Journal of Environmental Psychology 40 (2014) 117–130

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

Find the differences and the similarities: Relating perceived benefits, perceived costs and protected values to acceptance of five energy technologies

Vivianne H.M. Visschers*, Michael Siegrist

ETH Zurich, Institute for Environmental Decision Making, Consumer Behavior, Zurich, Switzerland

A R T I C L E   I N F O

Article history:
Available online 12 June 2014

Keywords:
Energy technologies
Acceptance
Protected values
Cognitive determinants
Affective determinants

A B S T R A C T

Few studies have investigated and compared the acceptance of different energy technologies, hence the need to examine a comprehensive model to explain their acceptance. Moreover, little is known about the role of protected values, that is, values that are extremely important and non-negotiable for a person, in the acceptance of different energy resources. In a large mail survey in Switzerland, we investigated the acceptance of five energy technologies, including a number of determinants, such as protected values. Based on our results, we concluded that perceived benefits, perceived costs and protected values were important in explaining the public's acceptance of an energy technology. Moreover, to change the level of acceptance of an energy resource, communication should best focus on its benefits. We found only small differences and mainly similarities between the same predictors of the acceptance of different energy resources. Hence, we can conclude that to explain the acceptance of various energy technologies, one model fits all.

1. Introduction

Investigating public perceptions of different energy resources is fundamental for the planning of future energy portfolios in any region or country as public opinion has a strong impact on policymaking (Burstein, 2003) and can determine the realization of policy plans related to energy resources. Several countries have been reviewing their energy portfolios in response to increasing energy demand, climate change and/or to protect their energy security (Toth, 2008). Also, the nuclear accident in Fukushima (Japan) affected energy policies in several countries (Jorant, 2011; Kanellakis, Martinopoulos, & Zachariadis, 2013) or may do so in the future (Cooper, 2011; Heung Chang, 2011). Various factors have been advanced to explain people's acceptance of energy resources (see Huijts, Molin, & Steg, 2012 for a review). Examples of such factors include perceived risks, affect, trust and personal values. The energy portfolio of a region or country includes various energy resources. Because each energy technology has different costs and benefits, the public is likely to have different opinions about each.

Although a significant amount of research attention has been devoted to understanding public opinion regarding nuclear power (e.g. Greenberg, 2009b; de Groot, Steg, & Poortinga, 2013; van der Pligt, 1985; Venables, Pidgeon, Parkhill, Henwood, & Simmons, 2012; Visschers, Keller, & Siegrist, 2011; Visschers & Wallquist, 2013), few studies have investigated public attitudes, beliefs and acceptance[1] of other energy resources (e.g. Jones & Eiser, 2009; Tampakis, Tsantopoulos, Arabatzis, & Rerras, 2013; Wallquist,

* Corresponding author. ETH Zurich, Institute for Environmental Decisions, Consumer Behavior, Universitaetsstrasse 22 CHN J 75.2, 8092 Zurich, Switzerland. Tel.: +41 44 632149; fax: +41 44 632 10 29.

E-mail address: vvisschers@ethz.ch (V.H.M. Visschers).

[1] We define 'acceptance' in this paper as the 'The action or fact of receiving something favourably; (of a situation, action, or thing) the fact of being received favourably; positive reception, approval' (Oxford English Dictionary, 2012). We are however aware that some scholars explicitly distinguish 'acceptance' from 'acceptability'; the former refers to the behaviour that supports an object and the latter to an attitude towards an object (Huijts et al., 2012).

http://dx.doi.org/10.1016/j.jenvp.2014.05.007
0272-4944/

Visschers, & Siegrist, 2010).[2] Moreover, only a limited number of studies have investigated the determinants of public perceptions of various energy resources among the same people (Ansolabehere & Konisky, 2009; Bronfman, Jiménez, Arévalo, & Cifuentes, 2012; Ertör-Akyazı, Adaman, Özkaynak, & Zenginobuz, 2012; Greenberg, 2009a; Greenberg & Truelove, 2011; Hobman & Ashworth, 2013; Spence, Poortinga, Pidgeon, & Lorenzoni, 2010; Truelove, 2012). A systematic comparison of a broad range of determinants of acceptance of different energy resources remains absent. Consequently, it is unknown to what extent the same determinants predict the acceptance of various energy sources.

Some people may find it difficult to support certain energy portfolios which violate fundamental values (i.e. protected values) (Baron & Spranca, 1997). People who hold protected values against particular energy sources may not wish to choose among them or to make trade-offs between them. The extent to which protected values affect perceptions of an energy source remains unexplored.

In sum, the aims of this study were twofold. First, we wanted to investigate a comprehensive model with a broad range of factors to explain people's acceptance of various energy technologies and whether the relations between these predictors and acceptance differed between energy resources. Second, we aimed to examine the role of protected values in determining people's acceptance of various energy technologies. We therefore conducted a mail survey among a large sample of the Swiss population.

