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Noppers, Ernst H.; Keizer, Kees; Bolderdijk, Jan Willem; Steg, Linda

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The adoption of sustainable innovations: Driven by symbolic and environmental motives

Ernst H. Noppers*, Kees Keizer, Jan Willem Bolderdijk, Linda Steg

University of Groningen, Grote Kruisstraat 2/1, 9712 TS Groningen, The Netherlands

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ABSTRACT

Critical to the environmental success of sustainable innovations is the adoption by consumers. The consensus is that instrumental shortcomings of sustainable innovations inhibit their adoption. However, we argue that the adoption of sustainable innovations does not exclusively depend on their instrumental attributes. In addition, people may be motivated to adopt sustainable innovations because of their positive environmental and symbolic attributes, that is, they benefit the environment and can be used to signal positive characteristics to oneself and others. We studied the significance of instrumental, environmental and symbolic attributes for the adoption of two sustainable innovations: electric cars (Study 1) and local renewable energy systems (Study 2), following two methods. Results showed that when asked directly, participants claimed that instrumental and environmental attributes are most important for their decision to adopt sustainable innovations, while symbolic attributes were rated as less important. Interestingly, evaluations of the symbolic and environmental attributes of sustainable innovations, but not evaluations of their instrumental attributes, predicted different indicators of adoption (i.e., interest in, the acceptability of, and intention to adopt these sustainable innovations), suggesting that the significance of symbolic motives for adopting sustainable innovations may not be recognized by consumers. Moreover, favorable evaluations of symbolic attributes particularly enhanced interest in and acceptability of sustainable innovation when participants evaluated the instrumental attributes more negatively, but not when instrumental attributes were evaluated relatively positively. This suggests that the instrumental drawbacks of sustainable innovations may sometimes strengthen their positive signal, which can promote interest in sustainable innovations.

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1. Introduction

Reducing fossil energy use and the emission of greenhouse gases is one of the major (environmental) challenges of the coming years. A key strategy is the transition to innovative products and services that use less energy or rely on renewable energy sources. Indeed, some promising sustainable innovations have been developed that can contribute to the reduction of fossil energy use and related emissions of greenhouse gases, including electric cars, led-lighting, and local renewable energy production and distribution. The “environmental success” of these sustainable innovations largely depends on the extent to which they are accepted and adopted by consumers. But which characteristics of sustainable innovations determine their adoption? In this paper

we introduce and test a conceptual model that proposes that the adoption of sustainable innovations depends on the evaluation of instrumental, environmental, and symbolic attributes of sustainable innovations. We first introduce our conceptual model, and next test whether the model can explain the adoption of two rather different types of sustainable innovations: electric cars and participation in local renewable energy initiatives.

2. The conceptual model

2.1. Instrumental attributes of sustainable innovations

Instrumental attributes reflect the functional (positive or negative) outcomes of ownership and use of a sustainable innovation (cf. Dittmar, 1992). Studies on product choice often focus on instrumental attributes. To illustrate, a review of eleven studies on factors influencing car choice revealed that studies typically exclusively focus on instrumental attributes, and showed that consumers are more likely to choose a car when they perceive more instrumental advantages (with regard to

* Corresponding author at: Faculty of Behavioral and Social Sciences, Department of Psychology, University of Groningen, Grote Kruisstraat 2/1, 9712 TS Groningen, The Netherlands. Tel.: +31 50 3639359; fax: +31 50 3636304.

E-mail address: e.h.noppers@rug.nl (E.H. Noppers).

purchase price, car weight, and number of seats) (Heffner, 2007; Choo and Mokhtarian, 2002). Hence, it is often assumed that instrumental attributes are of key importance for the adoption of products, including sustainable innovations. Yet, sustainable innovations typically have less favorable instrumental attributes compared to their traditional (less sustainable) alternatives, which may inhibit their adoption. For instance, solar panels and windmills require substantial financial investments and are considered a less reliable source of energy because their energy production depends on weather conditions (Shah, 2011). Likewise, the limited range (Bunch et al., 1993; Nemry and Brons, 2010), high purchase price (Nemry and Brons, 2010) and concerns about a dead battery (Cheron and Zins, 1997) have often been suggested as important barriers for the adoption of electric cars. Also, Dutch consumers named price and poor instrumental performance as the most important reasons for not willing to adopt an electric car (BMW, 2012). On the basis of this, it is often assumed that as long as electric cars have instrumental drawbacks compared to conventional, less sustainable cars, their wide-scale adoption is not likely. At best, electric cars will be purchased when they can be used in situations in which these instrumental drawbacks are less prominent, for example as a means of transport in inner cities (e.g. Meilhan, 2012). So both research and the public opinion suggest that consumers strongly focus on the instrumental attributes of a product or sustainable innovation, and that consumers' negative evaluation of these instrumental attributes inhibit the adoption of sustainable innovations.

But is this the complete picture? Does the adoption of a sustainable innovation indeed primarily depend on its perceived instrumental qualities, and does this inhibit the adoption of sustainable innovations? We argue that besides instrumental attributes, two other types of attributes are important for the adoption of sustainable innovations: environmental attributes and symbolic attributes (cf. Axsen and Kurani, 2012a). Hence, we propose that three distinct types of attributes may affect the adoption of sustainable innovations, each having a unique impact on consumers' decisions. Importantly, environmental and symbolic attributes may promote rather than inhibit adoption of sustainable innovations, as we will explain below.

