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**Article — Published Version**

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Journal of Consumer Behaviour

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*Suggested Citation:* Poier, Stefan; Nikodemska-Wołowik, Anna Maria; Suchanek, Michał (2022) : How higher-order personal values affect the purchase of electricity storage—Evidence from the German photovoltaic market, Journal of Consumer Behaviour, ISSN 1479-1838, Wiley, Hoboken, NJ, Vol. 21, Iss. 4, pp. 909-926, <https://doi.org/10.1002/cb.2048>

This Version is available at:

<https://hdl.handle.net/10419/265068>

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## ACADEMIC PAPER

# How higher-order personal values affect the purchase of electricity storage—Evidence from the German photovoltaic market

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## Funding information

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Abstract

Why do consumers make different decisions even when socioeconomic conditions are similar? The present article examines the effects of human values—as formulations of motivational goals—on the decision to purchase electricity storage for a photovoltaic system, a phenomenon hardly explored in prior research regarding high-priced household investments. About 50 percent of photovoltaic-system owners in Germany are also owners of an electricity storage. This study aims to explore the more deeply rooted motivational factors behind these different decisions to extend our understanding of consumers' decision-making processes regarding energy-efficiency investments. It is based on an online survey of 460 owners of residential photovoltaic systems in Germany in 2019 and focuses on the interplay between higher-order values, purchase decisions, perceived risk, and environmental concern. The analysis of the higher-order values showed direct effects of conservation and self-transcendence and indirect effects of openness to change and self-enhancement, both mediated by perceived risk.

## 1 | INTRODUCTION

Over the past decade, electricity-storage batteries have become increasingly affordable for owners of residential PV systems, making a cost-neutral self-supply of electricity possible. However, approximately 50 percent of households that invest in a PV system decide against a storage solution (Figgner et al., 2018, p. 36). Given similar sociodemographic characteristics of PV owners, e.g., age, income, household size, and education level (Jacksohn et al., 2019, pp. 222–223), investigating which other reasons, deeply rooted in users' value systems, determine these decisions is valuable.

As research on bounded rationality and behavioral economics (Barros, 2010; Beck, 2014; Simon, 1955, 1993) has shown, consumers

do not evaluate only on the basis of pure facts since the core element of behavioral economics is the idea of biases and heuristics (Del Campo et al., 2016; Gigerenzer & Gaissmaier, 2011; Mousavi & Gigerenzer, 2014). Both lead to non-optimal results in decision-making. Heuristics are simplification strategies that serve to facilitate and expedite the decision-making process by ignoring some information (Tversky & Kahneman, 1974; Willman-livarinen, 2017, p. 2; Zhang et al., 2020, p. 795). Biases, resulting from heuristics, can be referred to as “cases in which human cognition reliably produces representations that are systematically distorted compared to some aspect of objective reality” (Acciarini et al., 2021, p. 641). In other words, individuals interpret objective reality according to their values, biases, and perceptions (Acciarini et al., 2021, p. 644), which implies that their interpretations of reality vary depending on their individual value dispositions. Contrary to the utility maximization theory, which implies that there is one “right” decision that all individuals in a

This research was based on part of the first author's dissertation, conducted under the guidance of the second author.

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comparable situation would make, observed behavior is based intuitively on individual motivations, emotions, and cognitive biases (ElHaffar et al., 2020).

Consumers attempt to imagine how they would feel using a product, how their environment would respond to the decision, and how the decision would align with their individual desires and needs, which are determined by superordinate values and goals (Liebel, 2007, p. 453). The role of values in the decision-making process has been thoroughly documented in prior studies (Anic et al., 2019; Berglund & Matti, 2006; Farah & Fawaz, 2016).

Since values are to be understood as guiding principles in life, i.e., as a desirable state, they determine the direction of consumer decision-making (Parks & Guay, 2009, p. 676). Egoistic individuals with strong self-enhancement values are more likely to choose an option that enhances their own advantage, while altruistic individuals with strong self-transcendence values are more likely to care about the common good (Bouman et al., 2018). Personal human values determine the way a situation is interpreted (Sagiv & Roccas, 2021, p. 10), for example, how strongly a risk is perceived that discourages a purchase. According to de T'Serclaes (2010), risk perception is a major barrier to energy-efficiency investments. In the case of pro-environmental behavior, the strength of the perceived threat to nature may influence whether or not such a behavior is carried out. This can be, for example, simply switching off an unneeded electrical device (Kastner & Stern, 2015), but it can also be a costly investment in energy-efficiency measures (Kastner & Matthies, 2016; Ramos et al., 2016), provided that this is interpreted as environmentally friendly behavior.

Individuals attempt to align their behavior with their values and tend to purchase products that match these values (Voorn et al., 2018). Therefore, values can contribute to consumer loyalty and prevent the consumer from switching brands (Voorn et al., 2021).

In addition to values, personality traits are among the key content aspects of personality (Sagiv & Roccas, 2021, p. 2). Although they are considered to be independent constructs, recent research has revealed moderate relationships (Fischer, 2018; Parks-Leduc et al., 2015). McCrae and Costa (1999) and McCrae et al. (2000) considered that personality traits are expressed as characteristic adaptations, which include human values (Fischer & Boer, 2015, p. 493). Since traits determine what individuals are like and values indicate what is important to them in life, it can be said that "traits shape values in interaction with the local environment" (Fischer & Boer, 2015, p. 493). In recent years, Busic-Sontic and Fuerst (2018) and Busic-Sontic et al. (2017) have conducted pioneering research regarding the effects of personality traits on making energy-efficiency investments. Based on this, Poier (2021) investigated the influence of traits on decision-making between household members in the context of the purchase of photovoltaic systems.

However, relatively little is known about the contribution of human values to the purchase of high-priced energy-efficiency technology. Therefore, in general this research deepens and broadens prior studies on pro-environmental consumer behavior, as an extensive evaluation of sustainable consumer behavior is still under-

represented in the existing literature (Agrawal & Gupta, 2018; Kuanr et al., 2021; Marzouk & Mahrous, 2020).

In particular this study narrows the gap in research regarding how consumer behavior based on individual dispositions like basic human values can be more accurately inferred. Regarding pro-environmental behavior, most studies have examined everyday behaviors such as saving electricity and water, utilizing reusable packaging, and buying organic food (Gatersleben et al., 2014; Honkanen et al., 2006; Vega-Zamora et al., 2020). This research proposes a conceptual framework grounded in existing interdisciplinary literature for studying how individual dispositions among consumers affect their behavior. To the best of our knowledge, the effects of consumers' individual value dispositions on their decision to purchase a battery storage for self-generated solar power have not been investigated in previous studies. To assess these products' features, extensive knowledge and processing capacity on the part of the consumer is required. Moreover, values that develop from early childhood to young adulthood may explain differences in consumer behavior. In the aforementioned context, the role of environmental concern in the purchase decision as a control variable and as a mediator was examined.

The remainder of this article is organized in the following way. A review of the literature and a detailed description of the theoretical foundation of the model and the formulation of hypotheses is provided in Section 2. Section 3 presents the source of the data and describes how the working sample is prepared. After that, the results are presented in Section 5. This is followed in Section 6 by a discussion of the results including theoretical contributions and practical implications. The article ends with the conclusions, limitations of the study and an outlook for future research.

