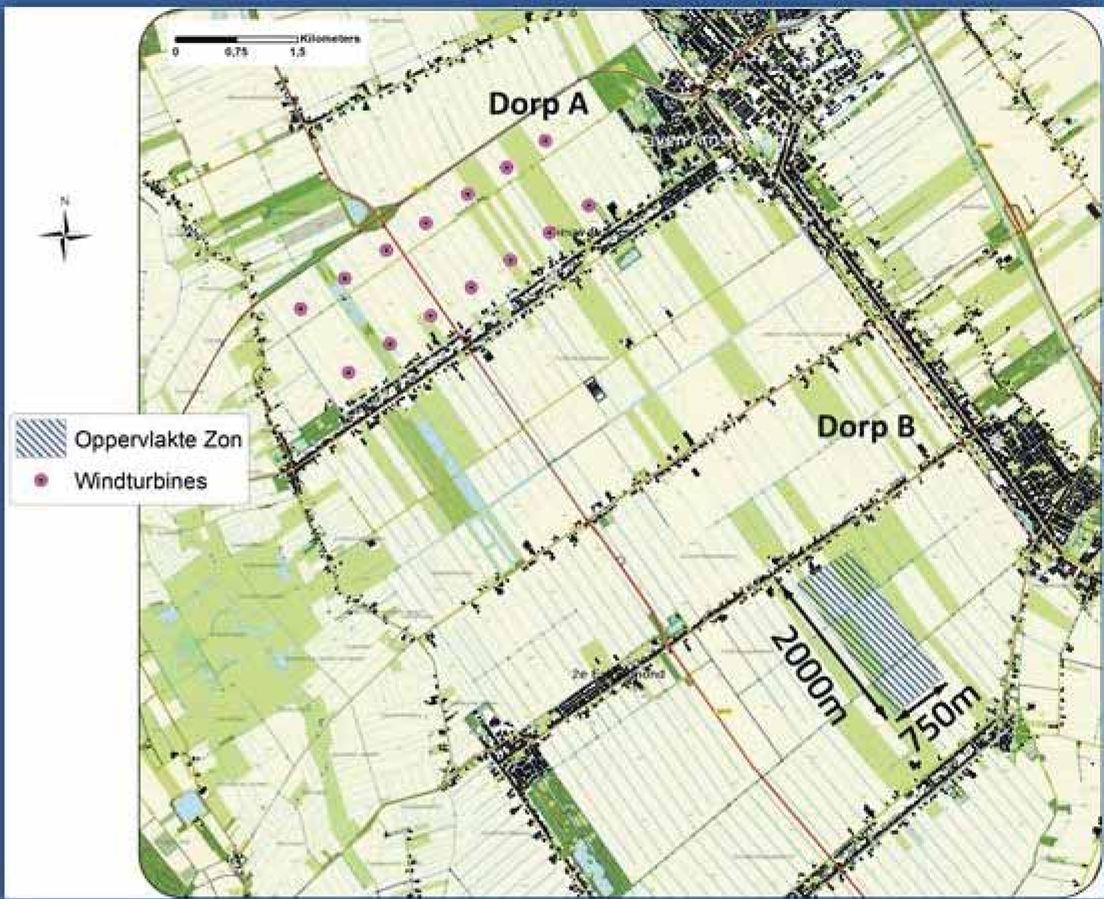
Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

12. Wij vragen u welk wind- of zonnepark u de overheid adviseert te financieren met belastinggeld, op basis van de effecten.