1.1. *Public acceptance of different energy resources*

Various studies have examined public acceptance of, preference for or opposition to several energy resources, ranging from fossil fuels, nuclear power and hydro-power to non-conventional renewables, such as solar and wind power (e.g. Ansolabehere & Konisky, 2009; Bronfman et al., 2012; Ertör-Akyazı et al., 2012; Greenberg, 2009a; Reiner, 2008; Spence et al., 2010; Tampakis et al., 2013; Truelove, 2012). Overall, these studies showed that the public prefers renewable solar, wind and hydro-power over nuclear and all fossil fuel technologies. Studies that differentiated between solar and wind power showed that the former was more positively perceived than the latter (Reiner et al., 2006; Tampakis et al., 2013). Tampakis et al. (2013) suggested that people have direct experience that the sun has beneficial effects, for example, heating water in Greece, whereas wind energy can have visible drawbacks, such as their impact on the local landscape (see also Jones & Eiser, 2009). Two studies found that hydro-power was perceived less positively than solar and wind power (Greenberg, 2009a; Tampakis et al., 2013), which may be because hydro-power plants, or dams, are perceived to spoil the landscape and the local environment.

Public perceptions of natural gas power appeared to be more positive than those of nuclear power (Ertör-Akyazı et al., 2012; Greenberg, 2009a; Truelove, 2012). People perceived natural gas-fired power as less environmentally harmful than nuclear power (Ansolabehere & Konisky, 2009). In some studies, nuclear power was preferred over oil- and coal-fired energy sources (Ertör-Akyazı et al., 2012; Greenberg & Truelove, 2011; Tampakis et al., 2013). The acceptance of nuclear power plants was similar to that of coal-fired power plants in three other studies (Ansolabehere & Konisky, 2009; Tampakis et al., 2013; Truelove, 2012). In a UK study, people favoured fossil fuels over nuclear power (Spence et al., 2010); however, the authors of this study averaged the acceptance of gas-, coal- and oil-fired power plants and compared this to the acceptance of nuclear power.

The ambiguous findings regarding the perception of nuclear power and coal- and oil-fired power may have been because energy resources can be evaluated on different dimensions. Respondents seemed to associate coal-fired power plants with more environmental harm than nuclear power plants, but at the same time, they believed that nuclear power was more costly than coal-fired power (Ansolabehere & Konisky, 2009). Also, personal experience with an energy resource may influence one's perception of it. People who directly experienced the environmental impact of coal-fired power plants—such as air pollution—opposed these power plants more often than any other energy resource (Ertör-Akyazı et al., 2012).

In sum, this short review revealed that the general public prefers green energy technologies, especially those with little impact on the local environment or scenery. Whether people prefer nuclear power over fossil fuels appears to depend not only on personal experience and the type of evaluation but also on the type of fossil fuel. For example, while nuclear power is seen as more environmentally friendly, it is associated with higher costs than oil- and coal-fired energy sources. Natural gas power plants are more positively perceived than nuclear power plants.

1.2. *Psychosocial determinants of the acceptance of energy technologies*

Recently, Greenberg (2009a) called for more research to investigate a broader range of determinants of public acceptance of energy resources besides demographic variables. Since then, a few studies have been published in which several psychosocial variables were seen as determining the acceptance of several energy sources. In what follows, we provide a short review of psychosocial determinants in relation to the acceptance of energy sources. We limit this review in two respects. First, we include only determinants that have been examined in various studies. Second, we restrict our review to determinants that are theoretically assumed to influence the acceptance of energy technologies. Consequently, we discuss the extent to which perceived risks, perceived benefits, trust, environmental concerns and values have been found to predict the acceptance of various energy resources.

Many studies have focused on the perceived risks of energy resources, that is, respondents evaluated the overall riskiness of energy resources (i.e. perceived risks, without specifying who or what was at risk; see Bronfman et al., 2012; Greenberg, 2009a) or more specific beliefs, such as perceived environmental harm and the perceived financial costs of the energy resource (Ansolabehere & Konisky, 2009; Truelove, 2012). Perceived risks appeared to strongly reduce the acceptance of nuclear power, hydro-power and fossil fuels but was either less strongly related or not related to the acceptance of unconventional renewable energy resources (Bronfman et al., 2012; Greenberg, 2009a). Perceived environmental harm was related to more opposition to building new power plants, and this relation seemed to be stronger for nuclear, wind and coal-fired power plants than for gas-fired power plants. On the other hand, perceived financial costs explained only a small portion of the opposition to any particular energy source (Ansolabehere & Konisky, 2009).

The perceived benefits of an energy resource and their relation to acceptance has received less research attention compared to the perceived risks. The perceived benefits for society and for the environment appeared to be significantly related to the acceptance of fossil fuels, nuclear and hydro-power (Bronfman et al., 2012). This was, however, not the case for the acceptance

[2] A quick literature search in Web of Science confirmed this assumption. The search terms ‘public perception’ and ‘nuclear power’ resulted in 166 hits; whereas ‘public perception’ combined with other energy sources resulted in a much lower number of hits (i.e. with ‘renewable energy’: 105, ‘wind power’: 77, ‘gas power’: 35, ‘coal power’: 21, ‘solar power’: 16, ‘fossil fuel power’: 11 and ‘photovoltaic’: 5 hits).

of non-conventional renewable energy resources. Truelove (2012) combined the perceived benefits and perceived risks of an energy resource in one and the same scale. This 'general beliefs' scale was a strong predictor of people's support for constructing new coal-fired, natural gas-fired, nuclear and wind power plants.