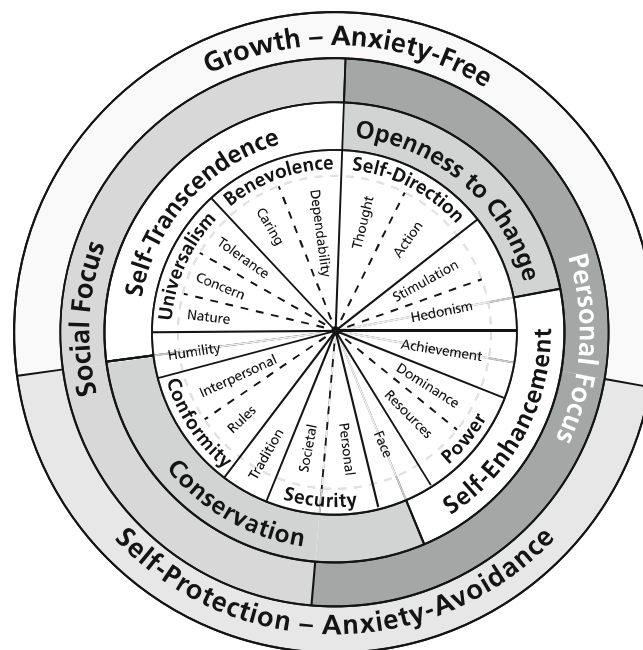
## 2 | LITERATURE REVIEW AND HYPOTHESES

The history of modern values research goes back to the work of Vernon and Allport (Cantril & Allport, 1933; Vernon & Allport, 1931), who developed a personality measurement instrument called "A Study of Values." Since the 1970s, several value theories have been developed that can be roughly divided into two areas of research at the individual level and at the cultural level (Hanel et al., 2018). The three most prominent value theories at the cultural level were developed by Inglehart (1977), Hofstede (1980), and Schwartz (1999). For this research article, however, tools that measure individual values are of importance, for example, the Rokeach Value Survey (RVS) (Rokeach, 1973), the Values, Attitudes, and Lifestyles (VALS) framework, which builds a connection between values and lifestyle (Mitchell, 1984), and Kahle's List of Values (LOV) (Homer & Kahle, 1988; Kahle et al., 1986). The Schwartz Theory of Basic Human Values (Schwartz & Bilsky, 1987, 1990) is among the most popular and researched models to date (Knafo et al., 2011, p. 181; Sagiv & Roccas, 2021, p. 3). In current psychological research, the term "values" is defined by Schwartz (1999, p. 24) as "(...) conceptions of the desirable that guide the way social actors (e.g., organizational

leaders, policy-makers, individual persons) select actions, evaluate people and events, and explain their actions and evaluations.” In the context of purchase situations, consumers seek to achieve certain goals through the acquisition of a commodity (Silberer, 1995, p. 2704). Although values are subjective for an individual consumer, they are generally shared within the social or cultural group. Values develop over the long term through individuals' experiences, education, and socialization (Bilsky et al., 2011). Schwartz expanded the individual value system of the earlier models to 10 and assumed that each type of value formulates a specific motivational goal. The 10 values, universal across cultures, were universalism, benevolence, conformity, tradition, security, power, achievement, hedonism, stimulation, and self-direction; they have been widely analyzed and confirmed by most studies (Bilsky et al., 2011; Schwartz, 1994; Schwartz & Boehnke, 2004). A revision of Schwartz's theory revealed a more differentiated structure with 19 values (Ciecuch et al., 2014; Ciecuch et al., 2015; Schwartz, 2017; Schwartz et al., 2012). This refinement was deemed necessary to better reflect the actual core idea of a circular continuum of values. Schwartz identified four higher-order values, each comprising several single values. Humility and face form their own values in the revised 19 values, which were not present in the original model. Like hedonism, each lies on the borders between two higher-order values. According to the Coding and Analysis Instructions (Schwartz, 2016b), humility aligns best with self-transcendence, while face should be assigned to self-enhancement.

The first higher-order value, self-transcendence, comprises universalism nature, universalism concern, universalism tolerance, benevolence caring, benevolence dependability, and humility. Individuals with high values of self-transcendence appreciate the well-being of others and a sense of community and nature. The second higher-order value is openness to change, comprising self-direction thought, self-direction action, and stimulation. People scoring high on openness to change seek excitement and new experiences, and they demonstrate independent thinking and self-realization. The third value cluster is called self-enhancement and includes achievement, power dominance, power resources, and face. Individuals with a high self-enhancement level seek prestige, personal success, and social status; they want to dominate others. Hedonism can be assigned to both openness to change and self-enhancement (Bilsky & Schwartz, 1994). The fourth higher-order value, conservation, comprises security personal, security societal, tradition, conformity rules, and conformity interpersonal. People with high conservation scores prefer safety and traditional values, desire security, and dislike improper behavior. While self-enhancement is about one's own advantage and dominance over others, self-transcendence focuses on the well-being of others. In openness to change, the focus is the view beyond one's own nose and the expansion of one's horizon that counts; in contrast, with conservation, it is the preservation of the status quo and adherence to rules (Schwartz, 2012). Figure 1 illustrates the circular arrangement of the 19 revised values.

Several researchers investigated the influence of values on consumers' purchase decisions (Kaže, 2010; Kosteljik, 2015; Krystallis et al., 2012; Leão et al., 2007). Furthermore, regarding a general

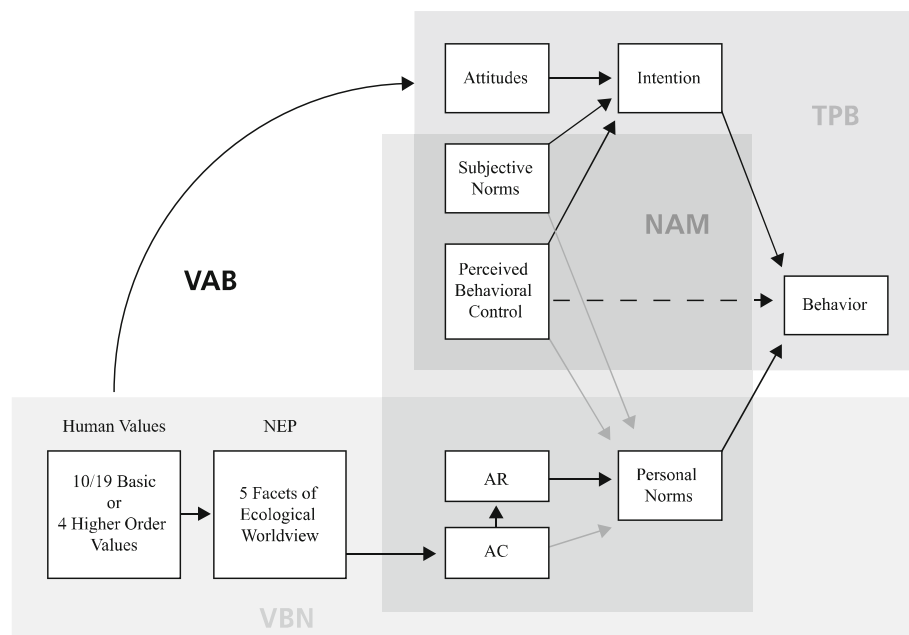


**FIGURE 1** Modified version of the motivational continuum of values. In the innermost circle, the circumplex structure of the 19 revised human values is shown. Surrounding this, the four higher-order values along the two dimensions openness versus conservation and self-transcendence versus self-enhancement are shown. Moving outward, the next circle divides the values into social and personal focus. The outermost circle distinguishes between the dimensions anxiety-avoidance and anxiety-free. Source: Own visualization, based on Schwartz et al. (2012, p. 669)

examination of the relationship between values and behavior, Ciecuch (2017) emphasized the simultaneous role of values as both drivers of and obstacles to behavior. Values affect the attractiveness of choice options as well as the perception and evaluation of alternatives (Honkanen et al., 2006; Schwartz, 2005). The connection between values and involvement was examined by O'Cass (2001) with the result that the involvement with an object is higher when it is strongly connected to the consumer's values. As for comparing values with personality traits, a study by Voorn et al. (2018, p. 537) found that values were the stronger factors in a consumer-brand relationship. They played a greater role in future decisions than traits, which is an indication of the importance of values for purchasing decisions.