Impressie bovenaanzicht

Wind en Zon



	Project A: Windpark op land	Project B: Grondgebonden zonnepark
Aantal huishoudens dat zichthinder ondervindt	0 huishoudens	100 huishoudens
Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart	100 huishoudens	0 huishoudens
Aantal hectare vervangen landbouwgrond (0.6 hectare = 1 voetbalveld)	40 hectare	50 hectare
Aantal hectare vervangen recreatiegrond (0.6 hectare = 1 voetbalveld)	5 hectare	100 hectare
Mate van participatie omwonenden	Beslissen	Samenwerken

Ik adviseer de overheid het volgende project:*

- Project A: Wind op Land
- Project B: Grondgebonden zonnepark

Belangrijkste criterium

13) Wat was voor u het belangrijkste criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare vervangen landbouwgrond
( ) Aantal hectare vervangen recreatiegrond
( ) Mate van participatie omwonenden

Motivatie belangrijkste criterium

14) Kunt u aangeven waarom dit het belangrijkste criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Minst belangrijke criterium

15) Wat was voor u het minst belangrijke criterium bij het bepalen van uw voorkeur?*

( ) Aantal huishoudens dat zichthinder ondervindt
( ) Aantal huishoudens dat een geluidsvolume van 42 dB op de gevel ervaart
( ) Aantal hectare ruimtebeslag landbouwgrond
( ) Aantal hectare ruimtebeslag recreatiegrond
( ) Mate van participatie omwonenden

Motivatie minst belangrijke criterium

16) Kunt u aangeven waarom dit het minst belangrijke criterium was bij het bepalen van uw voorkeur?
(let op: het invullen van deze vraag is een voorwaarde voor het toekennen van NIPO-punten)*

Stellingen over de keuzes

17) Hieronder volgen een aantal stellingen. Kunt u per stelling aangeven in welke mate u het er mee eens bent?*

	Helemaal mee eens	Mee eens	Neutraal	Mee oneens	Helemaal mee oneens
Ik was regelmatig overtuigd van mijn keuze	◯	◯	◯	◯	◯
Ik vond de keuzesituaties realistisch	◯	◯	◯	◯	◯
Dit experiment biedt de overheid relevante informatie bij het maken van keuzes	◯	◯	◯	◯	◯

Type leefomgeving

18) Welk van de volgende omschrijvingen past het best bij uw leefomgeving?*

( ) Sterk stedelijk gebied
( ) Matig stedelijk gebied
( ) Landelijk gebied

Eigen omgeving

19) Ervaart u thuis zichthinder van een windpark?*

( ) Ja
( ) Nee

20) Ervaart u thuis zichthinder van een zonnepark?*

( ) Ja
( ) Nee

21) Ervaart u thuis geluidsoverlast van een windpark?*

( ) Ik ervaar thuis zeer veel geluidsoverlast van een windpark
( ) Ik ervaar thuis veel geluidsoverlast van een windpark
( ) Ik ervaar thuis regelmatig geluidsoverlast van een windpark
( ) Ik ervaar thuis nauwelijks geluidsoverlast van een windpark
( ) Ik ervaar thuis geen geluidsoverlast van een windpark

22) Hoe vaak recreëert u in een recreatiegebied?*

( ) Dagelijks
( ) Meerdere keren per week
( ) 1 keer per week
( ) Meerdere keren per maand
( ) 1 keer per maand
( ) 1 of meerdere keren per jaar
( ) Nooit

Politieke voorkeur

23) Op welke politieke partij heeft u gestemd bij de vorige verkiezingen?*
( ) VVD
( ) Partij van de Arbeid
( ) CDA
( ) PVV
( ) GroenLinks
( ) SP
( ) D66
( ) ChristenUnie
( ) SGP
( ) Partij voor de Dieren
( ) Een andere politieke partij
( ) Ik heb niet gestemd
( ) Ik wil deze vraag niet invullen

NIPOpunten

24) Hartelijk dank voor uw medewerking!

Voor het invullen van deze vragenlijst ontvangt u NIPOpunten. Om u uw NIPOpunten te kunnen sturen, is het noodzakelijk dat u uw code hieronder invult. Deze code staat in de uitnodigingsmail.

Vul uw code hieronder nauwkeurig in.

Thank You!