Trust in owners, operators and regulatory institutions was found to be positively related to the acceptance of various energy sources. The direct impact of trust was however small to insignificant (Ansolabehere & Konisky, 2009; Greenberg, 2009a; Greenberg & Truelove, 2011). When trust was indirectly related to the acceptance of an energy resource through perceived risks and perceived benefits, it appeared to explain a large part of the variance in acceptance (Bronfman et al., 2012). Trust influenced perceived risks and benefits probably because people could not rely on their knowledge or experience to determine them (Siegrist & Cvetkovich, 2000).

Importantly also, affect and emotions have barely been studied with respect to the acceptance of various energy resources. Truelove (2012) assessed both specific emotions (e.g. happy, dread and anger) and affective image evaluations (see also Keller, Visschers, & Siegrist, 2012; Peters & Slovic, 1996) for nuclear, wind, coal-fired and natural gas-fired power plants. Both were significantly related to support for each energy resource (except for wind power). However, when cognitive determinants, such as beliefs and perceived social norms, were included in the models to explain support for an energy resource, the relations between affective evaluations and support, and between emotions and support, often decreased. In other words, compared to the cognitive predictors of support for energy resources, affective predictors appeared less important. Alternatively, it may have been that affective factors were only indirectly related to the support of an energy technology through risk and benefit perception (Visschers et al., 2011) because affective responses are often the first spontaneous responses to a stimulus that influences cognitive processing and, consequently, decision-making (see affective primacy, Zajonc, 1980).

Explanatory behaviour theories hypothesize that values predict people's attitudes, which again influence their intention and behaviour (e.g. Ajzen, 1991; Stern, 2000). We therefore also believe that personal values should be investigated when predicting people's acceptance of an energy resource. In the case of energy technologies, people's values regarding the environment and energy security can be considered. Environment-related values refer to the importance of environmental considerations in a person's judgements whereas the latter relate to the importance of a secure and stable energy production. Several studies have investigated how environmental *concern* and energy-security *attitudes* relate to the acceptance of energy resources (Demski, Poortinga, & Pidgeon, 2014; Ertör-Akyazı et al., 2012; Greenberg, 2009a; Greenberg & Truelove, 2011; Hobman & Ashworth, 2013; Spence et al., 2010). However, environmental and energy-security *values* have hardly been investigated in relation to the acceptance of an energy resource. In surveys on the acceptance of nuclear power, environmental values (i.e. biospheric values and the New Ecological Paradigm) hardly seemed to affect the acceptance of this energy resource (de Groot et al., 2013; Whitfield, Rosa, Dan, & Dietz, 2009). An explanation for this insignificant to small relation may be that environmental values were measured in rather general terms and did not directly apply to energy technologies. The New Ecological Paradigm (NEP), for example, only refers to the vulnerability of the environment and to human influence on the environment and not to the relation between energy production and the environment. However, we believe that values that are directly related to the environment and a secure energy production should be investigated in relation to the acceptance of energy resources. We therefore decided to include these in our study.

1.3. Protected values

A psychosocial factor that has not been considered in relation to the acceptance of energy resources is protected values. A value (i.e. personal principles about how to behave, such as 'do not lie' and 'protect nature') can be of utmost importance to a person and therefore needs to be protected at any cost (Baron & Leshner, 2000; Baron & Spranca, 1997). The violation of a protected value can have three main implications. First, by their very nature, protected values are non-tradable, which can induce more negative consequences than when action can be taken. This is called omission bias—not performing an action that violates protected values although the consequences of not performing the action are actually worse than the consequences of performing the action (Ritov & Baron, 1999). For example, people with protected values in relation to environmental protection would oppose a proposal to construct a new hydro-power dam in a nature reserve. They would be insensitive to the consequences of their opposition, and this could mean that an even more environmentally harmful energy technology might expand in an unprotected area.

Second, decisions by people with protected values are insensitive to quantity considerations. For example, someone with protected values relating to nuclear power would consider the construction of ten nuclear power plants just as bad as the construction of one nuclear power plant; however, the actual consequences of the former may be much worse than those of the latter. Protected values thus hold for the act, not the outcome (Baron & Spranca, 1997).

Third, protected values are agent-relative, which means that the fact that an agent participates in an action that violates his/her protected values is more important than the consequences of this participation (Baron & Spranca, 1997). For example, people whose protected values (e.g. climate change prevention) are affected by gas-fired power production believe that it is morally wrong to have a household energy mix that includes this energy resource among other types of energy resources, for this energy resource produces CO_2, even if only a very small amount of gas-fired power is included in this mix. This again implies that people whose protected values are violated regard the omission of an action as more important and are therefore insensitive to the actual consequences.

When people learn about a decision that violates their protected values, this can invoke negative feelings, such as outrage or anger, toward the decision-makers (Tetlock, Kristel, Elson, Green, & Lerner, 2000). Moreover, the decision can increase people's intention to punish or sanction the decision-makers, thereby lead to behaviours that offset their outrage as a way of recovering their lost self-worth (so-called moral cleansing), such as protesting against the decision.

Protected values thus make life easier for decision-makers; if one of the options in the decision-making situation violates a protected value, they can quickly decide against this option and need not elaborate further. Protected values can therefore work as a heuristic (Hanselmann & Tanner, 2008). However, they can also have negative implications for decision-making; when negotiating parties hold different values, the negotiation will be obstructed if at least one party holds protected values in relation to the debated issue.