## 2.1 | Conceptual framework

Aride and Pàmies-Pallisé (2019) and Wilson and Dowlatabadi (2007) used different approaches to introduce two integrated models of consumer decision-making. Both models proposed that it should be possible to explain differences in behavior, at least in part, through differences in consumers' individual value dispositions. A synthesis of these individual theories, models, and studies used in the present investigation is presented in Figure 2. Human values form the starting point of the value-belief-norm (VBN) theory, with the new ecological



**FIGURE 2** Conceptual framework. Figure 2 illustrates different models of consumer behavior with their interfaces, starting from human values and moving to intention, norms, and behavior. AC, awareness of consequences; AR, ascription of responsibility; NAM, norm activation model; NEP, new ecological paradigm; TPB, theory of planned behavior; VAB, value-attitude-behavior; VBN, value-belief-norm theory. Source: Own visualization, based on Poier (2021)

paradigm (NEP) in second place (Stern, 2000, p. 412). According to the VBN theory, personal norms affect not only behavior; they are the link between the VBN theory and the norm activation model (NAM), according to Schwartz and Howard (1981). The prerequisite for both theories is that personal norms are influenced by the consumer's ecological worldview. Concretely, this means they allow human values to influence purchase decisions only if consumers see the purchase as contributing to environmental protection or consider environmental concern as the reason for it. For the structural model, this meant that environmental concern, measured by the NEP, was included as a mediator variable in the model, in the case where consumers see the purchase of a battery storage system as a contribution to environmental protection. Although the protection of nature as a facet of the value "universalism nature" on the one hand and environmental concern on the other seem to say something similar at first glance, they differ from each other. Basic human values are, by definition, "conceptions of the desirable that guide the way social actors (...) select actions" (Schwartz, 1999). Values, therefore, indicate what is important to the individual (Schwartz, 2016a, p. 63). In contrast, the new ecological paradigm measures the individual's beliefs about nature and environmental issues, and thus, his or her level of environmental concern (Bagozzi et al., 2002). Therefore, values (in this case, universalism nature) and beliefs are two different constructs of consumer behavior (Steg & de Groot, 2012). This also becomes obvious in the value-belief-norm theory, which proposes that values influence beliefs about the environment, and thus, human values are mediated by environmental concern (Stern, 2000, p. 412). The NAM has subjective norms and perceived behavioral control in common with the theory of planned behavior (TPB), which ends with the individual's behavior (Ajzen, 1991). Thus, both the NAM and VBN theory identify behavior as a consequence of personal norms. In addition, with subjective norms and perceived behavioral control, the NAM forms two of the three prerequisites for the TPB. The final requirement for the TPB, attitudes, is influenced by values

via worldviews and is the missing link established by the value-attitude-behavior (VAB) hierarchy between human values and attitudes (Homer & Kahle, 1988). Thus, values have an effect on the purchase decision through attitudes even without the mediating function of environmental concern (Schwartz, 2016a, p. 72).

## 2.2 | Development of hypotheses

Following Wolske et al. (2017), renewable energy technology can be seen in different ways as a consumer good, an investment, a possibility to increase one's well-being, an innovative technology, and a contribution to environmental protection. Its perspectives as a consumer good and an investment justify viewing the subject of the study as a consumer or household decision. Accordingly, sociodemographic control variables were derived. The installation of novel energy-efficiency measures, such as electricity storage batteries, implies uncertainty and risk for consumers (Busic-Sontic & Brick, 2018, p. 2). Perceived risk has been one of the most important determinants of consumer behavior research since the 1960s (Li et al., 2020, p. 77). Dowling (1986) defined it as the uncertainty consumers face when making a purchase and it is commonly understood as a "cognitive evaluation of outcome probability and outcome severity" (Loewenstein et al., 2001; Slovic, 2011, pp. 364–371; Wolff et al., 2019, p. 3). In this context, the risk assessment, that is, the strength of risk perception, is influenced by the consumers' basic human values, in addition to other variables (Rundmo et al., 2011). Equipping one's household with energy-efficiency measures such as solar-power systems or battery storage requires a substantial financial investment that is often financed through loans. Future savings are uncertain and, like the service life of such systems, can only be estimated, resulting in a significant financial risk for the consumer (Rockstuhl et al., 2021). Moreover,

the potential for fire or defects in the battery storage system pose a risk to consumers' health and safety, as well as to their property. Many installations in one's own home depend on the companies and the people entrusted with them; therefore, trust in the installer is highly significant in relation to the purchase of a PV or storage system. Rai, Reeves, and Margolis (2016, p. 504) found that more than 50% of prospective PV customers considered the installer's opinion very important or even extremely important. Since trust presupposes a risk situation (Fjaeran & Aven, 2021; Luhmann, 1988), the study also inquired about perceived risk in the context of trust in people involved. A meta-analysis conducted by Li et al. (2020, p. 90) found a direct negative relationship between perceived risk and purchase behavior. Self-enhancement is located in the value circle in a segment that combines fear avoidance and focus on the self. Individuals who score high in power and achievement strive to preserve or increase their own advantage and react more strongly to threats to their own interests (Schwartz, 2016a; Schwartz et al., 2000, pp. 318–319). Thus, the following hypotheses were developed:

H\_01: Perceived risk has a negative influence on the battery purchase.

H\_02: Self-enhancement has a positive effect on perceived risk.

Regarding environmental concern, Kollmuss and Agyeman (2002) proposed a model according to which values were predecessors of pro-environmental behavior. Remarkably, most PV-storage owners cited a hedge against rising electricity prices as their primary motive for the purchase or said they wanted to contribute to energy-system transformation (Figgenger et al., 2018, p. 55). Therefore, at least the intention to make a contribution to the energy-system transformation—and thus to the environment as a common good—is about as rigid as the selfish motivation to save money. Individuals scoring high on openness seek challenges in life and want to implement their ideas and plans (Ciecuch & Schwartz, 2017). Together with persons with a high self-transcendence level, they are located in the sphere of anxiety-free values (Schwartz, 2017). They are interested not only in their own concerns but also in the environment. Primc, Ogorevc, Slabe-Erker, Bartolj, and Murovec (2021, p. 287) found that self-direction had a positive influence on environmental concern. Therefore, we expect a negative influence of openness on perceived risk and a positive effect on environmental concern, and we develop the following hypotheses:

H\_03: Openness to change has a negative influence on perceived risk.

H\_04: Openness to change has a positive effect on environmental concern.

Individuals with pronounced self-transcendence have a social rather than a selfish focus. They care about the well-being of others and the protection of nature (Schwartz, 2016a). Further research on

pro-environmental consumer behavior was conducted by Pinto et al. (2011). In a study on responsible water consumption in Southern Brazil, they concluded that socially oriented participants used water more responsibly than self-oriented individuals. In a study concerning the applicability of a new environmental-values scale, Bouman et al. demonstrated an effect of values on beliefs, norms, and behavior. For this purpose, they used a scale based on the measurement of values underlying environmental beliefs and behaviors. Of the 17 items used, 15 were from the Schwartz values continuum, rearranged to measure biospheric and altruistic values (representing self-transcendence values in the original values circle) and egoistic and hedonic values (representing the original self-enhancement values). The main findings were that biospheric and altruistic values lead to stronger climate-change beliefs, stronger pro-environmental personal norms, a greater willingness to engage in energy-saving behavior, and support for governmental sustainability investments (Bouman et al., 2018, pp. 9–11). Gatersleben et al. investigated the relationship between values, identity, and pro-environmental behavior among UK residents; they also used a modified scale to measure biospheric, altruistic, and egoistic values. Concerning values, they found that biospheric values most strongly predicted pro-environmental behavior (Gatersleben et al., 2014, p. 388). Primc et al. (2021, p. 287) argued that the opposite is true for egoistic, or self-enhancement, values, thus leading us to develop the following hypotheses:

H\_05: Self-enhancement has a negative effect on environmental concern.