2.2. Environmental attributes of sustainable innovations

Environmental attributes reflect the (positive and negative) outcomes of the ownership and use of a sustainable innovation for the environment. Almost all products have, next to outcomes for the owner, also consequences for the quality of the environment (e.g., Axsen and Kurani, 2012a). Research has shown that protecting the environment is generally an important goal in people's life. Moreover, individuals take environmental consequences into account when making choices (see De Groot and Steg, 2007, 2008; Steg et al., 2012; Steg and De Groot, 2012, for a review). However, in studies on motivations for pro-environmental behavior that include multiple attribute types predicting the behavior, results are more mixed: it seems that environmental attributes are sometimes less predictive of pro-environmental behavior than other attributes (such as instrumental attributes; Abrahamse and Steg, 2009, 2011; Bamberg and Schmidt, 2003; Poortinga et al., 2004).

Obviously, sustainable innovations have a less negative environmental impact than the alternatives they are supposed to replace. These favorable environmental attributes are likely to be important for consumers and may promote the adoption of sustainable innovations. Indeed, there is some evidence to suggest that environmental attributes promote the adoption of sustainable innovations. For example, people who more strongly endorsed environmental values appeared to be more willing to adopt

alternative fuel vehicles (Axsen and Kurani, 2012b; Jansson et al., 2010), and more willing to use renewable energy (De Groot et al., 2012; Steg et al., 2005; Van der Werff et al., 2013). However, as yet, it is not clear how important environmental attributes are for adoption of sustainable innovations relative to other attributes, as most studies examined the importance of environmental attributes without controlling for instrumental or symbolic attributes. We aim to address this gap in the literature.

2.3. Symbolic attributes of sustainable innovations

Symbolic attributes reflect the (positive or negative) outcomes of the ownership and use of the sustainable innovation for one's (self-)identity and social status. Theories and research in social psychology, sociology and marketing suggest that products have symbolic attributes that are likely to affect their purchase and use (e.g., Belk's (1988) theory on the extended self; Dittmar's (1992) theory on the meaning of material possessions; McCracken's (1990) theory on symbolic character of consumer goods; Park et al.'s (1986) theory on brand concept management; Sirgy's (1986) self-congruity theory). We are motivated to be seen by others in a positive way (Goffman, 1959), and also to see ourselves in a positive way (Belk, 1988; Dittmar, 1992; Giddens, 1991). We can shape a positive image of ourselves by purchasing and displaying products (Belk, 1981; Fennis and Pruyn, 2007). For example, designer clothing and caviar represent class and wealth, and their purchase signals good taste. Hence, the symbolic function of products is not limited to signaling our qualities to others, the products we possess shape our self-identity as well (Belk, 1988; Dittmar, 1992; Giddens, 1991). As we are motivated to see ourselves in a positive and consistent way, we prefer to own products that are congruent to how we do, or want to, see ourselves (Sirgy, 1985, 1986; Ericksen, 1997).

Symbolic attributes may encourage the adoption of sustainable innovations, because they enable a person to signal their status and identity. For example, sustainable innovations can signal that one is a green person. That is, people can be motivated to adopt a sustainable innovation to appear green (i.e., to signal to other or self that they are a pro-environmental person). Please note that this is different from adopting a sustainable innovation because one aims to benefit the environment as such (i.e., because of positive environmental attributes), as we discussed in the previous section. Sustainable innovations may not only signal that one is a green person, but may signal other aspects of a person as well. For example, research suggests sustainable innovations may signal one's innovativeness (Brown and Venkatesh, 2005; Simonson and Nowlis, 2000; Vande castele and Geuens, 2010), one's independence of oil producers, one's intelligence, or simply signal one's unique characteristics (Heffner et al., 2007).

While many products can signal the owner's status and identity, we argue that the signal ensuing from the adoption of sustainable innovations may be particularly strong. One important reason for this is that, as discussed above, sustainable products typically have instrumental drawbacks (e.g. a higher price, or less convenience). While these instrumental drawbacks may on the one hand inhibit adoption of sustainable innovations, such drawbacks could ironically at the same time stimulate adoption by making the symbolic attributes more impactful (Belk, 1981; Gneezy et al., 2012). For example, it was found that when people's status motives were activated, green products were preferred over more luxurious nongreen products, particularly when the green products were more expensive than their conventional counterparts (Griskevicius et al., 2010). It seems that the adoption of more expensive green products signals to others that you have the financial means that afford you to incur costs on behalf of others, thus boosting your status. Hence, the purchase of a green product is more likely to

signal your status and identity when these products have somewhat poor instrumental attributes (e.g., when they are financially costly). We therefore predict that the positive symbolic attributes of sustainable innovations become more influential in stimulating adoption when such innovations are somewhat costly. Importantly, we propose that this is not only true for financial costs, as suggested by the studies reported above, but for behavioral costs in general. As argued earlier, the instrumental drawbacks of sustainable innovations are not limited to a higher purchase price, but can also include additional uncertainty, time, and effort. We propose that these instrumental drawbacks can increase the strength of the signal (cf. Miller's (2009) costly signaling theory) and hence increase the importance of symbolic attributes for the adoption of sustainable innovations.