Based on this review, one could imagine that people who hold protected values that are violated by a particular energy source may thwart decision-making around the construction of a new power plant as they refuse to make trade-offs. Moreover, protected values may explain why some people oppose particular energy sources. Previous studies have investigated protected values in relation to health, social and environmental problems (e.g. CO_2 emissions, animal protection and genetic engineering, Baron & Leshner, 2000; Tanner & Medin, 2004; Tanner, Ryf, & Hanselmann, 2009). Whether people also hold protected values with respect to energy resources has not yet been investigated. It is unknown whether some energy resources are more likely to violate people's protected values than others and how protected values relate to the acceptance of energy resources.

1.4. Electricity production in Switzerland

Over the last ten years, around 55% of the electricity produced in Switzerland has come from hydro-power plants (Swiss Federal Office of Energy (SFOE), 2013b). Nuclear power plants provided up to 40% of total electricity production, and around 5% came from other sources, such as conventional thermal power plants and other renewables. A few months after the nuclear accident in Fukushima, the Swiss government and parliament decided that the existing five nuclear reactors would not be replaced when they reached the end of their operating lives.

Several policy measures have been suggested on how to fill this gap: more energy efficiency, expansion of renewable energy sources (mainly hydro-power plants), introduction of fossil fuel plants (e.g. combined cycle gas turbines (CCGTs)), and imports (Swiss Federal Office of Energy (SFOE), 2013a). Therefore, over the next few years, the Swiss energy portfolio will require a drastic overhaul. Combined cycle gas turbines (CCGTs) may be introduced as these are rather flexible, emit relatively low levels of CO_2 during production, and gas is relatively cheap. However, CCGTs are unknown to the Swiss public. The Swiss public's perception of gas-fired power plants may therefore be different in comparison to other countries. After the introduction of gas-fired power plants, Swiss electricity production will no longer be CO_2 neutral, which may affect people's acceptance of fossil fuel energy technologies included in the new energy policy plan. In sum, investigating the public's perception of various energy resources and their antecedents is currently especially interesting in Switzerland. We decided to focus this study on the five energy technologies that are currently under discussion in Switzerland: hydro-, nuclear, solar, wind and gas-fired power.

2. Research questions and hypotheses

This study had four research goals. First, since the Swiss energy portfolio is under transition, we wanted to determine the Swiss public's perceptions of five energy technologies currently under discussion in the new energy policy plans: hydro-, nuclear, gas-fired, solar and wind power. Several studies have investigated various factors in an attempt to predict the acceptance of various energy sources, each with diverging findings and many ambiguities. A comprehensive model to explain the public's perception of an energy resource remains wanting. Our second aim was to explain the acceptance of different energy technologies within the same sample of people using a comprehensive model of possible determinants grounded in previous research and existing frameworks. We investigated the following perception variables for each energy technology: perceived benefits, perceived costs, trust, positive emotions, negative emotions and protected values. In addition, we related two types of values—energy-security values and environmental values—to the acceptance of each energy resource.

We hypothesized that each of the perception variables would be significantly related to the overall acceptance of an energy resource (*Hypothesis 1*). More specifically, we expected that perceived benefits would have the strongest relation with the acceptance of an energy resource, and more strongly than perceived costs, trust, positive and negative emotions and values (*Hypothesis 2*) because one needs to see some kind of benefit as outweighing the unavoidable negative consequences of an energy technology (e.g. landscape disturbance) (Visschers et al., 2011). Compared to perception variables, values would barely be related to the acceptance of an energy resource as the latter are rather general terms that are supposed to influence acceptance indirectly through perceived benefits and costs (Stern, 2000).

Third, we wanted to compare the associations between the acceptance of an energy resource and its predictors in order to examine to the extent to which the same factors would have differing relations with the acceptance of different energy technologies. We hypothesized that the predictors would have different relations with acceptance depending on the type of energy resource (*Hypothesis 3*). Based on the affect heuristic (Finucane, Alhakami, Slovic, & Johnson, 2000), we assumed that for energy resources that are more strongly associated with negative images (i.e. nuclear and gas-fired power, see Truelove, 2012), the relationship between perceived benefits and acceptance would be stronger than for energy technologies that do not induce such negative associations (i.e. hydro, solar and wind power). Similarly, we hypothesized that perceived costs would have different relations with the acceptance of an energy resource, depending on the energy resource. The perceived costs of nuclear power and gas-fired power are recognized by most (i.e. people vary little on the amount of perceived costs of this energy resource) and therefore, the predictive value of perceived costs for acceptance ought to be lower compared to other energy resources. Lastly, we considered acceptance of the five energy resources in the context of energy-security values and environmental values. We expected that environmental values would be stronger related to the acceptance of renewable energy resources (i.e. hydro-, solar and wind power). Conversely, energy-security considerations would prevail in the acceptance of nuclear and gas-fired power as these represent a cheaper and more secure way of producing energy.

Fourth, we intended to investigate the role of protected values in explaining the acceptance of different energy technologies. We hypothesized that violations of protected values correspond with less acceptance of all energy resources (*Hypothesis 4*). Protected values are absolute and non-tradable; therefore, a violation of protected values automatically results in opposition (Baron & Spranca, 1997).