H\_06: Self-transcendence affects environmental concern positively.

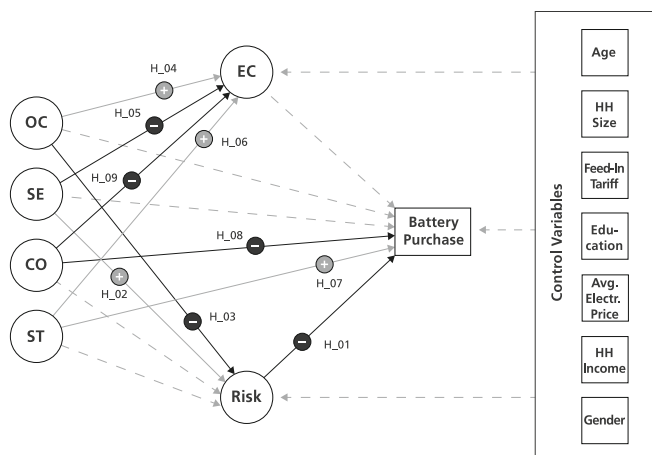
H\_07: Self-transcendence has a positive effect on the battery purchase.

Individuals with high conservation scores are eager to go along with the majority opinion instead of going their own way. They strive for security and stability and want to maintain the status quo without experimenting. Thus, they are unlikely to invest in a new and uncertain technology. Since their main interest lies in protecting themselves and their close associates, interest in global issues and protecting the environment plays a secondary role (Schwartz, 2016a). Therefore, we considered the following hypotheses:

H\_08: Conservation has a negative effect on the battery purchase.

H\_09: Conservation affects environmental concern negatively.

With increasing electricity demand, investing in renewable forms of energy becomes a growing need. Yet only every second residential PV system in the German market is sold with battery storage (Figgenger et al., 2018, p. 36). Environmental concern and perceived risk are among



**FIGURE 3** Hypotheses in the structural equation model. Figure 3 presents the hypotheses (H\_01–H\_09) within the structural equation model with mediation of higher-order values through perceived risk (Risk) and environmental concern (EC) on battery purchase with CO, conservation, OC, openness to change, SE, self-enhancement, and ST, self-transcendence

the possible influencing factors in energy-efficiency investments (Busic-Sontic et al., 2017, pp. 314–315). Consumers' varying value dispositions influence how they evaluate the different dimensions of the construct of perceived risk (Sutalaksana et al., 2019, p. 919), which in turn acts as an obstacle to purchase decisions. Therefore, perceived risk was included in the model as a mediator variable. Figure 3 summarizes the hypotheses of the study and shows the direct and indirect relationships considering the control variables. Whether environmental concern plays a mediating role in the purchase decision due to the influence of human values should be investigated. This leads to the question of the reason for the heterogeneity of consumer decisions and to the major research question: *How do the differences in human values contribute to the decision to buy a battery storage device?*

### 3 | MATERIALS AND METHODS

#### 3.1 | Survey design

To answer the research question and to accept or reject the aforementioned hypotheses, a survey was conducted via a paid consumer panel from October to November 2019. The target group included adult owners of a self-inhabited property with a PV system. An online questionnaire was distributed via a market research institute to 2828 panel participants, of whom 2266 started to respond to the survey. The questionnaire also offered the option of being sent by email to other owners of PV systems. In addition, the link to the questionnaire was published in the German online community “Photovoltaik-Forum,” the largest German online community for people interested in renewable forms of energy. A total of 844 community and snowball participants, according to Atkinson and Flint (2004), clicked on the link to the questionnaire.

The aim of the study was not to map a representative cross-section of the population but to identify the difference between two consumer groups. Since both groups had to be owners of photovoltaic systems, both the participants from the online forum and the panel participants fulfilled this criterion for the study.

A total of 2603 individuals edited the survey, and 605 of these completed the questionnaire. After deleting all cases in which the participant had not given serious answers, did not own a PV system, or had not reached at least the page with risk perceptions, 587 cases remained. In a further step, all cases with obviously incorrect or too-quick answers were deleted. Since only decision-makers were to be examined for the investigation, only those individuals who had made the purchase decision either alone or with a partner were included in the working sample. Therefore, the resulting working sample comprised 460 persons.

#### 3.2 | Construction of variables

Since a positive attitude toward a product or the intention to buy it does not necessarily result in a positive purchase decision—a phenomenon known as the energy-efficiency gap (Allcott & Greenstone, 2012, p. 19; Häckel et al., 2017)—we did not measure attitude toward batteries or purchase intention. Instead, the actual purchase decision was examined as the dependent variable. To obtain comparable results, we decided not to develop our own scales for the measurement of individual differences. However, this study relied on sufficiently well-known and widely tested scales from the fields of personality and values research.

#### 3.3 | Higher-order values

The basic human values were measured with a 57-item scale, the Portrait Values Questionnaire (PVQ)-57 on a six-point Likert-type scale where 1 denoted “Not like me at all” and 6 “Very much like me” (Schwartz et al., 2012). Each item consisted of one statement about a person, and each statement was formulated to take gender into consideration (“it is important to her...”; “it is important to him...”). For each of the four higher-order values, a raw average score and a centered score were calculated. The centered score is the raw score reduced by the participant's average score over all items and is thus adjusted for the participant's scale use preferences.

In the *Coding & Analysis Instructions* (Schwartz, 2016b), Schwartz provided details for how the individual items should be assigned to the different values. Regarding the 10 original individual values, “face” was not considered to contribute to a certain value, while “humility” items were part of tradition. Within the revised 19 values, both form their own values. In the majority of about 100 samples, “humility” fits best with “self-transcendence” and “face” is best combined with “self-enhancement” regarding the higher-order values (Table A1 in the Appendix A). For t-tests, higher-order values were computed as the mean of all related items.

Since many owners of PV systems indicated protection against electricity price increases or power failure as a reason for their purchase, safety values could also contribute to the decision-making process (Figgenger et al., 2018), while for technology enthusiasts, “openness” values could play an important role. Environmental concern was measured in detail with the 15-item NEP scale, according to Dunlap, van Liere, Mertig, and Jones (2000, p. 433).

### 3.4 | Socioeconomic variables

Sociodemographic variables such as age, gender, income, and household size were included as control variables. In addition, economic variables such as feed-in tariff and average electricity price in the year of installation of the PV system were taken into account. Finally, the analysis was controlled for two variables that were investigated in the context of energy-efficient investments: perceived risk as an obstacle to investment and concerns about the environment as a possible altruistic or ecological driver of the investment. However, both constructs were considered not only as control variables but also as mediator variables.

Age, gender, and level of education were observed variables as well as household income and educational level. Household income was a selection field with nine gradations from 0 to more than 5000 euros per month. The variable educational level was generated from school education and vocational education (university degree), based on the International Standard Classification of Education (ISCED).

The average electricity price as well as the average feed-in tariff in the year of PV installation were calculated using data provided by the BDEW for that year (BDEW Bundesverband der Energie- und Wasserwirtschaft e. V., 2020).

### 3.5 | Environmental concern

A standard scale was also used to measure environmental worldview. In its current form, the New Ecological Paradigm (NEP) scale comprises 15 statements on environmental attitude (Cronbach's  $\alpha = .812$ ), each rated on a Likert-type scale from 1 (do not agree at all) to 5 (fully agree). The eight odd-numbered items represent a pro-ecological worldview, while the seven even-numbered items reflect a more anthropocentric worldview according to the dominant social paradigm (DSP). To calculate the five individual facets of the NEP, the even-numbered pro-DSP items had to be reverse-coded so that all items measured the same dimension. A German translation of the original scale was adapted from a study by Menzel and Bögeholz (2010).