2.4. How to detect the importance of symbolic attributes for the adoption of sustainable innovations?

We argued in Section 2.3 that symbolic attributes can be an important factor for the adoption of sustainable innovations. If this is true, why is this not more commonly recognized? First, many studies did not ask consumers about relevant symbolic attributes of products, and therefore could not identify their importance (see Section 2.1). Second, when symbolic attributes are included in a study, respondents might indicate that these product attributes are not important to them, at least not when asked directly. For example, it was found that consumers rated status concerns as unimportant for their own purchase decisions, but simultaneously rated status as highly important for their neighbors' purchase decisions (Johansson-Stenman and Martinsson, 2006). A possible explanation could be that consumers do not fully acknowledge that symbolic attributes affect their choices, as it may not be socially desirable to admit to having purchased a product to gain status or to see oneself in a more positive way. This suggests that more appropriate methods may be called for in order to detect the significance of symbolic attributes for adoption of sustainable innovations. Indeed, when people were explicitly asked to evaluate the attractiveness of various attributes of car use, they specifically mentioned instrumental (and not symbolic) attributes as highly attractive. However, when the research task was more ambiguous, respondents indicated that particularly symbolic attributes make car use attractive (Steg et al., 2001). Furthermore, consumers might not exactly know which attributes truly affect their choices. For example, when respondents were asked which reasons were important for them to conserve energy, they indicated that information on the conservation efforts of others (i.e. their neighbors) would hardly affect their energy conservation behavior. Yet such information had substantial impact on their intention to conserve energy (Nolan et al., 2008). Finally, instrumental and environmental attributes of sustainable innovations are widely discussed in the media, while symbolic attributes are rarely mentioned. Therefore, people might be biased toward the more communicated attributes when providing reasons that affect their adoption decisions. This indeed implies that more appropriate methods than simply directly asking people may be called for in order to detect the significance of symbolic attributes for adoption of sustainable innovations.

3. The current study

We hypothesized that evaluations of instrumental, environmental and symbolic attributes are important for the adoption of sustainable innovations, and uniquely contribute to the explanation of the adoption of sustainable innovations (see Fig. 1). Extending previous research, we not only examined the importance of attributes separately, but also studied the relative

Fig. 1. Conceptual model on motivations to adopt sustainable innovations.

importance of each attribute type for the adoption of sustainable innovations. Specifically, we examined the extent to which evaluations of each attribute type predicts adoption, when controlling for the other attribute types. In addition, we tested whether positive evaluations of symbolic attributes will more strongly predict the adoption of sustainable innovations when people believe that sustainable innovations have some instrumental drawbacks (i.e., the interaction between symbolic and instrumental attributes).

We tested the conceptual model depicted in Fig. 1 in two questionnaire studies, focusing on the adoption of two different types of sustainable innovations: electric cars (Study 1) and renewable energy systems (Study 2). In both studies, we employed two different methods to examine the importance of the three types of attributes for the adoption of sustainable innovations. First, we used a direct method to establish the importance of the three different attributes for the adoption of sustainable innovations. In this case, we directly asked people to what extent several instrumental, environmental, and symbolic product attributes were important for them when considering adopting a specific sustainable innovation. This approach is commonly used in (qualitative and quantitative) research on adoption of sustainable innovations. Second, we established the importance of the three different attributes for the adoption of sustainable innovations in an indirect way, to meet the concerns raised in Section 2.4 (i.e., people may not be aware of their true motivations or not be willing to acknowledge them), and to examine the relative importance of each of the three attributes for adoption, when controlling for the impact of the other attributes. The indirect method involved that we tested the extent to which evaluations of instrumental, environmental and symbolic attributes predicted the adoption of sustainable innovations. If consumers truly care about certain attributes, this should be reflected in stronger associations between the evaluation of the particular attribute and adoption, when the effects of other attributes are controlled for. The higher the predictive power of the evaluation of an attribute, the more important the relevant attribute is for the adoption of sustainable innovations (relative to the other attributes). To summarize, the direct method reflects a direct assessment of the importance of attributes for the adoption of a sustainable innovation, while the indirect methods involves that we assess the importance of attributes on the basis of how well evaluations of these attributes uniquely predict adoption of the relevant sustainable innovation.

The adoption of innovations comprises of different stages (e.g. Palda, 1966; Rogers, 2003). Therefore, we included different indicators of adoption: interest in the sustainable innovation; the intention to adopt the sustainable innovation; and the acceptability of the sustainable innovation (the latter was only included in Study 2). Hence, we not only measured the intention to adopt, but also the preceding stages of interest in and acceptability of sustainable

innovations. For our first study, we chose a sustainable innovation in a product category that is known for its symbolic connotations and high conspicuousness: an electric car (Gatersleben, 2007; Heffner et al., 2007; Shove and Warde, 2002). However, many environmental behaviors, such as energy consumption, are inconspicuous by nature, making them less prone to social signaling motives (Shove and Warde, 2002). Therefore, in our second study, we tested whether evaluations of the three types of attributes predicted the adoption of a less visible sustainable innovation as well: participating in a local energy company that supplies renewable energy. We expected that such inconspicuous choices could still be influenced by symbolic considerations, given that consumers are also motivated by positive self-signals. Thus, the first study focuses on a conspicuous sustainable product while the second study focuses on a less conspicuous sustainable service.

4. Study 1: electric car

4.1. Method

4.1.1. Participants and procedure

Questionnaires were distributed door-to-door in the city of Groningen, a medium-large city in the North of The Netherlands. About 60% of the people contacted agreed to participate. They were handed a questionnaire and were told that the study was on 'developments in the automobile industry', as we did not want to reveal the exact purpose of the study to prevent socially desirable answers. The questionnaires were recollected at people's homes upon appointment, during which participants were debriefed. In total, 109 people participated in the study. Four questionnaires were removed from the dataset because they were filled out poorly: more than 25% of the answers were missing, indicating that these participants did not take the study seriously. The final sample comprised 105 participants (53% male). The mean age was 45 ($SD = 13.0$). The level of income and education of the sample was slightly higher than the Dutch average (CBS, 2012), but appeared to be comparable to that of Dutch car owners (CBS, 2007). Almost all participants had a driver's license (95%) and 86% had access to one or more cars.

