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The influence of values on evaluations of energy alternatives

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ABSTRACT

Although both promoted as sustainable, nuclear and renewable energy elicit different evaluations in people. People expect (whether true or not) different implications for the environment and for consumers' resources from these energy alternatives. But what factors define the perceived importance of these environmental and individual consequences, and will this affect people's attitudes toward energy alternatives? Do these factors also influence perceptions of consequences of energy alternatives? The authors propose that people's biospheric (e.g. valuing nature) and egoistic (e.g. valuing wealth) values affect evaluations of energy alternatives in three important ways. First, as expected, the results showed that the stronger their egoistic values, the more important people find individual consequences of energy alternatives, whereas the stronger their biospheric values, the more important they find environmental consequences. Second, this indeed translated into attitudes: the stronger their egoistic values, the more people favored nuclear energy and the less they favored renewable energy, whereas the opposite was found for biospheric values. Third, values colored the perceptions of consequences. Specifically, whether people ascribed negative or positive consequences to energy alternatives aligned with their value-based attitudes toward these alternatives. The results were robust despite variations in energy alternatives and the methods used. Practical implications are provided.

1. Introduction

Due to environmental problems and exhaustion of natural resources, the use of fossil fuels needs to be restricted and eventually replaced by alternative energy sources. Two such alternatives have been widely considered so far: nuclear and renewable energy [1,2]. Although both have been promoted as sustainable, nuclear and renewable energy are associated by people with different consequences for the environment and for consumers' resources. Despite being touted as a low-carbon energy alternative, nuclear energy is nevertheless perceived by people as having a relatively large negative environmental impact, larger than renewable energy [3–5]. People only 'reluctantly' accept nuclear energy as a means to combat climate change, if they have concluded that there is no other solution in the foreseeable future [6] or if nuclear energy is explicitly framed as a solution to tackle climate change [7,8]. People prefer alternative energy sources for combating climate change, particularly renewable energy sources [5–8]. They perceive renewable energy as more environmentally friendly than nuclear energy [3–5] and see it as the most adequate option for sustainable energy transitions [9,10]. At the same time, however, renewable energy is often associated by people with disadvantages for consumers' resources. Specifically, people consider it to be relatively pricy [11] and inconvenient (e.g. for cooking; [9,10]), and they may perceive renewable energy technology as spoiling the scenery and noisy. In comparison, people tend to associate nuclear energy with cheap and reliable energy, employment, and economic growth [13–16].

To sum up, surveys reveal that nuclear energy is generally associated by people with disadvantages for the environment and advantages for consumers' resources, whereas renewable energy is generally associated with advantages for the environment and disadvantages for consumers' resources. In this paper, these perceived various (dis)advantages are referred to as *generally perceived positive or negative environmental and individual consequences* of nuclear and renewable energy. The focus of this paper is on people's *subjective* evaluations of energy alternatives, which may not necessarily correspond to the *actual* consequences; the authors deliberately refrain from making implications about the actual objectively assessed consequences of energy alternatives. People may differ in their evaluations of energy alternatives. But what factors define the perceived importance of different

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environmental and individual consequences of energy alternatives, and will this affect people's attitudes toward energy alternatives? Do these factors also influence the perception of consequences of energy alternatives? It is proposed here that people's values play an important role in evaluations of energy alternatives. Values are abstract life goals or ideals that define what is *generally* important to people in their lives [17,18]. As such, values may affect how people appreciate specific consequences of many different objects and behaviors, including energy alternatives [19–22]. This paper examines how values affect evaluations of nuclear and renewable energy. More specifically, the paper aims to study how values affect three types of evaluations: I) the perceived importance of various (i.e. environmental and individual) consequences of energy alternatives, reflecting the extent to which people rate these consequences as important to them; II) attitudes toward energy alternatives, reflecting the extent to which people generally (dis) favor energy alternatives; and III) the perception of consequences of energy alternatives, reflecting how likely, people think, energy alternatives are to have various positive or negative consequences.

1.1. Values and the perceived importance of consequences of energy alternatives

When explaining sustainable attitudes and behaviors, it is important to distinguish between self-transcendence values, which refer to primarily considering collective consequences, and self-enhancement values, which refer to primarily considering individual costs and benefits [23–28]. Self-transcendence values encompass altruistic values, focusing on the well-being of other people and society (e.g. equality), and biospheric values, focusing on the quality of nature and the environment (e.g. protecting the environment). Self-enhancement values encompass egoistic values, focusing on safeguarding and promoting one's personal resources (e.g. wealth), and hedonic values, focusing on improving the way one feels (e.g. pleasure; [29]). Value theory posits that people selectively attend to information that is relevant for their important values [25,26,30–32]. This implies that people should consider particularly the consequences of energy alternatives that have implications for their important values as important (Hypothesis 1). Hence, the stronger people's egoistic values, the more likely they are to rate individual consequences of energy alternatives as important, whereas the stronger their biospheric values, the more likely they are to rate environmental consequences of energy alternatives as important. This hypothesis stems from value theory, but it has not been explicitly tested so far. Values are abstract and reflect what people find important in their lives in general, whereas the perceived importance of consequences is a specific construct, linked to a specific energy alternative, and thus the question remains whether the proposed relationship exists [cf. 33].