### 3.6 | Perceived risk

For the construction of the global variable for perceived risk (Cronbach's  $\alpha = .846$ ), four modified questions from the Socio-Economic Panel (SOEP), a representative nationwide German

household study, were used (Goebel et al., 2019). These originally asked about the consumer's risk preference and were reformulated in this study to capture the strength of the perceived risk (“Did you have the feeling of risk about purchasing the solar power storage?”). They included the domains of general and financial risk, risk related to the health of the participant, and risk related to trust in the persons or companies involved. The answer options on the Likert-type scale ranged from 0 (no risk) to 10 (high risk).

## 4 | ANALYSIS AND RESULTS

Since decision-making plays the central role in this study, only those survey participants who made the decision for or against purchasing a battery either by themselves or with a partner were considered. In the case of non-owners, it was assumed that decision-makers regarding the PV system would also decide about the battery; therefore, these persons were considered the decision-makers regarding storage as well. Of these 460 participants involved in the decision-making process, 173 (37.6%) owned a battery storage system. Of the 173 storage owners, 108 had made the purchase decision alone, while 65 had agreed on the decision with their partner. Eight stated that the battery was their partner's idea, and 38 said the idea was a joint one; the remaining 127 had the idea themselves. Of the 287 non-owners of a storage battery, 191 stated that they had made the decision to buy the PV system on their own, and 96 had made the decision with their partner. All control variables except for gender and environmental concern showed significant differences between the two groups (see Tables A2 and A3 in the Appendix A).

### 4.1 | Statistical analysis

To test the hypotheses, the latent variables were included in a structural model that depicts the dependencies of higher-order values, perceived risk, environmental concern and battery purchase. SEM was chosen as the analysis method to estimate the strength and significance of the effects between the interrelated constructs and to account for measurement error. The Analysis was conducted using Mplus, a statistical software to conduct structural equation modeling with latent variables and factor analyses with a binary outcome as it was needed in the present study (Muthén & Muthén, 1998–2020; Muthén et al., 2016). Mplus also provides the possibility to report total indirect, direct and total effects, even with a binary outcome (for a detailed explanation see Muthén et al., 2016, pp. 307–330). In addition, age, gender, household size, feed-in tariff, level of education, average electricity price, and household income were included as control variables that were regressed on battery ownership in the first model and also on environmental concern and perceived risk in the second analysis. To avoid misspecifications resulting from those assumptions that do not reflect reality, we used exploratory structural equation modeling (ESEM) in the final analyses (Asparouhov & Muthén, 2009; Marsh et al., 2020). The difference with confirmatory



factor analyses (CFA) is that cross-loadings to non-intended items are not constrained to zero but allowed as in exploratory factor analysis (EFA).

The following values represent common guidelines for an acceptable model fit: comparative fit index (CFI) > 0.90, Tucker-Lewis index (TLI) > 0.90, root mean square error of approximation (RMSEA) < 0.08, and standardized root mean square residual (SRMR) < 0.08 (Hu & Hu & Bentler, 1999; Marsh et al., 2010). A good model fit can be assumed with the following values: CFI > 0.95, TLI > 0.95, RMSEA < 0.05, and SRMR < 0.05. However, it is important to note that scales for personality research with real-world data and many items and factors rarely come close to a mediocre fit (Marsh et al., 2010, p. 477). As an example, a fit of CFI = 0.744, RMSEA = 0.062 was considered acceptable during the development of the regular German Big Five Inventory 2 (BFI-2) measurement instrument (Danner et al., 2016). If the fit is sufficient, it can be assumed that the data collected have satisfactory validity. To achieve an acceptable, if not good, model fit, it is almost always necessary in social science practice to adjust the data without distorting the underlying theories and models. In the present study, this was accomplished through a series of EFAs and CFAs. First, an EFA was performed, revealing which items loaded on the intended factors (i.e., were good predictors) and which items had overly strong significant cross-loadings (i.e., were weak predictors).

Following Cieciuch and Davidov (2012, p. 40) and Purc and Laguna (2019, p. 8), a CFA was conducted for all four higher-order values separately to evaluate model fit. With the original item structure, the results suggested that the models of higher-order values were not well-represented by the data. As a consequence, two methods were used to improve the model fit until the CFI reached a value of at least .90:

1. Items with non-significant loadings were excluded from the CFA;
2. For questions with very similar wording, it was assumed that the residuals also correlate.

Following Cieciuch and Davidov (2012), this is the justification to allow those residuals to be correlated. Table 1 shows the results for higher-order values' model fits.

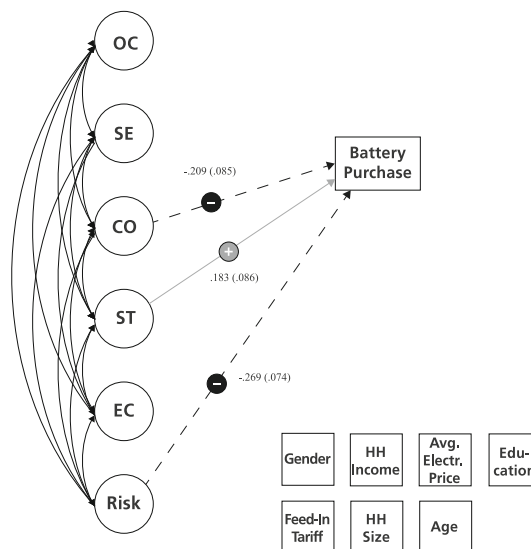
**TABLE 1** Model fit for higher-order values and mediator variables

Higher-order value	CFI	TLI	RMSEA	SRMR
Openness to change	0.927	0.903	0.092 (0.079/0.102)	0.049
Self-enhancement	0.913	0.873	0.108 (0.095/0.122)	0.069
Conservation	0.940	0.918	0.075 (0.065/0.085)	0.055
Self-transcendence	0.923	0.900	0.075 (0.067/0.082)	0.054
Mediator variable	CFI	TLI	RMSEA	SRMR
NEP	0.957	0.928	0.061 (0.045/0.078)	0.043
Perceived risk	0.942	0.826	0.232 (0.180/0.289)	0.039

Note: Table 1 presents model fit indices of four higher-order values and the NEP as a measure of environmental concern and for perceived risk using CFA. Abbreviations: CFA, confirmatory factor analysis; CFI, comparative fit index; NEP, new ecological paradigm; RMSEA, root mean square error of approximation with 90% confidence interval in brackets; SRMR, standardized root mean square residual; TLI, Tucker-Lewis index.

In the case of the NEP scale, the first step was to follow the approach of Xiao, Dunlap, and Hong (2019, p. 63) in order to increase the model fit. For this purpose, the item with the lowest factor load was deleted from each of the five domains. The result was a coherent measurement tool for the NEP, which still covered all five facets with an improved—but not yet good—model fit. Subsequently, as with the human values, those residuals with a very similar meaning or wording were allowed to be correlated. For perceived risk with four items (trust, health, financial, general), an acceptable model fit could be determined; therefore, this construct was not further optimized (Table 1).