4.1.2. Measures

4.1.2.1. Direct method. In the direct method, we directly asked respondents to indicate the importance of instrumental, environmental and symbolic attributes for the adoption of electric cars; this reflects the importance of attributes as such. More specifically, participants were asked to rate the importance of a set of instrumental, environmental and symbolic attributes of cars on a 6-point scale, ranging from "totally not important" to "very important". Half of the participants ($N = 52$) indicated how important these attributes would be for them when considering buying a full electric car (e.g. "I find it important that the electric enhances my social status"). We did not give detailed specifications of the full electric car as we were interested in perceptions of the relevant attributes. Although these perceptions may not reflect actual outcomes, the perceptions of outcomes, rather than objective outcomes, eventually affect electric car adoption. The other half of the participants ($N = 53$) indicated how important these attributes would be for them if they were considering buying a car in general. The results of the latter group will not be discussed here because they are not relevant for the purpose of the present paper. Note that we did not find significant differences between these two groups in their responses to the key variables included in our study.

We carefully selected 22 car attributes reflecting instrumental, environmental, and symbolic attributes, on the basis of prior

research (Dittmar, 1992; Steg et al., 2001; Steg, 2005; Vrkljan and Anaby, 2011), and discussions on (electric) cars in reviews and Internet forums (e.g., autoweek.nl). Some participants failed to fill out all items included in a specific attribute scale, and were consequently excluded from the relevant analyses. Eleven instrumental attributes reflected the functional costs and benefits of the electric car, such as "comfortable", "affordable", and "the ability to drive long distances without interruptions". The eleven items formed a reliable scale (Cronbach's $\alpha = .91$), so we computed the mean score for items included in this scale ($M = 4.67$, $SD = .91$). Three environmental attributes, which reflect the impact of electric cars on the environment, were included in the questionnaire, such as "low CO₂ emissions" and "environmentally-friendly". These items also formed a reliable scale, so we computed mean scores ($M = 4.92$, $SD = 1.24$, Cronbach's $\alpha = .87$). Finally, we included eight symbolic attributes, which reflect the impact of the electric car on self-identity and social status, such as "the electric car shows who I am" and "the electric car enhances my social status". Again, we computed the mean scores for these items as they formed a reliable scale ($M = 2.27$, $SD = .93$, Cronbach's $\alpha = .90$). The 22 items were placed in random order.

4.1.2.2. Indirect method. In the indirect method, the importance of attributes was established by examining how well evaluations of the three types of attributes of electric cars uniquely predict different indicators of electric car adoption. For this purpose, all participants first evaluated the likelihood that a 'typical' full electric car would have the 22 instrumental, environmental and symbolic attributes mentioned above. Again, we did not give a detailed specification of the electric car. Respondents were asked to indicate to what extent they agreed that a typical full electric car would have the given attributes (e.g. "An electric car enhances my social status"). Items were placed in a random order; responses were given on a 6-point scale, varying from "totally disagree" to "totally agree". All scales showed good reliability, so we computed the mean scores for participants' evaluations of the instrumental, environmental, and symbolic attributes, respectively. Overall, participants evaluated the environmental attributes of a typical full electric car positively ($M = 5.16$, $SD = 1.01$, Cronbach's $\alpha = .79$), the instrumental attributes slightly positively ($M = 3.68$, $SD = .82$, Cronbach's $\alpha = .83$), while they evaluated the symbolic attributes rather negatively ($M = 2.73$, $SD = 1.10$, Cronbach's $\alpha = .90$).

To assess the relationship between the evaluation of attributes of the electric car and different indicators of the adoption of electric cars, we included two indicators of adoption. Interest in an electric car was measured with the statement "I am interested in an electric car" ($M = 3.06$, $SD = 1.51$). Responses were given on a 6-point scale, ranging from "totally disagree" to "totally agree". Buying intention was assessed with two items. First, we asked participants how likely it is that they would consider an electric car in their next car purchase. Answers were given on an 11-point scale varying from "0% – not likely at all" to "100% – definitely" ($M = 3.55$, $SD = 2.89$). Second, participants rated to what extent they agreed with the statement "I will never buy an electric car" on a 6-point scale ranging from "totally disagree" to "totally agree". Responses to this last item were reverse-coded, so that higher scores reflected a stronger intention to buy an electric car ($M = 4.34$, $SD = 1.51$). We standardized the scores on both items and computed a composite intention-scale (Cronbach's $\alpha = .66$).

4.2. Results

4.2.1. Direct method

When participants were asked directly how important the attributes are for adopting an electric car, they rated the instrumental ($M = 4.67$, $SD = .91$) and environmental attributes

Fig. 2. Means and 95% confidence intervals of importance ratings of electric car attributes ($N = 48$).

Table 1
Bivariate correlations between evaluations of attributes and adoption of electric car.

	Instrumental	Environmental	Symbolic	Interest
Environmental ^a	.37**			
Symbolic	.21*	.31**		
Interest	.01	.27**	.29**	
Buying intention	.25*	.40**	.45**	.69**

* $p < .05$.

** $p < .01$.

^a Number of participants included in analysis differs per bivariate correlation due to missing values, N is between 92 and 102.

($M = 4.92$, $SD = 1.24$) as significantly more important than the symbolic attributes ($M = 2.27$, $SD = .93$); see Fig. 2.

4.2.2. Correlations

Table 1 shows bivariate relationships between the evaluations of the three attributes and the adoption indicators, which reflect the extent to which the evaluations of the attributes are related to adoption indicators. Most correlations were significant and positive: more positively evaluations of the attributes of electric cars were associated with a stronger interest in electric cars (although evaluations of instrumental attributes were not significantly related to interest), and with stronger intentions to adopt an electric car. Furthermore, evaluations of the different attributes of electric cars correlated only moderately positively, indicating that these questions tap into theoretically and psychologically distinct concepts. This finding implies that respondents who attach more importance to the symbolic

outcomes of an electric car do not necessarily also attach more importance to instrumental or environmental outcomes of the car. Also, not surprisingly, the adoption indicators were correlated positively: the more participants were interested in electric cars, the stronger their intention to buy one.