3. Method

3.1. Procedure and sample

Our mail questionnaire was sent to a sample in the German-speaking part of Switzerland. Addresses were randomly selected from the telephone directory. Data collection took place from August—October 2012. The mailing included an introductory letter, a 12-page questionnaire and a stamped and addressed return envelope. We invited an adult in the household and whose birthday was soonest to complete the survey. After four weeks, a reminder was sent to those households that were yet to return the questionnaire.

After deleting invalid addresses (e.g. moved and deceased), 863 questionnaires remained for analysis (response rate: 37%).[3] The final sample included 63% men ($n = 547$), 36% women ($n = 314$) and two individuals who did not report their gender. The mean age of the sample was 56 years ($SD = 38$). The majority of our respondents completed vocational school (43%, $n = 372$) or college or university (29%, $n = 251$). Approximately 17% finished higher secondary school ($n = 149$), and almost 10% completed compulsory education ($n = 82$). Nine respondents did not indicate their educational level. Compared to the Swiss population, our sample included more men and more people who had completed higher secondary school and less people who had only completed compulsory education (Swiss Statistics, 2012a, 2012b), which may be because of the technical focus of our survey. Moreover, our sample was older than the Swiss population (Swiss Statistics, 2012a), probably because we used the telephone directory to select addresses as older people are more likely have a landline and be listed in the telephone directory than younger people.

3.2. Questionnaire

The questionnaire assessed respondents' perception of five energy sources, environmental and energy-security values and demographics. Each energy source was briefly introduced with the same type of information: the current number of sites or plants of this type of energy source, the 2011 output level, future expansion possibilities and two advantages and two disadvantages of this type of power generation (see Appendix I for all five descriptions). The introductions were based on information from Swiss government agencies and Swiss research institutes. We maintained a fixed order in the manner in which the five energy sources were presented and evaluated by all respondents: solar, nuclear, hydro-, gas-fired (combined cycled gas turbines) and wind power.

Following each energy resource description, respondents completed questions on protected values, positive and negative emotions, acceptance, perceived benefits and perceived costs regarding the specific energy resource and trust in operators or owners. Most items were newly formulated for this study. In the few cases in which we could base our items on previous work, the source was cited. All items were assessed on 7-point Likert scales (except when otherwise stated); higher values indicated stronger agreement with the item's statement. For all constructs assessed with more than one item, we calculated the internal reliability and the mean score over the items per construct for each energy resource. We further analysed the resulting scales. Overall, the internal reliabilities of the scales per energy technology were acceptable to high, as reported in Appendix II, Table A.

Three items assessed the extent to which respondents held *protected values* in relation to the energy resource under investigation (see Appendix II, Table A for items, means, standard deviations and internal reliability for each energy source). The items concerned the absoluteness of the issue, quantity insensitivity and the trade-off taboo (cf. Tanner et al., 2009). The first two items indicated the cause of the violation of the protected values (i.e. the expansion/construction of power plants; see Appendix II, Table A) whereas the last item did not specify what caused the violation. This difference may explain the lower relation between this item and the other two (see Appendix II, Table A, corrected item–total correlation). Because of insufficient space on the questionnaire and the expectation that protected values would be less relevant in the case of solar power, we assessed protected values only for nuclear, hydro, gas-fired and wind power.[4]

Three items were included in the questionnaire to assess participants' *positive emotions* regarding each energy technology: pride, satisfaction and enthusiasm. Four items measured *negative emotions* in relation to each energy source: fear, anger, nervousness and threat.[5] Respondents were asked to indicate the extent to which thinking about each energy source evoked these emotions (Appendix II, Table A).

The three *acceptance* items per energy resource referred to the acceptance of constructing more plants or sites (in the case of nuclear power, rebuilding existing nuclear power plants) and the sustainability of the energy resource (Appendix II, Table A). Item 2 for nuclear power was taken from Visschers and Siegrist (2012).

The questionnaire included four items to assess respondents' *perceived benefits* per energy technology, namely, a secure energy supply, climate change mitigation and the price of electricity (Appendix II, Table A). Items 1 and 3 for nuclear power were taken from Visschers and Siegrist (2012).

We used two items to measure the *perceived costs* of each energy technology. These costs concerned the general negative consequences of the energy resource and one particular negative consequence. In the case of solar power, for example, this was scenery disruptions in cities and villages (Appendix II, Table A). The two items relating to nuclear power were taken from Visschers and Siegrist (2012). *Trust* was assessed with one item: the perceived trust of the operators of the sites or plants, or—in the case of solar power—of the owners of the sites (see Appendix II, Table A).

In addition, we used two scales to measure respondents' *energy-security values* and *environmental values*. These items were not related to each energy resource but to energy production in general. The five energy-security value items concerned economic aspects of electricity production and the security of the electricity supply. The four items on environmental values covered environmental protection, future generations and human and environmental safety (Appendix II, Table A). Finally, we asked respondents to report their gender, year of birth and education level.

3.3. Data analysis

First, in order to investigate our respondents' perception of the five energy sources, we conducted analyses of variances (ANOVAs) with repeated measures on acceptance, perceived benefits, perceived costs, trust, protected values, positive emotions and negative emotions with type of energy resource (within-subjects) and gender (between subjects) as independent variables. We included gender as independent variable in the ANOVA as previous

[3] We were able to get a response rate of 37% for our mail survey by stressing in the introductory letter the importance of participating in this survey to get results that represent the Swiss population, the institute conducting the study (which has a very good reputation in Switzerland) and the fact that the data would only serve scientific research. Moreover, we sent a reminder letter and another copy of the questionnaire to addresses that failed to respond at first, again emphasising the importance of obtaining representative data.