In order to avoid misspecification of the models due to low case numbers, multiple imputation had to be performed to reduce missing



**FIGURE 4** Significant regressions of battery purchase on higher-order values. Figure 4 presents significant regression paths of battery ownership on higher-order values; estimator = WLSMV, multiple imputation generated 50 datasets ( $n = 383$  on average). Solid lines stand for positive (+) effects; dotted lines indicate negative (-) effects. CO, conservation; EC, environmental concern; Education, no degree; OC, openness to change; risk = perceived risk; SE, self-enhancement; ST, self-transcendence

data. The reason for this is the dichotomous nature of the dependent variables, that is, battery purchase yes/no. In combination with exploratory SEM, it was not possible to perform a calculation using full information maximum likelihood (FIML) estimators. The FIML estimator can handle missing data well but requires numerical integration, which is not allowed with EFA factors. Consequently, the calculation could be performed only with a weighted least square mean and variance (WLSMV) estimator, which in turn cannot handle missing data and excludes cases listwise. The solution was to calculate a multiple imputation with the Bayes estimator on the H1 model in advance. The analysis of the generated data is equivalent to the calculation with the FIML estimator (Asparouhov & Muthén, 2010, p. 23). According to Schwartz's coding and analysis instructions and after personal conversations, the uncentered raw scores were used here as observed variables for higher-order human values in the ESEM (Schwartz, 2016b).

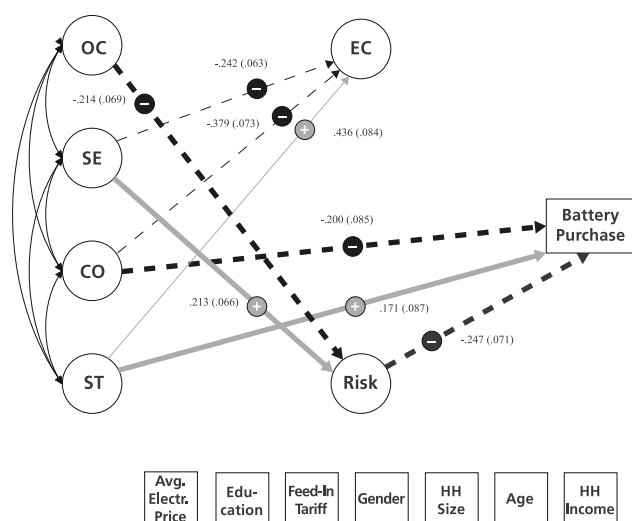
### 5 | RESULTS

Environmental concern and perceived risk were used as regular control variables in the ESEM (CFI = 0.860, TLI = 0.846, RMSEA = 0.028, SRMR = 0.158). In this step, perceived risk had a significant negative effect on the battery purchase ( $-0.269, p < .001$ ), while none of the control variables had a positive effect—an indication of the very homogeneous target group. Two of the higher-order human values also had a detectable influence. Conservation had a negative influence ( $-0.209, p = .014$ ), while self-transcendence had a positive ( $0.183, p = .032$ ) effect on the purchase decision. Environmental concern played no role in the purchase decision (Figure 4).

Since perceived risk was significant, a new structural equation model (CFI = 0.853, TLI = 0.836, RMSEA = 0.029, SRMR = 0.154) was calculated using both constructs as mediator variables (Figure 5). Again, the control variables had no significance as predictors of the battery purchase. Conservation ( $-0.200, p = .019$ ) and self-transcendence ( $0.171, p = .049$ ) retained their influence on the outcome.

Self-transcendence also had a measurable positive effect on environmental concern ( $0.436, p < .001$ ) while conservation ( $-0.379, p < .001$ ) and self-enhancement ( $-0.242, p < .001$ ) had a negative effect. Self-enhancement ( $0.213, p = .001$ ) and openness to change ( $-0.214, p = .002$ ) had a positive and negative influence on perceived risk, respectively. In addition, perceived risk not only had a negative impact on the battery purchase ( $-0.247, p = .001$ ) but also served as a mediating variable for openness to change and self-enhancement. However, environmental concern had no significant effect on the decision regarding a battery purchase (Table 2).

It can be assumed that individuals who have a high regard for preserving values, i.e., a need for security, tradition, and rules, were less likely to buy a battery storage system. Therefore, conservation values can be seen as obstacles to the purchase of batteries. In contrast, PV owners with a high level of self-transcendence who valued self-determined thinking and actions and who sought stimulation and entertainment were more likely to opt for a battery storage system. If perceived risk and environmental concern were made dependent on higher-order values, the significant influences passed to them. Perceived risk as a mediator revealed indirect effects of openness to change and self-enhancement on the purchase decision that were not measurable if it was only a regular control variable.



**FIGURE 5** Significant effects of higher-order values on battery purchase. Figure 5 presents significant regression paths of battery ownership on higher-order values with environmental concern (EC) and perceived risk (Risk) as mediator variables; estimator = WLSMV, multiple imputation generated 50 datasets ( $n = 383$  on average). Solid lines stand for positive (+) effects, dotted lines indicate negative (-) effects; bold lines represent significant direct effects. CO, conservation; OC, openness to change; SE, self-enhancement; ST, self-transcendence

**TABLE 2** Direct and indirect effects of higher-order values on battery purchase

	PR	EC	PR + EC	Direct	Total
OC	0.053 (0.008, 0.098)	-0.006 (-0.024, 0.012)	0.046 (-0.001, 0.094)	-0.035 (-0.189, 0.118)	0.011 (-0.144, 0.166)
SE	-0.052 (-0.096, -0.009)	0.029 (-0.009, 0.066)	-0.024 (-0.082, 0.035)	-0.009 (-0.156, 0.137)	-0.033 (-0.176, 0.110)
CO	-0.012 (-0.044, 0.019)	0.045 (-0.013, 0.102)	0.032 (-0.036, 0.101)	-0.200 (-0.367, -0.033)	-0.168 (-0.323, -0.013)
ST	0.013 (-0.021, 0.047)	-0.051 (-0.118, 0.016)	-0.038 (-0.111, 0.034)	0.171 (0.001, 0.342)	0.133 (-0.025, 0.291)

Note: Table 2 presents unstandardized indirect, direct, and total effects of higher-order human values ( $n = 383$  on average). 95% CI in brackets. Abbreviations: CO, conservation; EC, environmental concern; OC, openness to change; PR, perceived risk; SE, self-enhancement; ST, self-transcendence.

Hypothesis	H_01	H_02	H_03	H_04	H_05	H_06	H_07	H_08	H_09
Result	+	+	+	0	+	+	+	+	+

**TABLE 3** Hypotheses concerning higher-order values and perceived risk

Note: Table 3 presents results for hypotheses; 0 = rejected, + = accepted.

## 6 | DISCUSSION

Conservation values showed a negative effect and self-transcendence a positive effect on the decision to purchase a battery storage system. Perceived risk as a control variable had a negative effect on the battery purchase that persisted when it was considered as a mediator variable and, thus, hypothesis H\_01 could be accepted, confirming the findings of Li et al. (2020, p. 90). Environmental concern was not significant, which could be evidence of the energy-efficiency gap; in this case, consumers rate a storage battery as good for the environment but do not invest in the technology. It is also possible that consumers simply do not believe that buying a storage battery benefits the environment. He, Zhan, and Hu encountered this dilemma in their study on purchase intentions regarding electric vehicles in China. Similar to solar-power storage batteries, electric vehicles are high-priced consumer goods that require considerable involvement from consumers. Moreover, given their potential savings, electric cars can be regarded as household investments. The researchers demonstrated significant effects of environmental concerns on purchase intentions, although prospective buyers did not believe they were contributing to environmental protection by purchasing electric cars (He et al., 2018).