Alternatively, one could think that it depends on a specific energy alternative how important its consequences are to people, for example, that people merely highlight the importance of the positive consequences of their favored energy alternative and the negative consequences of their disfavored energy alternative. Value theory would posit, however, that people consistently prioritize the same consequences that are congruent with their important values, irrespective of which energy alternative they are considering. The perceived importance of consequences should therefore not depend on people's attitudes and the perceived consequences of a specific energy alternative.

1.2. Values and attitudes toward energy alternatives

Attitude theories propose that people build their attitudes by weighing costs and benefits that are important to them [34]. Given that values guide the perceived importance of consequences of energy alternatives (Hypothesis 1), it follows that people's attitudes toward energy alternatives will depend on what consequences, people generally think, these alternatives have for their important values (Hypothesis 2). Due to their generally perceived different environmental and individual consequences, nuclear energy is likely to be seen by people as supporting their egoistic values and threatening their biospheric values, whereas renewable energy is likely to be seen as supporting their biospheric values and threatening their egoistic values. As a result, these energy alternatives should yield exactly opposite patterns of the value–attitude relationship. Specifically, the stronger their egoistic values, the more likely people are to favor nuclear energy, whereas the less likely they are to favor renewable energy. In contrast, the stronger their biospheric values, the more likely people are to favor renewable energy, whereas the less likely they are to favor nuclear energy.

There is initial evidence that nuclear energy is less favored by people with strong (versus weak) biospheric values [7,14,35],[1] whereas it is more favored by people with strong (versus weak) egoistic [14] and traditional (e.g. security, discipline; [35]) values. Another study found that renewable energy (i.e. wind energy) was more favored by people with strong (versus weak) biospheric and altruistic values, whereas it was less favored by people with strong (versus weak) traditional values [36]. The evidence, however, comes from studies using various value measures and typically focusing on a single energy alternative, which makes it difficult to systematically compare the effects of values on attitudes toward different energy alternatives. If attitudes toward energy alternatives are indeed rooted in values, one should be able to find that these values lead to different attitudes toward different energy alternatives, depending on people's generally perceived consequences of these alternatives for their important values. The current study seeks to capture, if present, such systematic differences in the value–attitude relationship. This would suggest that the effects of values may generalize to attitudes toward many different energy alternatives, but yield different outcomes depending on the generally perceived consequences of these alternatives for people's important values.

1.3. Values and perceptions of consequences of energy alternatives

People differ in the extent to which they perceive energy alternatives as having various positive and negative consequences. Indeed, the environmental and individual consequences of nuclear and renewable energy have been widely debated. Both types of consequences of each energy alternative have been framed positively as well as negatively by, respectively, supporters and opponents, and both parties have provided arguments to support their position [37]. For example, while supporters argue that nuclear energy is 'good for the environment' (e.g. because, according to them, it emits relatively little CO_2), opponents argue that it is 'bad for the environment' (e.g. because, according to them, the risks of environmental pollution in case of nuclear accidents is very high) [13,14]. An important question is how people develop their perception of these consequences. Values may play an important role in this process.

[1] In some studies [e.g. [35]], biospheric values were not measured separately but included in a scale including altruistic values as well, which together reflect a concern with the welfare of other people and other species. Since biospheric and altruistic values are typically positively correlated and have similar effects on attitudes and evaluations (as long as these values are not in conflict; see Ref. [26]), the effects of combined biospheric and altruistic values are interpreted and cited in this paper as the effects of biospheric values.

While value theory mainly focuses on how people prioritize values and how that might affect their general attitudes toward, in this case, energy alternatives, it is reasoned in this paper that values may also color people's perceptions of consequences of energy alternatives. It is expected that values will influence the perceived consequences of energy alternatives in the same direction as they influence attitudes toward these alternatives (Hypothesis 3). Specifically, the stronger their egoistic values, the more positive consequences people will ascribe to nuclear energy, whereas the less positive consequences they will ascribe to renewable energy. In contrast, the stronger their biospheric values, the less positive consequences people will ascribe to nuclear energy, whereas the more positive consequences they will ascribe to renewable energy.

There is some initial support for this hypothesis. In one study, the stronger their egoistic values, the more advantages (including reduced CO_2 emissions), but not disadvantages, people ascribed to nuclear energy, whereas for those with strong biospheric values, the opposite was true [14]. In another study, people with strong altruistic values were most likely to expect communal economic benefits from wind energy, whereas those with strong traditional values were less likely to have this belief [36]. However, the evidence is again scattered across studies using various value measures and each focusing on a single energy alternative. If people really ascribe consequences to energy alternatives in line with their value-based attitudes toward these alternatives, one should be able to find that the effects of values on the perceived consequences, just like on attitudes, systematically vary across energy alternatives.