[4] We actually included six items to assess protected values in relation to each energy resource. We wanted to limit the questionnaire to 12 pages, including instructions and an introduction to the topic. The latter (see Appendix I) covered half a page. As a result, we had to eliminate one set of items for one energy resource. Because three renewable energy resources were investigated in our survey, we decided to delete one scale for solar power. We chose the protected value scale as we considered the other scales to be more important in predicting the acceptance of an energy resource (remember that we were the first to relate protected values to the acceptance of an energy resource). Internal reliability analyses of the protected value scales for each energy resource showed that only three items resulted in the highest internal reliabilities (see Appendix II, Table A).

[5] We did not calculate an overall emotion scale, including both positive and negative emotions, because we believed that the relations between positive emotions and the acceptance of an energy resource could be of different strengths than the relation between negative emotions and acceptance.

studies revealed gender differences regarding the perception of environmental technologies (Davidson & Freudenburg, 1996). In cases where we found a significant main effect relating to type of energy resource or a significant interaction between gender and energy resource on one of these seven variables, we compared the 95% confidence intervals to determine which combinations between energy resource and gender significantly differed from each other on this variable.

In addition, we tested a two-level hierarchical linear model (HLM) to find out which factors could explain the acceptance of an energy resource and the extent to which the relationship between these factors and acceptance differed between the five energy resources. In HLM, data are collected at different levels of analysis, for example, in a nested design (e.g. pupils nested in schools) or in a repeated-measures design (e.g. various attitudes assessed simultaneously in the same respondents) (Raudenbush & Bryk, 2002; West, Welch, & Galecki, 2006a). A synonym for HLM is the linear mixed model, which refers to the possibility of including both fixed effects and random effects in the regression model (i.e. a mixed model). Fixed effects are regression coefficients for which all values are theoretically present in the dataset. Random effects can be added to the fixed effects when it is expected that there is a random deviation in the relation between a dependent variable and a fixed effect. This can be a random deviation on an intercept or on the slope of a fixed effect.

We used a repeated measures design as all respondents were asked to evaluate their acceptance, perceived benefits, perceived costs, trust etc. for all five energy resources. We conducted the analyses in several steps, using a top-down approach, and evaluated the quality of the models at each step (West, Welch, & Galecki, 2006b). In order to analyse the interactions, all predictors were centred on their respective grand means before entering them into the model. Our first level of analysis was the acceptance of each energy resource; the second level of analysis was the respondent. Before analysing the HLM in HLM7 (Raudenbush et al., 2011), we applied the expectation-maximization (EM) algorithm to replace missing values using SPSS 20.0 (IBM Corp., 2011). The values of the items in the respective construct were used to estimate the missing values.

In Step 1, we entered all fixed effects, covariates and interactions between them. Level 1 therefore included type of energy resource, perceived benefits of the energy resource, its perceived costs, trust in the operator/owner, positive emotions and negative emotions, and these were regressed on the acceptance of the respective energy resource (see Table 1). The five energy resources were recoded into four dummy variables with hydro-power as a reference group. Level 2 included two personal characteristics, namely, energy-security values and environmental values.[6] The relations between the predictors and acceptance and between the interaction effects and acceptance were examined by means of the 95% confidence intervals (*95% CI*) around the unstandardized coefficient. If the value of 0 was not

Table 1
Means (and standard errors) of perception variables per energy source (ER), and for men and women, including the multivariate test results of ANOVAs with repeated measures.

Energy resources	Acceptance				Perceived benefits				Perceived costs				Positive emotions				Negative emotions				Trust				Protected values			
	Men		Women		Men		Women		Men		Women		Men		Women		Men		Women		Men		Women		Men		Women	
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Solar	5.81	(.06)^{b}	6.19	(.07)^{a}	4.13	(.06)^{e}	4.61	(.08)^{c,d}	2.74	(.06)^{e}	2.37	(.08)^{f}	4.52	(.07)^{b,c}	4.81	(.10)^{a,b}	1.44	(.04)^{g}	1.30	(.05)^{g}	4.81	(.08)^{b}	5.14	(.10)^{a,b}	*n/a*		*n/a*	
Nuclear	4.08	(.07)^{e}	3.79	(.10)^{e}	4.40	(.06)^{d}	3.88	(.09)^{e}	4.29	(.07)^{b}	4.74	(.10)^{b}	2.52	(.06)^{e}	1.99	(.09)^{f}	3.62	(.08)^{b}	4.35	(.11)^{a}	3.38	(.09)^{c}	2.73	(.12)^{d,e}	3.80	(.08)^{b}	4.37	(.10)^{a}
Hydro-	6.09	(.05)^{a}	5.62	(.07)^{b,c}	5.31	(.05)^{a}	4.90	(.07)^{b}	2.73	(.06)^{e}	3.21	(.09)^{c,d}	4.99	(.07)^{a}	4.38	(.09)^{c}	1.77	(.04)^{d,e}	1.87	(.06)^{d}	5.38	(.07)^{a}	4.82	(.09)^{b}	2.25	(.05)^{d}	2.58	(.07)^{c}
Gas-fired	3.07	(.07)^{f}	3.02	(.09)^{f}	2.93	(.05)^{f}	2.92	(.07)^{f}	5.21	(.07)^{a}	5.27	(.09)^{a}	2.05	(.05)^{f}	1.92	(.07)^{f}	3.00	(.08)^{c}	3.42	(.11)^{b}	2.88	(.07)^{d}	2.40	(.10)^{e}	4.30	(.08)^{a}	4.42	(.10)^{a}
Wind	5.15	(.07)^{d}	5.42	(.10)^{c,d}	4.50	(.06)^{c,d}	4.76	(.08)^{b,c}	3.48	(.07)^{c}	3.15	(.09)^{d}	4.01	(.08)^{d}	4.17	(.12)^{c,d}	1.63	(.05)^{e,f}	1.52	(.06)^{f,g}	4.89	(.08)^{b}	5.02	(.11)^{b}	2.59	(.07)^{c}	2.42	(.09)^{c,d}
F_{ER} (*df1, df2*)	(4, 3160) 580.57***				(4, 3160) 276.30***				(4, 3144) 415.48***				(4, 3048) 651.95***				(4, 3000) 633.44***				(4, 3116) 375.13***				(3, 2382) 350.40***			
F_{gender} (*df1, df2*)	(1, 790) .480				(1, 790) .91				(1, 786) 1.05				(1, 762) 5.18*				(1, 750) 10.88**				(1, 779) 12.33***				(1, 794) 11.29***			
$F_{ER*gender}$ (*df1, df2*)	(4, 3160) 11.44***				(4, 3160) 19.07***				(4, 3144) 13.76***				(4, 3048) 28.17***				(4, 3000) 16.58***				(4, 3116) 12.81***				(3, 2382) 8.12***			