The positive effect of self-transcendence on the battery purchase confirmed hypothesis H\_07. Like openness to change, self-transcendence is part of the hemisphere of growth and freedom from anxiety. Together with conservation, self-transcendence is one of the higher-order values with a social focus rather than a personal focus. Social values, therefore, play a crucial role in consumers' decision-making. This aligns with the findings of Hansla (2011), who confirmed that people with a high degree of self-transcendence were more willing to pay high prices for environmentally friendly electricity. The positive effect of self-transcendence on environmental concern confirmed Schwartz's (2016a) definition of self-transcendent individuals as people who value equal rights and protecting nature. Thus, hypothesis H\_06 could be accepted. Due to the negative effect of self-enhancement on environmental concern, hypothesis H\_05 could be accepted. This confirms the results of a multinational study that found that self-enhancement correlated negatively with biospheric concerns (Schultz, 2001; Schultz & Zelezny, 1999). At the same time, the negative effect of self-enhancement values on environmental concern confirms Schwartz's idea of a circular value continuum since they are opposed to self-transcendence in the value circle and, thus, form a contrasting position (Ciecuch & Schwartz, 2017; Sagiv & Roccas, 2021, p. 5). The positive effect of self-enhancement on perceived risk leads to the acceptance of hypothesis H\_02 and can be explained by the fact that individuals with a high score in self-enhancement focus more on their own interests than on those of other people or nature. Therefore, risk to one's own interests is perceived more strongly than it is by individuals with a social focus (Schwartz et al., 2000).

Openness to change values had a negative effect on perceived risk and, thus, hypothesis H\_03 could be accepted. Openness also had an indirect positive effect on the purchase decision through the negative effect of risk on the battery purchase. Apart from perceived risk, no other effect of openness was found. Environmental concern was not affected, and thus hypothesis H\_04 had to be rejected. While the influence of openness to change on perceived risk can be explained by the fact that people with a high appreciation for openness are more likely to be assigned to the anxiety-free individuals who perceive risk less strongly, the lack of influence on environmental concern is contrary to, e.g., (Primc et al., 2021), whose research linked self-direction to environmental concern. An explanation can be taken from the theory that assigns openness to change to the personal rather than the social hemisphere (Ciecuch & Schwartz, 2017). Individuals scoring high on openness, therefore, place a higher value on their own development than on their environment (Schwartz, 2016a).

As expected, conservation had a negative effect on both battery purchase and environmental concern. Thus, hypotheses H\_08 and H\_09 could be accepted. One reason for the negative effect on the battery purchase could be that individuals scoring high on conservation are not willing to acquire new, additional knowledge in order to make the most informed decision. Instead, they use heuristic decision-making based on what they already know and, if in doubt, prefer to maintain the status quo (Andor et al., 2017). In the same vein, staying with the status quo and rejecting new thinking and action could also be responsible for the negative effect on environmental concern. The negative (direct) effect on the battery purchase aligns with the positive (indirect) effect of openness on the outcome, since openness and conservation are two opposite value clusters in the value circle and, thereby, suggest opposing behaviors (Schwartz, 2012).

In summary, eight of the nine hypotheses could be accepted, and one had to be rejected (Table 3).

The econometric studies showed that the control variables, except for perceived risk, were without influence, possibly due to the narrow target group of PV-system owners, among whom scores for income, household size, electricity costs, etc. did not vary greatly. The findings partially contradict consumers' statements about purchase motivation (Figgenger et al., 2018, p. 55). In that research, consumers reported making a contribution to environmental protection and protecting themselves against rising energy prices as their main motivations for purchasing battery storage systems. Hedging against rising energy costs corresponds to averting the unpredictable and to preserving what already exists—that is, a motivation belonging to the higher-order value of conservation, which has a negative effect on the battery purchase. However, it could be due to the fact that the consumer takes the initiative to gain an advantage, although without knowing whether this will lead to any success at all.

## 6.1 | Theoretical contributions

In an article published more than a decade ago, Borghans, Duckworth, Heckman, and ter Weel (2008, p. 1037) called for including validated personality measures in economic studies in order to use their predictive capabilities to develop behavioral models. The present study shows the importance of individual personality dispositions and, specifically, human values in understanding consumer behavior, especially when many other factors are quite similar in a very narrow target group such as PV owners. In addition, it provides a conceptual framework grounded in existing interdisciplinary research for studying how individual dispositions among consumers affect their behavior. The results show clear and significant effects of consumers' individual value dispositions on their decision to purchase a battery storage for self-generated solar power—partially mediated by perceived risk. However, environmental concern did not play a role in the purchase decision, either as a control variable or as a mediator. This is an important finding because, after all, measures to increase energy efficiency in the home are generally regarded as measures to protect the environment.

Indeed, the influence of human values on the purchase of electricity storage for PV systems underpins the theories of product or brand value and value congruence that result from the consideration that consumers use not only purely functional attributes to distinguish and evaluate brands but also attributes from personality research. The point of product or brand value is that products and brands can also be loaded with individual dispositions such as basic human values, while value congruence describes matching value ascriptions of consumer and product. In the process, Voorn et al. (2021) were able to demonstrate the significant effect of value congruence on repurchase intentions. Their findings confirm the clear effect of individual differences among consumers on their behavior as economic actors.

## 6.2 | Practical implications

The findings additionally offer several implications for practical application, both for the private sector and for policymakers. Not only can battery manufacturers more precisely tailor their marketing efforts to the relevant values of target consumers (Kosteljik, 2015); they can also improve their products to meet consumers' needs, thereby endowing them, to a certain degree, with individual dispositions that, to some extent, align with those of their potential buyers (Torelli et al., 2012). In regard to marketing activities, the concepts of brand value and value congruence can also be applied. In considering value congruence, marketing professionals may attempt to design products in ways that maximize congruence between the individual dispositions of the target consumer group and the products (Cazier et al., 2017; Voorn et al., 2021). Alternatively, politics could take the lead, e.g., by addressing the topic intensively in schools and in the media, to convey and strengthen values that support the purchase of the product.

To increase acceptance and, thereby, sales of battery storage systems among PV owners seeking to boost the total storage capacity

needed for the energy transition, manufacturers can attempt to mitigate perceived risk during the purchase decision-making process by addressing those specific factors with, for instance, marketing measures (Allen, 2001). In addition, the results suggest that improvements could be made to enhance the safety of products. As the results of the research indicated, the higher-order values of openness to change and self-enhancement were entirely mediated by perceived risk. At the same time, electricity storage was perceived by participants as a commodity that does not meet self-enhancement values but instead runs counter to them. Therefore, manufacturers should frame electricity storage devices as products that fulfill the values of self-enhancement. The situation is similar with the higher-order values of conservation. For consumers, electricity storage has become increasingly unattractive as values such as tradition, conformity, and safety have been given higher priority. In view of that trend, manufacturers should also frame electricity storage devices as products that ensure values of conservation while preserving the values of tradition or security as well.

In light of the upcoming energy-system transition, with the aim of not only slowing climate change but also making domestic economies independent of resource-rich nations, the results presented in this study are relevant in a number of ways. On the government side, the findings can be applied to designing programs offering financial or construction incentives as well as government guarantees to align with individual dispositions among consumers and to mitigate consumers' perceived risk related to purchasing an electricity storage device. Government benefits could include free or reduced homeowner's insurance to alleviate consumers' concerns about their homes in the event of a fire. Alternatively, a government guarantee that the purchase price of a device would be covered by the grid-related energy saved by the battery could also mitigate the risk in addition to boosting consumers' confidence in electricity storage.

## 7 | CONCLUSIONS

The overarching aim of this study was to determine why consumers in a specific situation, namely owners of PV systems, arrive at different conclusions in their purchase decision-making. The objective was to identify influences of individual differences between consumers' higher-order value orientations and, thus, their underlying motivations for their decisions to purchase storage batteries for self-generated solar power. Differences in higher-order human values accounted for variance in individuals' purchase behaviors, mediated in part by perceived risk. Assuming all other parameters to be constant, as typically done for narrowly defined target groups, consumers' individual value orientations take on special relevance in shaping their purchase decisions.