Appendix D: MNL model results

Model file citizen experiment:

```
// File : Modelfile_burgerwaarden1_Scaled.mod
// Author : Jori Corbié
// Date : Thu July 13th
//
// MNL model Experiment 1: Burgerwaarden specificatie 1 ALLE DATA
// Two alternatives : Wind, Solar
// SP data


// Declare model parameters
// Name         Value    Lower Bound    Upper Bound     status (0= variable, 1=fixed)

[Beta]
ASC_Wind        0        -10000         10000           1
ASC_Solar       0        -10000         10000           0
B_WZicht        0        -10000         10000           0
B_WGeluid       0        -10000         10000           0
B_WLand         0        -10000         10000           0
B_WRecr         0        -10000         10000           0
B_ZZicht        0        -10000         10000           0
B_ZLand         0        -10000         10000           0
B_ZRecr         0        -10000         10000           0

// Utility specification
//ID     Name     Avail      Linear-in-parameter

[Utilities]
  1      A        AV_A     ASC_Wind * one + B_WZicht * WZicht_SCALED + B_WGeluid * WGeluid_SCALED + B_WLand * WLand_SCALED + B_WRecr * WRecr_SCALED
  2      B        AV_B     ASC_Solar * one + B_ZZicht * ZZicht_SCALED + B_ZLand * ZLand_SCALED + B_ZRecr * ZRecr

[Choice]
CHOICE

// Set one to 1

[Expressions]
one = 1
// For numerical reasons it is good practice to scale the data to values around 1.0
// A previous run with unscaled data generated parameters around 0.002-0.009
// Therefore, parameters are scaled by dividing by 100
WZicht_SCALED = WZicht / 100
WGeluid_SCALED = WGeluid / 100
WLand_SCALED = WLand / 100
WRecr_SCALED = WRecr / 100
ZZicht_SCALED = ZZicht / 100
ZLand_SCALED = ZLand / 100
ZRecr_SCALED = ZRecr / 100


// Specify which model to estimate

[Model]
$MNL
```

Model file consumer experiment:

```
// Date : Fri July 13th
// MNL model Experiment 2: Consumentenwaarden eindversie alle data
// Three alternatives : Base, Wind, Solar
// SP data

// Declare model parameters
// Name         Value    Lower Bound    Upper Bound    status (0= variable, 1=fixed)

[Beta]
ASC_Wind        0       -10000          10000           0
ASC_Solar       0       -10000          10000           0
ASC_NUL         0       -10000          10000           1
B_WZicht        0       -10000          10000           0
B_WGeluid       0       -10000          10000           0
B_WLand         0       -10000          10000           0
B_WRecr         0       -10000          10000           0
B_ZZicht        0       -10000          10000           0
B_ZLand         0       -10000          10000           0
B_ZRecr         0       -10000          10000           0
B_Tax           0       -10000          10000           0

// Utility specification
//ID     Name    Avail     Linear-in-parameter

[Utilities]
  1      A       AV_A    ASC_NUL * one
  2      B       AV_B    ASC_Wind * one + B_WZicht * WZicht_SCALED + B_WGeluid * WGeluid_SCALED + B_WLand * WLand_SCALED + B_WRecr * WRecr_SCALED + B_Tax * WWTT_SCALED
  3      C       AV_C    ASC_Solar * one + B_ZZicht * ZZicht_SCALED + B_ZLand * ZLand_SCALED + B_ZRecr * ZRecr_SCALED + B_Tax * ZWTT_SCALED

[Choice]
CHOICE

// Set one to 1

[Expressions]
one = 1
// For numerical reasons it is good practice to scale the data to values around 1.0
// A previous run with unscaled data generated parameters around 0.002-0.009
// Therefore, parameters are scaled by dividing by 100
WZicht_SCALED = WZicht / 100
WGeluid_SCALED = WGeluid / 100
WLand_SCALED = WLand / 100
WRecr_SCALED = WRecr / 100
WWTT_SCALED = WWTT / 100
ZZicht_SCALED = ZZicht / 100
ZLand_SCALED = ZLand / 100
ZRecr_SCALED = ZRecr / 100
ZWTT_SCALED = ZWTT / 100

// Specify which model to estimate

[Model]
$MNL
```