4.2.3. Indirect method

Finally, we examined to what extent the evaluation of instrumental, symbolic and environmental attributes uniquely predicted adoption of electric cars. The more an attribute contributes to the explanation of variance in adoption, the more important that attribute is for the adoption of electric cars (relative to the other attributes). First, we regressed the interest in an electric car on the evaluations of its instrumental, environmental and symbolic attributes, and the interaction between the evaluations of instrumental and symbolic attributes. Before doing so, scores on the attribute scales were centered (by subtracting the scale mean-score from individual scores on the scale, see Aiken and West, 1991) to facilitate the interpretation of the results. As expected, the more participants believed that electric cars have positive symbolic and environmental attributes, the more they were interested in electric cars (see Table 2). Interestingly, the evaluation of the instrumental attributes of electric cars only had a marginally significant negative relationship with interest in electric cars when the evaluations of the other attributes were controlled for, suggesting that the evaluation of the instrumental attributes is not an important unique predictor of interest in full electric cars. As expected, the interaction between the evaluations of instrumental and symbolic attributes was a significant predictor of interest in electric cars. To further explore this interaction, we conducted a simple slopes analysis (see Aiken and West, 1991). Fig. 3 reveals that evaluations of the symbolic attributes of an electric car significantly enhanced interest in electric cars when participants evaluated the instrumental attributes of electric cars relatively negatively ($\beta = .47$, $t(86) = 3.40$, $p = .001$), but not when they evaluated the instrumental attributes relatively positively ($\beta = .11$, $t(86) = \text{n.s.}$). This suggests that a positive evaluation of symbolic attributes particularly promoted interest in electric cars when participants believed that electric cars have somewhat poor instrumental outcomes.

Second, we performed the same analyses with buying intention as the dependent variable. Results showed that more favorable evaluations of the environmental and symbolic attributes of electric cars were associated with stronger intentions to buy an electric car, while evaluations of instrumental attributes did not significantly affect buying intentions when the evaluations of the other attributes were controlled for (see Table 2). The interaction term was not significant, meaning that the strength of the relationship between evaluations of symbolic attributes and intention to buy the electric car did not depend on the evaluation of the instrumental attributes of electric cars.

Table 2
Regression of indicators of adoption on evaluations of the instrumental, environmental and symbolic attributes of electric cars.

	R^2	F	df	β	t	p
DV: Interest	0.21	5.58	4.86			<.001
Evaluation of instrumental attributes				−0.18	−1.75	0.085
Evaluation of environmental attributes				0.22	2.03	0.045
Evaluation of symbolic attributes				0.29	2.75	0.007
Interaction term instrumental and symbolic attributes				−0.26	−2.62	0.010
DV: Buying intentions	0.29	8.76	4.88			<.001
Evaluation of instrumental attributes				0.08	0.83	0.406
Evaluation of environmental attributes				0.27	2.64	0.010
Evaluation of symbolic attributes				0.34	3.40	0.001
Interaction term instrumental and symbolic attributes				0.01	0.06	0.953

Fig. 3. Relationship between evaluations of symbolic attributes and interest in electric cars for groups with relatively negative versus relatively positive evaluations of instrumental attributes of electric cars.

4.3. Discussion

As expected, both the indirect and direct method revealed that environmental attributes are important for the adoption of electric cars. Furthermore, the indirect method revealed a significant positive relationship between evaluations of the symbolic attributes of an electric car and both interest in electric cars and buying intention, suggesting that favorable evaluations of symbolic attributes indeed enhance adoption. Yet, when asked directly, participants evaluated the symbolic attributes of electric cars as not very important. When asked directly, participants indicated that instrumental attributes of electric cars are important to them. Interestingly however, although the evaluation of the instrumental attributes correlated weakly with buying intention (but not with interest), the evaluation of the instrumental attributes did not significantly predict buying intention and only had a marginally significant negative relationship with interest in electric cars when the evaluations of the other attributes were controlled for. Hence, the indirect method suggests that instrumental attributes are less important for adoption decisions than the environmental and symbolic attributes. The interaction between symbolic and instrumental attributes predicted interest in electric cars. As expected, favorable evaluations of symbolic attributes particularly enhanced interest in electric cars when participants evaluated the instrumental attributes more negatively, but not when instrumental attributes were evaluated relatively positively. However, we did not find this interaction effect for the intention to buy an electric car.

5. Study 2: local renewable energy systems

5.1. Method

5.1.1. Participants and procedure

Questionnaires were distributed in public places (e.g. trains) in the western part of the Netherlands. An interviewer approached people and asked if they were willing to participate in the study. In total, 143 people filled out the questionnaire on the spot, of which 65 were men and 73 were women; 5 participants did not specify their gender. The mean age was 39 ($SD = 19.2$). The level of education was somewhat higher than the Dutch average. The

distribution of income in the sample was similar to the Dutch population, although the lower and higher income levels were somewhat over-represented (CBS, 2012).

5.1.2. Measures

5.1.2.1. Direct method. In the direct method, participants were asked to rate the importance of various instrumental, environmental and symbolic attributes of local energy systems on a 7-point scale, ranging from “totally not important” to “very important”. Half of the participants ($N = 73$) were asked how important these attributes would be for them if they were considering making use of local energy systems. The other half ($N = 70$) of the participants indicated how important these attributes would be for them if they were considering making use of energy systems in general. The results of the latter group will not be discussed here because they are not relevant for the purpose of the present paper. As in Study 1, we found no differences between these two groups in their responses to the other questions.