This study has demonstrated that interdisciplinary research on the values of consumers can provide important insights into how marketing storage batteries can be improved and how consumer behavior based on individual dispositions can be better inferred. Relatedly, the results can help nations become independent of resource-rich countries and improve suboptimal allocations of electricity storage for

targeting socially desirable outcomes. Researchers should continue to assume that those values can be decisively influenced by culture and socialization. Perceived risk was found to negatively affect the battery purchase; thus, producers should implement strategies to reduce it, for example, with long-term guarantees and/or transparent communication about product safety. Whether electricity storage truly addresses the desire among consumers to protect the environment or whether they remain apathetic continues to be unclear. Altogether, the results of the study have demonstrated the usefulness of psychometrics for economic science, and they offer implications for both consumer psychology and marketing research. However, future research remains necessary to compare the results of the study on an international scale and to test them regarding other high-priced consumer goods and household investments.

## 7.1 | Limitations

Several limitations of the research for this study warrant attention, e.g., the questionable extent to which self-reported personality assessments accurately capture one's personality. Indeed, countless researchers have expressed concerns that socially desirable answers are liable to contradict real-life tendencies and circumstances. A persistent question in consumer research is how many questions consumers can realistically be expected to answer before they become resistant and decline to respond. Future research will also need to strike a balance between lengthy item batteries that provide accurate but potentially incomplete results and shorter, user-friendly questionnaires that are less accurate but more likely to be answered honestly and consistently. The investigation with ESEM involved not only omitting items but also allowing cross-loadings. Therefore, another question for future research is whether to continue using theory-based constructs or the more currently applied method of exploratory structural equation modeling. These real-world examples deviating from theory and their problems with poor model fit in realistic psychological data are well-established (Borkenau & Ostendorf, 1990).

## 7.2 | Future research

Although the impact of human values on the purchase of PV-storage batteries has been clearly established, the role of pro-environmentalism continues to be unclear, particularly in terms of whether consumers view the purchase of electricity storage devices as contributing to environmental protection. Future research should aim to capture whether potential buyers are truly apathetic about threats to nature or whether they care about the environment but simply do not perceive that buying an electricity-storage device will reduce environmental impacts. Thus, additional research is thus needed to elucidate consumers' decision-making processes about high-cost energy-efficiency investments. A further step should be to test whether marketing measures tailored to different value propositions among consumers produce different results. If so, not only can a more refined, targeted approach to

consumers be explored but also conjoint analyses can be used to test different product variants that take into consideration consumers' individual value facets and/or mitigate their perceived risks. Overall, the recommended research could contribute to the decentralized storage of more electricity and, thereby, ensure a sufficient supply of renewable solar power without burdening energy grids.

Lastly, because the German market is the singular focus of this study, its results for international applicability may be limited. As human values show essential differences among nations and cultures, international comparative studies should reveal different results for values across cultures (Roccas et al., 2002, p. 799). Therefore, conducting international studies that consider different cultural aspects can be valuable. For business research and practical applications, the findings from intercultural research can also help clarify and overcome differences in the success of measures taken to improve communication and sales promotions.

## ACKNOWLEDGEMENT

Open Access funding enabled and organized by Projekt DEAL.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## ETHICAL HARMLESSNESS OF THE EXAMINATION

The Committee for Scientific Research Ethics at the Faculty of Economics of the University of Gdansk confirmed the ethical harmlessness of the superordinate dissertation project.

## DATA AVAILABILITY STATEMENT

The data is available from the corresponding author upon request.

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**How to cite this article:** Poier, S., Nikodemka-Wołowik, A. M., & Suchanek, M. (2022). How higher-order personal values affect the purchase of electricity storage—Evidence from the German photovoltaic market. *Journal of Consumer Behaviour*, 21(4), 909–926. <https://doi.org/10.1002/cb.2048>

## APPENDIX A

**TABLE A1** Assignment of the items to the different values classifications

Higher order values	10 original values	$\alpha$	19 revised values	$\alpha$	Items
Openness to change ( $\alpha = .824$ )	Self-direction	.870	Self-direction thought	.754	1, 23, 39
			Self-direction action	.810	16, 30, 56
	Stimulation	.510	Stimulation	.510	10, 28, 43
	Hedonism	.773	Hedonism	.773	3, 36, 46
Self-enhancement* ( $\alpha = .851$ )	Achievement	.741	Achievement	.741	17, 32, 48
	Power	.863	Power dominance	.764	6, 29, 41
			Power resources	.830	12, 20, 44
			Face*	.692	9, 24, 49
Conservation ( $\alpha = .879$ )	Security	.821	Security-personal	.668	13, 26, 53
			Security-societal	.777	2, 35, 50
	Conformity	.783	Conformity-rules	.836	15, 31, 42
			Conformity-interpersonal	.627	4, 22, 51
	Tradition**	.718	Tradition	.834	18, 33, 40
			Humility**	.584	7, 38, 54
Self-transcendence** ( $\alpha = .902$ )	Universalism	.870	Humility**	.584	7, 38, 54
			Universalism-nature	.807	8, 21, 45
			Universalism-concern	.778	5, 37, 52
	Benevolence	.879	Universalism-tolerance	.758	14, 34, 57
			Benevolence-care	.784	11, 25, 47
			Benevolence-dependability	.816	19, 27, 55

Note: Table presents the assignment of PVQ-57 items to the 19 revised human values, 10 original human values and four higher order values according to the coding & analysis instructions by Schwartz (2016a, 2016b). Face, as an own revised value, is part of self-enhancement but not part of one of the original values. Humility, as an own revised value, is part of the original tradition value to get closer to the original score. However, it is not part of the higher order conservation but part of the higher order self-transcendence;  $n = 521$ .

Abbreviation:  $\alpha$  = Cronbach's alpha for uncentered values.

**TABLE A2** t test for significant differences of continuous control variables

		Levene's test		t test for equality of means						
		F	p	t	df	p	$\Delta M$	$\Delta SE$	95% CI	
									Lower	Upper
Age	EV	.002	.960	3.387	390	.001	4.426	1.307	1.857	6.996
	UV			3.367	296.395	.001	4.426	1.315	1.839	7.014
Household size	EV	4.343	.038	-2.117	457	.035	-.243	.115	-.468	-.017
	UV			-2.027	314.525	.043	-.243	.120	-.478	-.007
Feed-in tariff	EV	3.617	.058	2.794	381	.005	4.704	1.683	1.394	8.013
	UV			2.758	283.807	.006	4.704	1.706	1.347	8.061
Average electricity price	EV	2.571	.110	-3.261	446	.001	-1.266	.388	-2.029	-.503
	UV			-3.258	350.857	.001	-1.266	.388	-2.030	-.502
Environmental concern (FS)	EV	.296	.586	1.476	458	.141	.142	.096	-.047	.331
	UV			1.468	356.101	.143	.142	.097	-.048	.332
Perceived risk (FS)	EV	4.430	.036	2.410	458	.016	.230	.095	.042	.418
	UV			2.360	339.037	.019	.230	.097	.038	.422

Note: Presented are scores for mean differences of the control variables;  $n = 460$ .

Abbreviations:  $\Delta SE$  = standard error of difference; 95% CI = 95% confidence interval of the difference; EV, equal variances assumed; FS, factor score; M, mean;  $p$ , 2-tailed  $p$  value; SD, standard deviation; UV, equal variances not assumed.

**TABLE A3** Mann-Whitney test for differences of categorical control variables

		n	Ranks		Test statistics			
			Mean	Sum	Mann-Whitney U	Wilcoxon W	Z	p (2-tailed)
Gender	Non-adopters	286	222.80	63,721.00	22,680.00	63,721.0	-1.862	.063
	Adopters	173	241.90	41,849.00				
Household income	Non-adopters	265	198.68	52,649.50	17,404.50	52,649.5	-3.070	.002
	Adopters	159	235.54	37,450.50				
Education level	Non-adopters	285	217.96	62,119.00	21,364.00	62,119.0	-2.550	.011
	Adopters	173	248.51	42,992.00				

Note: presented are scores for differences of categorical control variables;  $n = 460$ .