Importantly, it follows from the reasoning in this paper that values can *color* the perceived consequences of energy alternatives. It has indeed been argued that people evaluate some costs and benefits of objects based on their general attitudes or feeling toward an attitude object [38,39]. However, it has not been studied how this attitude or feeling develops. It is reasoned in this paper that people base their attitudes toward energy alternatives on the consequences for aspects that they value most, and they may then use these values-based attitudes to derive their perceptions of other consequences that are not particularly important to them. Values may therefore have far reaching effects and color the perception of a range of consequences of energy alternatives, in a way that supports value-based attitudes towards these alternatives. To test this, the current study compared the effects of values on the *perceived importance* of consequences of energy alternatives and on the *perceived likelihood* that energy alternatives have these consequences. The question was whether people would ascribe certain consequences to energy alternatives, thus supporting their value-based attitudes toward these alternatives, even if these consequences were not particularly important to them on the basis of their values. Such findings would suggest that people derive their perception of some consequences of energy alternatives from their general value-based attitudes toward these alternatives.[2]

To sum up, it is proposed that values are an important overarching factor influencing people's evaluations of energy alternatives in three important ways. Values are expected to I) guide the perceived importance of consequences of energy alternatives, II) shape general attitudes toward energy alternatives, and III) color the perception of consequences of energy alternatives. While value-driven importance ratings should be consistent across energy alternatives, value-driven attitudes and the perception of consequences should systematically vary, depending on which consequences an energy alternative is expected to have for one's important values.

2. Method

Two studies with general samples of the Dutch population were conducted to test the hypotheses about the effects of values on evaluations of nuclear energy (Study 1) and local renewable energy system (Study 2).[3] Values were measured in the same way in the present studies. In order to cross-validate the results and to test the generalizability of the results, the measures of evaluations of energy alternatives (i.e. the perceived importance of consequences, general attitudes, and the perception of consequences) were varied. If the same values demonstrate the expected relationship across studies, irrespective of the various methods for measuring the dependent variables, that would provide strong support that the relationship indeed exists and is not merely an artifact of a specific measurement used [41].

2.1. Study 1: the influence of values on evaluations of nuclear energy

2.1.1. Participants and procedure

Study 1 was carried out via an online survey system with respondents from a pre-recruited panel of the Dutch population. Participants received an email with an invitation to complete an online study on public views on nuclear energy. They could access the study via the website, where instructions on how to complete the study were provided. At the end of the study, participants received an email address with which to contact the researcher with questions, were thanked for their participation, and received a token amount of money for participation. In total, 279 respondents participated in the study.[4] Of those, 170 were men and 108 were women (one respondent did not indicate the gender), varying in age from 20 to 62 ($M = 47.63$, $SD = 8.29$). Given these characteristics, as well as sample distribution across education and income groups (see Appendix A), the current sample was considered to be reasonably representative of the Dutch population (www.cbs.nl).

2.1.2. Measures

2.1.2.1. Values. At the beginning of the study, respondents' biospheric and egoistic values were measured by means of a brief version of Schwartz's (1992) value scale [cf. 29].[5] Participants received a list of values accompanied by short descriptions and were asked to rate the importance of these values 'as guiding principles in their lives' on a 9-point scale from −1 *opposed to my principles*, 0 *not important*, to 7 *extremely important*. Egoistic values were represented by five items: social power, wealth, authority, influential, and ambitious. Importance ratings for these items were averaged to form a composite scale of egoistic values (α [269] = .80, $M = 2.24$, $SD = 1.39$). Biospheric values were represented by four items: preventing pollution, respecting the earth, unity with nature, and protecting the environment. Importance ratings for these

[2] This reasoning suggests that attitudes toward energy alternatives may determine perceptions of consequences, especially if these consequences are not particularly important to people given their values. However, it is not the purpose of this study to unravel the cause and effect relationships between attitudes and perceptions of consequences (future research could address this question; see also General discussion). Most importantly, the purpose here is to test whether attitudes as well as perceptions of consequences can be influenced by a third variable, namely people's values.

[3] Evaluations of localized renewable energy were studied, since the use of renewable energy sources implies a shift from central to local energy systems [40].

[4] Across both studies, not all participants completed all items in the questionnaires, resulting in varying sample sizes across the analyses. The numbers of responses for each measure are reported. Numbers of responses available for each analysis are available upon request.

[5] The value scale also measured hedonic and altruistic values, but they are not directly relevant to the goals of this research and are not further discussed.

items were averaged to form a composite scale of biospheric values (α [276] = .90, M = 4.90, SD = 1.39).

Next, respondents read a short description of nuclear energy in the Netherlands, which was pertinent to the time when the study was conducted. The information was basic and same to all respondents, as the goal was to study how people's evaluations of energy alternatives are linked to their values, rather than how they may be affected by various information strategies. Afterward respondents received a battery of questions on their opinions of nuclear energy. Items relevant for the current study are described below.[6]

2.1.2.2. Consequences of nuclear energy. A number of 'potential consequences' of nuclear energy were introduced, asking respondents to first evaluate the extent to which they perceived that nuclear energy would have these consequences and, afterward, the importance of these consequences to them. These consequences were not framed as facts, but as possibilities, which respondents could judge as likely or unlikely. If importance ratings remain congruent with people's values, even when perceptions are provided first (rather than follow the same pattern as the value-driven perceptions of consequences), it would provide evidence that importance ratings reflect what is truly important to people based on their values, and that they are not fickle and dependent on how a specific energy alternative is believed to affect their values. The consequences were chosen and framed in the way that they often occur in public debates on nuclear energy, namely as valenced arguments [13,14,37]. As specified by the hypotheses, only individual and environmental consequences were included in this study (see Appendix B for other consequences included in the questionnaire).