Note. Mean values with different superscripts within the same construct imply that the respective energy resources (and possibly women and men) differ on this construct, $p < .05$.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

[6] Since previous studies had shown that of the demographic variables, mainly gender was related to the acceptance of an energy resource (e.g. Ansolabehere & Konisky, 2009; Davidson & Freudenburg, 1996; Hobman & Ashworth, 2013), we included gender in the ANOVAs to investigate whether acceptance, perceived benefits etc. (see Table 1) differed between different energy resources. The results showed that gender significantly interacted with energy resource on perceived benefits, perceived costs and other predictors (see Table 1). This implied that if we wanted to add gender as a predictor in our HLM, we would have to include it as a fixed effect and in interactions with each energy resource as well as in interactions with energy resources and each predictor. This would result in 25 additional coefficients to estimate in our HLM and would drastically increase the probability of a Type 1 error. Consequently, we decided to omit gender and other demographic variable from our HLM.

included in the *95% CI*, this meant that the respective fixed effect or interaction effect was significantly related to the acceptance of energy resources. Moreover, if the *95% CI*s of different fixed effects or interactions did not overlap, this meant that the coefficients of these factors were significantly different in relation to acceptance.

We added a random intercept to the model in Step 2. In Step 3, we tested whether these predictors had different relations with acceptance depending on the type of energy resource they related to. Hence, we included the interactions between energy resource (i.e. their dummies) and perceived benefits, perceived costs, trust, positive emotions and negative emotions at level 1. We also added personal values to the slopes of the energy resources at level 2, namely energy-security and environmental values.

Last, we wanted to control for the specific evaluation patterns of the energy resources from our respondents, that is, person-specific evaluations of energy resources. Therefore, at Step 4, we included random slopes for each energy resource at level 2. Because the models were nested, we compared the model fit at each step to that of the previous step using a likelihood ratio test, that is, the −2 maximum likelihood (ML) estimates of the respective models were compared in a chi-square test.

To examine whether protected values affected the acceptance of an energy resource, we again used HLM. This time, we excluded solar power as protected values were not measured for this energy resource. In the first step of the analysis, all perception variables (except protected values) and values were included as fixed factors and as interactions in the model (see Step 3 of the previous HLM analysis). In Step 2, we added protected values and their interactions with nuclear, gas-fired and wind power (hydro-power was the reference category) as fixed effects. In Step 3, random slopes were added to the slopes of each energy resource at level 2. Again, the model fit at each step was compared to that of the previous step using a likelihood ratio test, that is, the -2ML estimates of the respective models were compared in a chi-square test.

4. Results

4.1. Perceptions of the five energy resources

The five energy resources had different levels of acceptance, perceived benefits, perceived costs, positive emotions, negative emotions, trust and protected values, *Fs* > 348.74, *ps* < .0001. A post-hoc analysis of the acceptance of energy resources showed that acceptance was highest for solar power and hydro-power. Men showed highest acceptance for hydro-power and women for solar power and (see Table 1). This was followed by the acceptance of wind power among men and women. The acceptance of nuclear power was again lower than the latter three. The acceptance of gas-fired power was the lowest of all five energy sources.

Respondents perceived the highest benefits from hydro-power, and were higher than those of women (see Table 1). The perceived benefits of wind power were significantly less than those of hydro-power. Perceived benefits of solar and nuclear power were lower than those of wind and hydro-power but appeared equal to each other. Men saw more benefits in nuclear power than women, and women perceived higher benefits in solar power than men. Both men and women perceived the lowest benefits from gas-fired power plants.