Local energy systems were introduced to participants as a relatively new means of production and distribution of renewable energy at a local level. We indicated that the main energy sources in a local energy system are wind, solar, and geothermal energy. As in Study 1, we did not give a detailed description of local energy systems as we are interested in people's perceptions of local renewable energy systems. Participants rated the importance of thirteen attributes, which were selected on the basis of prior research (Bergmann et al., 2006; Gerpott and Mahmudova, 2010) and expert opinions (e.g. Shah, 2011). Some participants failed to fill out all items included in a scale, and were consequently excluded from the relevant analyses. The three scales showed good reliability, so we computed mean scores on the items included in each scale. Six items reflected instrumental attributes of local energy systems, for example price, time and effort it costs to make use of local energy, comfort, and blackouts and malfunctions ($M = 4.83$, $SD = .98$, Cronbach's $\alpha = .80$). Three environmental attributes were included, such as CO_2 emissions and environmental quality ($M = 4.84$, $SD = 1.20$, Cronbach's $\alpha = .83$). Finally, we included four symbolic attributes, such as “the use of local energy shows who I am”, and “the use of local energy gives me the opportunity to distinguish myself from others” ($M = 3.09$, $SD = 1.40$, Cronbach's $\alpha = .91$).

5.1.2.2. Indirect method. Next, all participants evaluated local energy systems on the same 13 attributes. More specifically, participants indicated to what extent they evaluated instrumental, environmental, and symbolic consequences of local energy systems positively or negatively (from -5 very negative to 5 very positive, with 0 neither negative nor positive). Negatively framed questions were reverse-coded before computing mean scores of items included in each attribute scale, so that higher scores reflected more positive evaluations of the attributes. The scales of the environmental ($M = .93$, $SD = 1.46$, Cronbach's $\alpha = .73$) and symbolic attributes showed good reliability ($M = -.13$, $SD = 1.92$, Cronbach's $\alpha = .88$), while the reliability of the instrumental attributes scale ($M = -.43$, $SD = 1.11$, Cronbach's $\alpha = .62$) was lower yet acceptable. On average, environmental attributes were evaluated positively, while instrumental and symbolic attributes were evaluated slightly negatively.

We included three different indicators of adoption: interest in and intention to use local energy systems (also included in Study 1), and the acceptability of local energy systems (reflecting a positive attitude toward adoption). The level of interest in using local energy systems was measured with the statement “I am interested in local energy systems” ($M = 3.74$; $SD = 1.56$). Intention was measured by the statement “I am definitely going to make use

Fig. 4. Means and 95% confidence intervals of importance ratings of local energy system attributes ($N = 68$).

of a local energy system" ($M = 3.91$; $SD = 1.49$). Responses to both questions were given on a 7-point scale, ranging from "totally disagree" to "totally agree". We included two items to measure acceptability of local energy systems. First, participants were asked to what extent they were in favor of local energy systems when considering its advantages and disadvantages. Answers were given on an 11-point scale varying from -5 "I am very much against local energy" to 5 "I am very much in favor of local energy" ($M = 1.12$, $SD = 1.83$). Second, participants indicated to what extent they agreed with the statement "I am in favor of a transition from centralized energy systems toward local energy systems" ($M = 3.89$, $SD = 1.52$) on a 7-point scale, ranging from "totally disagree" to "totally agree". Responses on both items were standardized before averaging them into an acceptability-scale (Cronbach's $\alpha = .77$; $M = .00$ $SD = .90$).

5.2. Results

5.2.1. Direct method

As in Study 1, the direct method revealed that participants rated the instrumental ($M = 4.83$, $SD = .98$) and environmental ($M = 4.84$, $SD = 1.20$) attributes of local energy systems as significantly more important than the symbolic attributes ($M = 3.09$, $SD = 1.40$, see Fig. 4).

Table 3

Bivariate correlations between evaluation of attributes and adoption of local energy systems.

	Instrumental	Environmental	Symbolic	Acceptability	Interest
Environmental ^a	.05				
Symbolic	.19*	.34**			
Acceptability	.19*	.54**	.48**		
Interest	.01	.49**	.46**	.66**	
Intention	.09	.41**	.36**	.66**	.64**

* $p < .05$.

** $p < .01$.

^a Number of participants included in analysis differs per bivariate correlation due to missing values, N is between 125 and 139.

5.2.2. Correlations

Evaluations of the symbolic and environmental attributes were positively related with acceptability of, interest in, and intention to use local energy systems, while the evaluations of the instrumental attributes of local energy system only correlated weakly with acceptability of local energy, and not significantly with interest in and intention to use local energy systems. So as in Study 1, more positive evaluations of symbolic and environmental attributes enhanced adoption, while evaluations of instrumental attributes were less strongly or even not significantly related to different indicators of adoption. Correlations between different evaluations of attributes of local energy systems were again moderate or even not significant (see Table 3), suggesting that they indeed reflect different attributes of local energy systems. As in Study 1, we found strong positive relationships between the indicators of adoption.

5.2.3. Indirect method

To establish the relative importance of the three types of attributes for adoption of local energy systems, we first regressed acceptability of local energy systems on the evaluations of the instrumental, environmental and symbolic attributes, and the interaction between the evaluations of the instrumental and symbolic attributes (similar as in Study 1). Results showed that the more positive participants' evaluation of environmental and symbolic attributes of local energy systems, the more acceptable they found these systems (see Table 4). The evaluations of the instrumental attributes did not contribute significantly to the explanation of the acceptability of local energy systems, but the interaction between evaluations of instrumental and symbolic attributes was marginally significant. Simple slopes analysis revealed that symbolic attributes did not significantly predict

Table 4

Regression of indicators of adoption on evaluations of the instrumental, environmental and symbolic attributes of local energy systems.