2.1.2.3. Perceived likelihood. Respondents were first asked to evaluate how likely, they think, the utilization of nuclear energy would result in the listed consequences, on a 7-point scale from 1 *very unlikely* to 7 *very much likely*. Individual consequences included: economic growth, cheaper energy, and increased employment. Environmental consequences included: reduced climate change, threatened quality of nature and the environment (reversed coding), and reduced CO_2 emissions. Ratings for the corresponding items were averaged to form the composite scales of the perceived likelihood of individual (α [279] = .85, M = 3.97, SD = 1.40) and environmental (α [276] = .67, M = 3.93, SD = 1.32) consequences of nuclear energy, with higher ratings representing the perception that more positive (or less negative) consequences are likely.

2.1.2.4. Perceived importance. Next, respondents rated the importance of the same individual and environmental consequences to them, on a 7-point scale from 1 *not at all important* to 7 *very important*. All items were now framed positively to better fit the question of perceived importance (the environmental consequence 'threatened quality of nature and the environment' was reframed as 'the quality of nature and the environment'). Ratings for the corresponding items were averaged to form the composite scales of the perceived importance of individual (α [276] = .79, M = 5.10, SD = 1.05) and environmental (α [276] = .80, M = 5.57, SD = 1.02) consequences, with higher ratings representing higher perceived importance.

2.1.2.5. Attitudes toward nuclear energy. Since generating nuclear energy does not require active participation from citizens, attitudes toward nuclear energy were measured as 'passive' support or tolerance for nuclear energy. Respondents were asked to what extent they agreed, on a 7-point scale from 1 *completely disagree* to 7 *completely agree*, with the following statements: 'I find the use of nuclear energy acceptable', 'I find it acceptable to build a new nuclear power station in the Netherlands', 'I find it acceptable that a part of the overall energy mix in the Netherlands consists of nuclear energy', and 'I find it acceptable to use more nuclear energy in the Netherlands than is used now' (adapted from Ref. [14]). Ratings for these items were averaged to form a composite scale of attitudes toward nuclear energy (α [274] = .995[7]; M = 3.76, SD = 2.13), with higher ratings representing more positive attitudes.

2.2. Study 2: the influence of values on evaluations of renewable energy

2.2.1. Participants and procedure

Study 2 was a paper-and-pencil study. An interviewer approached people in public places (e.g. on a train, in a public library) in the Netherlands and asked them to take part in the study. In total, 143 people completed the questionnaire. Of those, 65 were men and 73 were women (five respondents did not indicate their gender), varying in age from 17 to 83 (M = 39.49, SD = 19.25). While individuals with a higher education level were slightly overrepresented in the sample (see Appendix A), the current sample was considered to be representative of the Dutch population (www.cbs.nl).

2.2.2. Measures

2.2.2.1. Values. The same values measure as in Study 1 was used. Again, importance ratings for the egoistic value items were averaged to form a composite scale of egoistic values (α [135] = .81, M = 2.43, SD = 1.33), and importance ratings for the biospheric value items were averaged to form a composite scale of biospheric values (α [136] = .91, M = 4.33, SD = 1.65).

Next, respondents read a short description of local renewable energy system (later in the questionnaire referred to as local energy services). Several examples of renewable energy sources (e.g. wind, water stream) were provided and differences from traditional central energy system were explained. Again, the information was very basic and same to all participants. Items relevant for the goals of this study are described below.

2.2.2.2. Consequences of renewable energy. In Study 2, the importance ratings were provided first, but while half of the respondents rated the importance of consequences of localized renewable energy, the other half of the respondents rated the importance of consequences of energy alternatives in general. If value-congruent importance ratings are observed not only for specific energy alternatives but also for energy alternatives in general (before a specific energy alternative is introduced), it would further rule out the alternate explanation that importance ratings are influenced by one's attitudes and the perceived consequences of a specific energy alternative.

A number of consequences were chosen that often occur in public debates on renewable energy sources [11,12,37,42]. In order to cross-validate the results, the consequences were now framed in a neutral way, differently when compared to valenced arguments used in Study 1. As specified by the hypotheses, only environmental

[6] Full questionnaires used in both studies are available from the first author upon request.

[7] The four items measuring attitudes toward nuclear energy overlapped to a large extent. A similarly large overlap of these items was observed in a previous study (α = .98; [14]). This is not considered as particularly problematic in this study, since each separate item yielded the same conclusions for the hypotheses as the overall scale.

and individual consequences were included in this study (see Appendix B for other consequences included in the questionnaire).