Model file citizen participation experiment:

```
// File : Modelfile_burgerwaarden_Scaled.mod
// Author : Jori Corbié
// Date : Thu July 22th
// MNL model Experiment 3: Burgerwaarden en participatie Alle data
// Two alternatives : Wind, Solar
// SP data

// Declare model parameters
// Name         Value    Lower Bound    Upper Bound    status (0= variable, 1=fixed)

[Beta]
ASC_Wind        0       -10000          10000           1
ASC_Solar       0       -10000          10000           0
B_WZicht        0       -10000          10000           0
B_WGeluid       0       -10000          10000           0
B_WLand         0       -10000          10000           0
B_WRecr         0       -10000          10000           0
B_ZZicht        0       -10000          10000           0
B_ZLand         0       -10000          10000           0
B_ZRecr         0       -10000          10000           0
B_Raad          0       -10000          10000           0
B_Samen         0       -10000          10000           0
B_Beslis        0       -10000          10000           0

// Utility specification
//ID     Name    Avail     Linear-in-parameter

[Utilities]
  1      A       AV_A    ASC_Wind * one + B_WZicht * WZicht_SCALED + B_WGeluid * WGeluid_SCALED + B_WLand * WLand_SCALED + B_WRecr * WRecr_SCALED + B_Raad * WRaad + B_Samen * WSamen + B_Beslis * WBeslis
  2      B       AV_B    ASC_Solar * one + B_ZZicht * ZZicht_SCALED + B_ZLand * ZLand_SCALED + B_ZRecr * ZRecr + B_Raad * ZRaad + B_Samen * ZSamen + B_Beslis * ZBeslis

[Choice]
CHOICE

// Set one to 1

[Expressions]
one = 1
// For numerical reasons it is good practice to scale the data to values around 1.0
// A previous run with unscaled data generated parameters around 0.002-0.009
// Therefore, parameters are scaled by dividing by 100
WZicht_SCALED = WZicht / 100
WGeluid_SCALED = WGeluid / 100
WLand_SCALED = WLand / 100
WRecr_SCALED = WRecr / 100
ZZicht_SCALED = ZZicht / 100
ZLand_SCALED = ZLand / 100
ZRecr_SCALED = ZRecr / 100


// Specify which model to estimate

[Model]
$MNL
```

Appendix E: MNL model excluding non-traders

The model file for the MNL model excluding

The model fit parameters from the MNL model excluding non-traders are outlined below.

Model:	Multinomial Logit
Number of estimated parameters:	8
Number of observations:	1764
Number of individuals:	1764
Null log-likelihood:	-1222.712
Cte log-likelihood:	-1213.716
Init log-likelihood:	-1222.712
Final log-likelihood:	-1090.032
Likelihood ratio test:	265.360
Rho-square:	0.109
Adjusted rho-square:	0.102

The model utility parameters are depicted below.

Name	Value	Std err	t-test	p-value		Robust Std err	Robust t-test	p-value
ASC_Solar	0.194	0.258	0.75	0.45	*	0.256	0.76	0.45
ASC_Wind	0.00	fixed						
B_WNoise	-1.06	0.0976	-10.83	0.00		0.0976	-10.83	0.00
B_WAgr	-0.0240	0.478	-0.05	0.96	*	0.483	-0.05	0.96
B_WRecr	0.113	0.917	0.12	0.90	*	0.914	0.12	0.90
B_WVis	-0.217	0.0460	-4.70	0.00		0.0463	-4.68	0.00
B_SAgr	-0.0987	0.0968	-1.02	0.31	*	0.0977	-1.01	0.31
B_SRecr	-0.00212	0.000953	-2.23	0.03		0.000960	-2.21	0.03
B_SVis	-0.454	0.0491	-9.25	0.00		0.0497	-9.13	0.00