	R^2	F	df	β	t	p
DV: Acceptability	0.40	19.18	4.116			<0.001
Evaluation of instrumental attributes				0.10	1.41	0.163
Evaluation of environmental attributes				0.40	5.23	0.000
Evaluation of symbolic attributes				0.27	3.14	0.002
Interaction term instrumental and Symbolic attributes				−0.14	−1.66	0.100
DV: Interest	0.35	16.95	4.124			<0.001
Evaluation of instrumental attributes				−0.09	−1.18	0.239
Evaluation of environmental attributes				0.38	4.90	<0.001
Evaluation of symbolic attributes				0.25	2.83	0.005
Interaction term instrumental and Symbolic attributes				−0.16	−1.84	0.068
DV: Intention to use	0.21	8.12	4.125			<0.001
Evaluation of instrumental attributes				0.04	0.52	0.603
Evaluation of environmental attributes				0.29	3.38	0.001
Evaluation of symbolic attributes				0.22	2.34	0.021
Interaction term instrumental and Symbolic attributes				−0.07	−0.79	0.430

Fig. 5. Relationship between evaluations of symbolic attributes and acceptance of local energy for groups with relatively negative versus relatively positive evaluations of instrumental attributes of local energy.

acceptability of local energy systems ($\beta = .14$, $t(116) = 1.00$, n.s.) when participants evaluated the instrumental attributes of local energy systems relatively positively. However, the evaluation of symbolic attributes was positively related to acceptability of local energy systems when participants believed that these systems had relatively weak instrumental attributes ($\beta = .39$, $t(116) = 4.52$, $p < .001$; see Fig. 5).

Second, we conducted the same regression analysis with interest in local energy as the dependent variable. Results revealed that the more positive participants evaluated the environmental and symbolic attributes of local energy systems, the higher their interest in these systems (see Table 4). The evaluations of the instrumental attributes did not significantly contribute to the explanation of interest in local energy systems when the other attributes were controlled for. Again, the interaction between evaluations of the instrumental and symbolic attributes had a marginally significant effect on the explanation of interest in local energy systems. Simple slopes analysis revealed that symbolic attributes did not significantly predict interest in local energy systems when participants evaluated the instrumental attributes of local energy systems relatively positively ($\beta = .10$, $t(124) = .70$, n.s.). However, as expected, positive evaluation of symbolic attributes promoted interest when participants evaluated the instrumental attributes of local energy systems relatively negatively ($\beta = .40$, $t(124) = 4.66$, $p < .001$; see Fig. 6).

Third, we performed the same regression analysis with intention to use local energy systems as the dependent variable. The more positively participants evaluated the environmental and symbolic attributes, the higher their intention to use local energy (see Table 4). Neither evaluations of the instrumental attributes of local energy systems nor the interaction between evaluations of instrumental and symbolic attributes contributed significantly to the model.

5.3. Discussion

The results of Study 2 were similar to the results of Study 1. Again, both the indirect and direct method revealed that positive environmental attributes enhance the adoption of local energy. Moreover, when asked directly, participants evaluated the symbolic attributes of local energy systems as less important

Fig. 6. Relationship between evaluations of symbolic attributes and interest in local energy for groups with relatively negative versus relatively positive evaluations of instrumental attributes of local energy.

than the instrumental and environmental attributes. However, as expected, the indirect method revealed that respondents were more likely to adopt local energy systems when they evaluated its symbolic attributes positively. These results suggest that the signaling function of sustainable innovations is indeed not limited to conspicuous products, but also holds for inconspicuous services. Again, as in Study 1, respondents rated the instrumental attributes of local energy systems as important. Yet, as with electric cars, evaluations of the instrumental attributes of local energy systems did not predict interest in, intention to use and acceptability of local energy systems when the other variables were controlled for. Also, correlations between instrumental attributes and adoption indicators were weak. Hence, the indirect method again suggests that evaluations of instrumental attributes are relatively less important for adoption than are evaluations of environmental and symbolic attributes. Finally, for both interest in and acceptability of local energy systems, the effect of the evaluation of symbolic attributes was moderated by participants' evaluations of the instrumental attributes. As expected, positive evaluations of symbolic attributes significantly increased interest in and acceptability of local energy systems when people evaluated instrumental aspects of these systems relatively poorly, but not when the instrumental attributes were evaluated relatively positively. Yet, these moderating effects were only marginally significant, and the interaction effect was not significant for intention to use local energy.

6. General discussion

This paper introduced and tested a conceptual model which proposes that the adoption of sustainable innovations depends on the evaluation of instrumental (i.e. functional outcomes), environmental (i.e. the impact on the environment) and symbolic attributes (i.e. the impact on self-identity and social status) of such innovations. We tested the perceived importance of these three attribute types for the adoption of two different sustainable innovations, the electric car and the use of local energy system, following two different methods.

The results of the two studies indicated that the adoption of sustainable innovations is indeed driven by the evaluation of its environmental attributes. On average, respondents believed that

both sustainable innovations were beneficial to the environment. More importantly, we found positive relationships between evaluations of the environmental attributes of sustainable innovations and the adoption indicators when evaluations of the other attributes were controlled for. This suggests that people are motivated to adopt sustainable innovations because of its environmental benefits, and that this effect is independent of image considerations. This finding is in line with previous research suggesting that people engage in pro-environmental actions because they aim to benefit the environment (Steg and De Groot, 2012, for a review), and extends this research by showing that environmental attributes are also important predictors of the adoption of sustainable innovations.