2.2.2.3. Perceived importance. Respondents were first asked to rate the importance, on a 7-point scale from 1 *not at all important* to 7 *very important*, of the listed consequences to them, either of localized renewable energy or of energy alternatives in general. Individual consequences included: energy prices, possibility to provide enough energy to satisfy the needs of households, effects of energy use on daily comfort, and stability of energy prices.[8] Environmental consequences included: amount of CO_2 emissions, effects on environmental problems such as the greenhouse effect, and effects on environmental quality. Ratings for the corresponding items were averaged to form the composite scales of the perceived importance of individual and environmental consequences of localized renewable energy ($\alpha_{individual}$ [70] = .70, $M_{individual}$ = 5.01, $SD_{individual}$ = 1.02; $\alpha_{environmental}$ [70] = .83, $M_{environmental}$ = 4.84, $SD_{environmental}$ = 1.20) and of energy alternatives in general ($\alpha_{individual}$ [67] = .74, $M_{individual}$ = 4.78, $SD_{egoistic}$ = 1.00; $\alpha_{environmental}$ [69] = .91, $M_{environmental}$ = 5.10, $SD_{environmental}$ = 1.21).

2.2.2.4. Perceived likelihood. Next, all respondents evaluated the likelihood of localized renewable energy having the above individual and environmental consequences, listed in a different order. Respondents evaluated the neutrally framed consequences on an 11-point scale from −5 *very negative* to 5 *very positive*. For individual consequences, respondents assessed the effects of the utilization of renewable energy on energy prices (from −5 *strongly decrease* to 5 *strongly increase*; reversed coding), satisfaction of energy needs of households (from −5 *household energy needs will be satisfied worse* to 5 *household energy needs will be satisfied better*), stability of energy price (from −5 *will be less stable* to 5 *will be more stable*), and daily comfort (from −5 *strongly decrease* to 5 *strongly increase*). For environmental consequences, respondents assessed the effects of renewable energy on CO_2 emissions (from −5 *strongly decrease* to 5 *strongly increase*; reversed coding), environmental quality (from −5 *strongly decrease* to 5 *strongly increase*), and environmental problems (from −5 *strongly decrease* to 5 *strongly increase*; reversed coding). Ratings for the corresponding items were averaged to form the composite scales of the perceived likelihood of individual (α [134] = .60, M = −.17, SD = 1.23) and environmental (α [140] = .73, M = .93; SD = 1.46) consequences of localized renewable energy, with higher scores representing the perception that more positive (or less negative) consequences are likely.

2.2.2.5. Attitudes toward renewable energy. A slightly different measure of attitudes, considered to better fit the context of renewable energy, was used in Study 2. It was less focused on acceptability of the current utilization of an energy alternative in the Netherlands, and was more focused on general (dis)favor and acceptability of utilizing an energy alternative in the future. Since renewable energy systems imply more active participation of citizens (e.g. purchasing solar panels), attitudes were measured as more 'active' support and engagement with renewable energy sources. Additionally, more diverse attitude items were chosen in Study 2. Respondents were first asked to what extent they were against or in favor of localized renewable energy, on an 11-point scale from −5 *very much against*, 0 *neither against nor in favor*, to 5 *very much in favor* (M [130] = 1.12, SD = 1.83). Next, respondents indicated the extent to which they agreed, on a 7-point scale from 1 *completely disagree* to 7 *completely agree*, with the following statements: 'I am interested in local energy services' (M [137] = 3.74, SD = 1.56) and 'I will certainly use local energy services' (M [137] = 3.91, SD = 1.50). The z-scores for these three attitude items were averaged to form a composite scale of attitudes toward localized renewable energy (α [125] = .81).

3. Results

In both studies, the hypotheses were tested by using Pearson's correlations.[9] Correlational analyses are considered to serve the current research goals better than regression analyses, as the main interest lies in the direction and strength of the bivariate relationships between values and people's evaluations of energy alternatives, as reflected in the hypotheses.

3.1. Values and importance of consequences of energy alternatives

In line with Hypothesis 1, respondents saw the consequences of energy alternatives that are congruent with their important values as particularly important (see Table 1). That is, the stronger their egoistic values, the more importance respondents ascribed to individual consequences of nuclear and renewable energy, as well as of energy alternatives in general. Interestingly, stronger egoistic values tended to correlate negatively with the perceived importance of environmental consequences of energy alternatives (although this relationship was not significant for renewable energy). In contrast, as expected, stronger biospheric values were related to ascribing significantly more importance to environmental consequences of nuclear and renewable energy, as well as of energy alternatives in general. There was no significant relationship between biospheric values and the perceived importance of individual consequences of energy alternatives. Such consistent findings across the two studies support the assumption that values guide the perceived importance of value-congruent consequences, irrespective of a given energy alternative. This implies that the effects of values may apply to many different energy alternatives. Results also ruled out the alternate explanation that importance ratings are influenced by people's attitudes and the perceived consequences of a specific energy alternative, as the value-congruent importance ratings were found irrespective of whether these ratings were provided after (Study 1) or before (Study 2) evaluations of the perceived consequences of energy alternatives, and occurred not only for specific energy alternatives (Study 1 and 2) but also for energy alternatives in general (Study 2).

3.2. Values and attitudes toward energy alternatives

In line with Hypothesis 2, respondents' attitudes toward energy alternatives depended on the generally perceived consequences of

[8] Two other individual consequences were included, namely level of employment and amount of shortcuts and malfunctions. However, the perceived importance and likelihood of employment correlated poorly with the perceived importance and likelihood of other individual consequences of renewable energy, and hence this item was excluded from the analyses. For the amount of shortcuts and malfunctions, including the evaluation of its likelihood would have reduced the reliability of the perceived likelihood of individual consequences scale to $\alpha < .60$, and hence this item was excluded from the analyses. Including these two individual consequences in the analyses yielded the same conclusions for the hypotheses as when they were excluded.

[9] Some variables in the analyses showed deviations from normal distribution (i.e. scores for the biospheric value scale and for the perceived importance of consequences of energy alternatives tended to follow a negatively skewed distribution, whereas scores for attitudes toward energy alternatives tended to follow a flat distribution). To control for these deviations, the hypotheses were also tested by using Spearman's rho correlations, which yielded the same conclusions. For the sake of consistency, Pearson's correlations are reported across the analyses.

Table 1
The relationship (Pearson's correlations) between values and evaluations of nuclear (Study 1) and renewable (Study 2) energy.

Study 1: nuclear energy		Egoistic values	Biospheric values
Importance of	Individual consequences	$r = .20^{***}$ (.001)	$r = -.01$ (.898)
	Environmental consequences	$r = -.15^{*}$ (.017)	$r = .53^{***}$ (<.001)
Attitudes		$r = .24^{***}$ (<.001)	$r = -.34^{***}$ (<.001)
Perception of	Individual consequences	$r = .25^{***}$ (<.001)	$r = -.09$ (.141)
	Environmental consequences	$r = .17^{**}$ (.005)	$r = -.25^{***}$ (<.001)
Study 2: renewable energy		**Egoistic values**	**Biospheric values**
Importance of	Individual consequences:		
	• Renewable energy	$r = .30^{*}$ (.015)	$r = -.05$ (.701)
	• Energy alternatives in general	$r = .48^{***}$ (<.001)	$r = -.04$ (.763)
	Environmental consequences:		
	• Renewable energy	$r = -.18$ (.154)	$r = .57^{***}$ (<.001)
	• Energy alternatives in general	$r = -.29^{*}$ (.021)	$r = .72^{***}$ (<.001)
Attitudes		$r = -.25^{**}$ (.007)	$r = .33^{***}$ (<.001)
Perception of	Individual consequences	$r = -.02$ (.836)	$r = .19^{*}$ (.036)
	Environmental consequences	$r = -.26^{**}$ (.003)	$r = .12$ (.157)

$^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$ (p-values are reported in brackets).

these alternatives for their important values (see Table 1). As expected, the stronger their egoistic values, the more respondents favored nuclear energy, whereas the stronger their biospheric values, the less they favored this energy alternative (Study 1). In contrast, stronger egoistic values were related to less favorable attitudes toward renewable energy, whereas stronger biospheric values were related to more favorable attitudes toward this energy alternative (Study 2). Thus, nuclear and renewable energy indeed yielded exact opposite patterns of the value–attitude relationship. This implies that values may guide attitudes toward many different energy alternatives, but yield different outcomes depending on the generally perceived consequences of these alternatives for people's important values.

3.3. Values and perceptions of consequences of energy alternatives

The results also provided support for Hypothesis 3. Indeed, values influenced the perceived consequences of energy alternatives in the same direction as they influenced attitudes toward these alternatives (see Table 1). As expected in Study 1, the stronger their egoistic values, the more positive (or less negative) consequences, including individual and environmental consequences, respondents ascribed to nuclear energy. The stronger their biospheric values, the less positive (or more negative) consequences, particularly environmental consequences, respondents ascribed to nuclear energy. As predicted in Study 2, the opposite relationship between values and perceptions of consequences was observed for renewable energy. Stronger egoistic values were related to less positive (or more negative) evaluations of consequences, particularly environmental consequences, of renewable energy. Stronger biospheric values were related to more positive (or less negative) evaluations of consequences, particularly individual consequences, of renewable energy. The results support the assumption that values can color the perceived consequences of energy alternatives, in line with the value-based attitudes toward these alternatives.

Interestingly, the findings indicate that values can color the perceptions of consequences, irrespective of how important these consequences are to people given their values. For example, while stronger egoistic values were in fact associated with lower perceived importance of environmental consequences of energy alternatives, these values nevertheless enhanced positive evaluations of environmental consequences of nuclear energy and at the same time diminished positive evaluations of environmental consequences of renewable energy. Although individual consequences of energy alternatives were not particularly important to those with strong biospheric values, these same respondents evaluated individual consequences of localized renewable energy most positively (or least negatively). The findings provide the first empirical support for the assumption that, while people base their attitudes toward energy alternatives on the consequences for aspects that they value most, they may then use these value-based attitudes to derive their perceptions of other consequences that are not particularly important to them.

4. General discussion

The aim of this paper was to empirically test the premise that values play an important role in people's evaluations of energy alternatives, by testing theory-driven hypotheses on the relationship between values and I) the perceived importance of consequences of energy alternatives, II) general attitudes toward energy alternatives, and III) the perceived likelihood that energy alternatives have certain positive or negative consequences (i.e. perceptions of consequences). Two studies were conducted on nuclear and renewable energy, respectively, to be able to capture systematic differences in the effects of values on evaluations of these energy alternatives.