The results further suggest that, as expected, symbolic attributes were important for adopting sustainable innovations: the more people think that adopting a sustainable innovation has positive outcomes for their self-identity and social status, the more likely they are to adopt sustainable innovations. As expected, the evaluation of symbolic attributes proved to be a significant predictor of all adoption indicators when evaluations of other attributes were controlled for. Furthermore, evaluations of symbolic attributes not only predicted the adoption of the electric car, but also to the adoption of the less conspicuous local renewable energy system. Apparently, symbolic attributes are also important predictors of the adoption of inconspicuous sustainable innovations that are less suitable to signal one's status or identity to others. This finding suggests that symbolic attributes are indeed not only important for the adoption of sustainable innovations because of their potential to signal our status or identity to others (Griskevicius et al., 2010) but also because of their potential to signal to the self (e.g., Belk, 1988; Giddens, 1991; Sirgy, 1986). This finding may have broader implications, as the same is likely to be true for many other products, and not only for sustainable innovations.

Results from the indirect method suggest that evaluations of symbolic attributes were an important predictor of the different indicators of adoption for both sustainable innovations. Yet, when asked directly participants indicated that symbolic attributes would not be important for them when they would consider the adoption of sustainable innovations. It seems that people do not recognize the true causes of their behavior (cf. Nolan et al., 2008); they may not fully know or want acknowledge that they buy and use sustainable innovations in order to show off or to feel good about themselves. Rather, people stress instrumental and environmental attributes of sustainable innovations (see also Steg and Vlek, 1997; Tertoolen et al., 1998). Our indirect method, in which we studied how well different product attributes predicted adoption, appeared to be less susceptible to socially desirable answers or lack of awareness of one's true motivations (cf., Steg, 2005). Future research should study whether this is a general phenomenon, or whether the tendency to underestimate the significance of symbolic motivations is subject to individual or cultural differences.

When asked directly, participants tended to rate instrumental attributes as very important. This is in line with findings from previous studies employing similar methods to assess the importance of attributes of sustainable innovations (e.g. Deloitte, 2010; Steinhilber et al., 2013; Zhang et al., 2012). However, the indirect method revealed that the evaluation of instrumental attributes was only weakly and sometimes even not significantly correlated with the different indicators of adoption, and more importantly, the evaluation of the instrumental attributes did not significantly predict the different indicators of adoption when evaluations of environmental attributes and symbolic attributes were controlled for. Hence, results of the indirect method suggest that instrumental attributes are less important for adopting sustainable innovations than often assumed. This is an important finding that should be further explored in future research.

Overall, our results suggest that having the highest standard of instrumental attributes may be less important for the uptake of sustainable innovations than is often assumed, and that environmental and symbolic attributes are important as well, or even more important to enhance the adoption of sustainable innovations. Our results even suggest that symbolic attributes particularly promote the adoption of sustainable innovations when people evaluated the instrumental attributes of sustainable innovations relatively negatively. However, we only found this pattern of results for the interest in and acceptability of sustainable innovations but not for the intention to adopt sustainable innovations; the former are more distant indicators of adoption than intentions. Future research is needed to study the interaction between evaluations of instrumental and symbolic attributes in more depth, and explore under which conditions poor instrumental attributes may increase the significance of symbolic attributes for adoption of sustainable innovations. For instance, we expect that poor instrumental performance will not always boost the symbolic motive for adopting sustainable innovations. Indeed, it is likely that instrumental attributes do have to meet certain minimum standards to satisfy basic consumer needs. For instance, an electric car that can only drive 2 km per charge would not be very functional, and in this case, it is not likely that the positive symbolic attributes will promote adoption. Possibly, the instrumental attributes should be good enough (for example, an electric car with a range of 120 km) before a sustainable innovation with some instrumental drawbacks can be appealing for some groups of consumers. Future research could also test our model for actual adoption of sustainable innovations, and investigate whether actual adoption increases when people evaluate instrumental attributes somewhat negatively, or whether the effect is limited to less committed statements like interest in and acceptability of sustainable innovations.

Another important question that was not addressed in our study is why sustainable innovations may have positive symbolic attributes. What exactly is signaled with the use of sustainable innovations? Our research did not aim to address this question. Yet, our results suggest that sustainable innovations not only signal one's pro-environmental attitudes or values, as symbolic and environmental attributes both uniquely predicted adoption, suggesting that they reflect independent motivations for adoption. Many other aspects can be signaled as well, such as one's innovativeness, knowledge or status. Future research could examine this further, and study individual differences in the extent to which specific symbolic attributes are important for the adoption of sustainable innovations. For instance, sustainable innovations may symbolize a 'green image' for people who endorse environmental values (Steg and De Groot, 2012) or "sustainability-oriented" values (Axsen and Kurani, 2012b), while they may symbolize innovativeness or uniqueness for people who are keen to be early adopters (Vande castele and Geuens, 2010).

Policies to enhance the acceptability and uptake of sustainable innovations pay much attention to the instrumental attributes of sustainable innovations. Typical communication campaigns tend to downplay possible instrumental shortcomings. This is not surprising because the majority of the public says and thinks that instrumental attributes will affect their adoption decision most (see also the results of the direct method we employed in our studies). However, our research (in particular the indirect method) suggests that this might not always be the most effective strategy. Stressing the symbolic and environmental attributes of sustainable innovations could be an important additional or even alternative strategy, especially in the first stages of adoption when the instrumental drawbacks of sustainable innovations are not easily eliminated in the short run. For example, battery technology and charging technology for electric cars and energy production efficiency for local energy systems will not improve overnight. Sustainable innovations are also

more likely to be used for their symbolic value in the early adoption phases, as people can more distinctively signal their personal qualities when products are not owned by the masses (cf. Berger and Heath, 2007). As for the detection of symbolic motivations, targeting symbolic attributes might need subtle and indirect methods as well. Lessons can possibly be drawn from promotion strategies of high-status and innovative brands. Taken together, the success of the adoption of sustainable innovations is most likely preceded by the recognition of the importance of symbolic and environmental motives for adopting sustainable innovations.

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