The results supported the hypotheses. First, respondents consistently prioritized consequences of energy alternatives that are congruent with their important values. Second, as expected, respondents expressed more positive (or less negative) attitudes toward an energy alternative that is generally seen as supporting their important values, whereas they expressed less positive (or more negative) attitudes toward an energy alternative that is generally seen as threatening their important values. Third, as hypothesized, values seemed to color the perceived consequences of energy alternatives, producing the same patterns of relationship as for value-based attitudes. These results were found systematically across both studies and were not affected by variations in the methods used. This suggests that the effects of values may generalize to many different energy alternatives.

4.1. Theoretical implications

This paper builds on and extends value theory. First, it explicitly showed that values provide a stable basis for the perceived importance of consequences of energy alternatives, irrespective of which energy alternative people are considering. Next, for the first time so far, this study systematically compared the effects of values on evaluations of two different energy alternatives. As such, this study could capture the predicted opposite patterns of relationship between values and attitudes toward energy alternatives. The current results thus make a novel contribution to the literature, as they demonstrate the generalizability of the effects of values on evaluations of different energy alternatives and show that the direction of this relationship (i.e. positive or negative) depends on the generally perceived consequences of energy alternatives for people's important values.

It was proposed and demonstrated in this paper that values can color the perceptions of consequences of energy alternatives. Value theory so far focused exclusively on how people prioritize values

and how that influences their attitudes. This cannot explain, however, why people sometimes perceive the consequences of energy alternatives differently. While it has been argued that people may derive perceptions of some costs and benefits from their general attitudes toward an attitude object [38,39], the question of how these attitudes develop remains. The current results demonstrated that values act as a third variable influencing both attitudes and the perceived consequences of energy alternatives. By comparing value-driven importance ratings and value-driven perceptions of consequences, this study managed to show that values can color the perceived consequences of energy alternatives, irrespective of how important these consequences are to people on the basis of their values. Values may therefore have far reaching effects and guide the perceptions of a range of consequences of energy alternatives. This possibility has been underexplored in value literature, which builds an important theoretical contribution of the current work.

4.2. Practical implications

The results reported here suggest that people with different values attend to different aspects of energy alternatives when building their evaluations of these alternatives. For example, low energy prices may be very important for people with strong egoistic values, and hence likely to promote their positive evaluations of energy alternatives that are perceived to be relatively cheap. This might be less persuading to people with strong biospheric values, who are primarily concerned with the effects of energy alternatives on the environment. This has direct implications for the effectiveness of information strategies in promoting energy alternatives. Specifically, providing information that is not important to people's key values is not likely to influence their evaluations, whereas information that resonates with their important values might be more effective [43]. Tailoring information to people's important values might thus be an effective strategy to influence evaluations in the energy domain [cf. 44].

More importantly, even if information is relevant to people's important values, it might not have the desired effects on evaluations if people consider a given energy alternative as threatening their important values. The current results suggest, for example, that people with strong (versus weak) biospheric values are less likely to agree with arguments that nuclear energy, generally associated with environmental disadvantages, might have some benefits for the environment. This suggests that providing information on environmental benefits of nuclear energy is unlikely to promote positive evaluations among those with strong biospheric values. It might sometimes be necessary to actually change the characteristics of energy alternatives so that they have more positive (or less negative) consequences for the things that people value most (e.g. enhancing safety measures of nuclear energy to prevent contamination in case of accidents or using alternative technology, such as thorium-based nuclear power). Such changes are needed most when severe barriers for using energy alternatives exist (e.g. unaffordable energy prices), which may inhibit the positive effects of values on evaluations of energy alternatives. For example, this study found that people with strong biospheric values favored renewable energy and also evaluated its individual consequences relatively positively. However, biospheric values may lose their positive effect on evaluations in cases where the costs of renewable energy are so high that people cannot afford it. While actual changes in energy alternatives may not always be possible or may be highly costly, (sustainable) energy policies should nevertheless try and target people's important values (see also Ref. [9,10]).

While it is often assumed in practice that financial arguments are most important to people, the current results indicate that this is not necessarily the case. Next to egoistic values, biospheric values were found to play an important role in evaluations of energy alternatives. This implies that environmental appeals or incentives may (also) be effective in influencing evaluations of energy alternatives. There is evidence to suggest that environmental appeals are actually more effective than financial appeals in encouraging sustainable choices [45–47].

The current results suggest that policy makers need to be cautious when interpreting people's perceptions of consequences of energy alternatives, as these perceptions may be colored by values. For example, the current results showed that less favorable attitudes toward renewable energy and poor evaluations of its environmental consequences were prominent among people with strong egoistic values, who in fact rated individual rather than environmental consequences of energy alternatives as important. These people seem to have derived their (poor) environmental evaluations from their general (negative) attitudes toward renewable energy. Trying to convince them that renewable energy has environmental benefits is not likely to change their evaluations. It is proposed that policy makers should try and identify the 'true' drivers of people's attitudes, by taking values into account, and, when planning interventions, target the particular consequences that are most important to people given their values.

4.3. Future research

Various renewable energy sources were compiled under a single label of locally produced renewable energy in this study. This allowed testing the hypotheses for renewable energy in general, irrespective of which particular source respondents could have had in mind. Future research could take the current findings further and study the effects of values on evaluations of specific renewable energy sources, for example, generating energy from biomass, ocean sources, geothermal heat, wind and solar power. Also, the current study explored evaluations of locally produced renewable energy sources, since transition to renewable energy sources implies a shift from centralized to localized generation of energy. Future studies need to unravel to what extent the observed results were due to the perceived characteristics of renewable energy sources versus the perceived characteristics of localized energy production.

An interesting question for future research is whether the effects of values on evaluations depend on how much knowledge people have about energy alternatives. It is unlikely that respondents in this study had much knowledge about localized renewable energy, yet their evaluations of this energy alternative were related to their values. It could be that some immediate associations between energy alternatives and one's important values provide a sufficient basis for the influence of values on evaluations. Knowledge about energy alternatives was not measured in this research. Future studies could address this question.

The theoretical reasoning in this paper builds on value theory, which has proven to be useful for explaining people's evaluations of sustainable developments. Another relevant theory here could be cultural theory, which posits that people's general worldviews, namely individualistic, hierarchical, egalitarian, and fatalistic, are important antecedents of their more specific evaluations [48]. A separate theory on worldviews is the new environmental (or: ecological) paradigm, reflecting the extent to which people believe that humans are entitled to dominate over nature [49]. It would be interesting to see in future studies whether and how such worldviews influence people's evaluations of energy alternatives.

Given the correlational nature of the current results, definite conclusions cannot be made about the causal relationship between

attitudes toward energy alternatives and the perceived consequences of these alternatives. The fact that some consequences were not particularly important given certain values but nevertheless came under the influence of value-driven evaluations implies that these perceived consequences were a result rather than a cause of value-based attitudes. At the same time, however, these perceptions may further strengthen the initial attitudes. Future experimental studies need to test such causal inferences in detail (see also [50]). To test the robustness of the current findings, future studies could examine the relationship between values and evaluations of diverse energy sources and technologies, and across different countries and cultures. Additionally, it is important to replicate the current findings with different measures of evaluations of energy alternatives. For example, the studies reported here employed different measures of attitudes, which reflected 'passive' acceptability or tolerance of nuclear energy (Study 1) and 'active' engagement with renewable energy sources (Study 2). The hypotheses about the effects of values on attitudes were confirmed, irrespective of differences in attitude measures; however, more studies with different attitude measures are needed to test the generalizability and validity of the present findings (i.e. conceptual replication).

5. Conclusion

In general, people's evaluations of energy alternatives, including the perceived importance of consequences, general attitudes, and the perceptions of consequences, were systematically related to their values. Hence, in order to better understand people's evaluations of energy alternatives, it is important to take values into account and to consider what consequences people generally expect from energy alternatives for their important values.

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Appendix A

Sample characteristics in Study 1 ($N = 279$) and Study 2 ($N = 143$).

Study 1	
Age	$M = 47.63$; $SD = 8.29$ [min = 20; max = 62]
Gender	**Valid %**
Male	61.2
Female	38.8
Highest completed level of education	**Valid %**
Primary	1.4
Lower vocational or technical	18.7
Intermediate vocational or secondary	36.7
Higher vocational or highest secondary	27.3
College or university degree	14.7
Other	1.1
Net income per household per month (in euros)	**Valid %**
<1000	6.9
1000–2000	25.0
2000–3000	28.5
3000–4000	21.9
4000–5000	10.0
>5000	7.7
Study 2	
Age	$M = 39.49$; $SD = 19.25$ [min = 17; max = 83]
Gender	**Valid %**
Male	47.1
Female	52.9
Highest completed level of education	**Valid %**
Primary	.7
Lower vocational or technical	1.4
Intermediate vocational or secondary	14.5
Higher vocational or highest secondary	51.5
College or university degree	31.9
Net income per household per month (in euros)	**Valid %**
<750	13.0
750-1500	15.4
1500-2250	12.2
2250-3000	21.1
3000-3750	13.0
3750-4500	8.9
>4500	16.3

Appendix B

Other (not specified by the current hypotheses) 'potential consequences' of energy alternatives included in Study 1 and Study 2 (provided in the same order as they appeared in the study).

Study 1

Perceived likelihood: increased risks of accidents for future generations, increased health risks for people in the Netherlands, increased risks of accidents with nuclear waste, increased risks of accidents due to transportation of nuclear waste to storage locations.

Perceived importance: low risks of accidents for future generations, low health risks for people in the Netherlands, lower possibility of accidents with nuclear waste, low risks of accidents due to transportation of nuclear waste to storage locations.

Study 2

Perceived importance (respondents evaluated these either for energy alternatives in general or for localized renewable energy): the extent to which you have influence in energy policy, the extent to which you know where your energy comes from.

Perceived likelihood (evaluated for localized renewable energy only): I will know where my energy comes from: strongly disagree vs strongly agree, I will have less vs more influence on energy policy (for explorative reasons and to answer specific questions from practitioners, additional items were included in the task on the perceived likelihood, which are not reported here as they were not based on the current theory and were not included in the task on the perceived importance).

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