The patterns of the results for perceived costs, positive emotions, negative emotions and trust were comparable. In each of these variables, the three renewable energy resources were evaluated more positively (e.g. high trust and low negative emotions) than nuclear power and gas-fired power among both men and women (see Table 1). Respondents associated the highest costs with gas-fired power plants and the most negative emotions with nuclear power plants. Additionally, wind power did not evoke the same high level of positive emotions as hydro-power and solar power. Respondents held stronger protected values regarding gas-fired power and nuclear power than hydro-power and wind power (see Table 1). The highest level of protected values was reported for gas-fired power.

4.2. Explaining acceptance of the five energy resources

The results of the basic model at Step 1 were in line with *Hypothesis 1*: perceived benefits, trust and positive emotions significantly increased the acceptance of an energy resource, *ts* > 10.31, *ps* < .001 whereas perceived costs and negative emotions significantly decreased the acceptance of an energy resource, *ts* < −9.93, *ps* < .001. Moreover, perceived benefits was a stronger predictor of acceptance (β_{10} = .45, *95% CI* [.42; .48]) than perceived costs (β_{20} = −.15, *95% CI* [−.18; −.12]), positive emotions (β_{30} = .15, *95% CI* [.12; .18]), negative emotions (β_{40} = −.14, *95% CI* [−.17; −.11]) and trust (β_{50} = .14, *95% CI* [.11; .17]). Compared to hydro-power, solar power significantly increased acceptance (β_{60} = .37, *95% CI* [.30; .45]) whereas nuclear power (β_{70} = −.34, *95% CI* [−.44; −.24]), gas-fired power (β_{80} = −.57, *95% CI* [−.67; −.48]) and wind power (β_{90} = −.25, *95% CI* [−.32; −.18]) significantly decreased acceptance. In addition, stronger energy security values resulted in the significantly lower acceptance of an energy resource (β_{01} = −.04, *95% CI* [−.06; −.01]) whereas environmental values significantly increased the acceptance of an energy resource (β_{02} = .06, *95% CI* [.02; .10]).

The inclusion of the random intercept (Step 2) resulted in a significantly better model fit than the basic model (Step 1), $\Delta\chi^2(1) = 125.00$, $p < .001$ (see Table 2). Thus, accounting for person-specific differences in the acceptance of energy resources seemed worthwhile.

In Step 3, we tested whether the attitudinal variables and values would have different relations with acceptance depending on the energy resource evaluated. The inclusion of the interactions between the energy resources and the perception variables (level 1) as well as the addition of energy-security and environmental values to the slopes of the dummies of the energy resources (level 2) resulted in a significantly better model fit than the previous model (Step 2), $\Delta\chi^2(40) = 338.20$, $p < .001$ (see Table 2).

Last, the inclusion of random slopes for the energy resources (Step 4) also significantly improved the model fit, $\Delta\chi^2(14) = 148.75$, $p < .001$ (see Tables 2–4). Thus, person-specific differences in the acceptance of each energy resource resulted in a better explanation of the acceptance of specific energy resources.

Table 2
Model statistics of the HLM analyses to explain acceptance of hydro-, solar, nuclear, gas-fired and wind power, per step.

Model	*-2LL ML*	*Nr. of parameters*	$\Delta\chi^2$	*df*	σ^2	*PVE*
Step 1: All fixed effects at Level 1 and Level 2	11,025.18	1			.75	
Step 2: Random intercept added	10,900.18	2	125.00***	1	.65	.13
Step 3: Interactions at Level 1 and Level 2 added	10,561.98	42	338.20***	40	.61	.06
Step 4: Random slopes added	10,413.24	56	148.75***	14	.41	.33

Note. *−2LL ML* = −2 log likelihood of maximum likelihood, $\Delta\chi^2$ = difference between *−2LL ML* of current model and *−2LL ML* of previous model, σ^2 = residual variance; *PVE* = Proportion Variance Explained compared to previous step = $(\sigma^2_{model\ 1} - \sigma^2_{model\ 2})/\sigma^2_{model\ 1}$. ***$p < .001$.

Table 3
Final estimations of fixed effects (with robust *SEs*) in Step 4 of the HLM analyses on acceptance of hydro- (reference group), solar, nuclear, gas-fired and wind power.

Fixed effects[a]	*Coefficient*	*SE*	*t-ratio*	*Approx. df*	*95% CI*
For Intercept 1, π_0					
Intercept 2, β_{00}	5.28	.19	27.36***	856	4.90; 5.65
Energy-security values, β_{01}	−.07	.02	−3.02**	856	−.12; −.03
Environmental values, β_{02}	.07	.03	2.43*	856	.01; .12
For Perceived benefits slope, π_1, Intercept 2, β_{10}	.45	.03	14.58***	4270	.39; .51
For Perceived costs slope, π_2, Intercept 2, β_{20}	−.18	.02	−7.68***	4270	−.23; −.14
For Positive emotions slope, π_3, Intercept 2, β_{30}	.12	.02	5.61***	4270	.08; .17
For Negative emotions slope, π_4, Intercept 2, β_{40}	−.11	.03	−3.17**	4270	−.17; −.04
For Trust Slope, π_5, Intercept 2, β_{50}	.11	.03	3.94***	4270	.05; .16
For Solar slope, π_6					
Intercept 2, β_{60}	.91	.30	2.97**	856	.31; 1.50
Energy-security values, β_{61}	−.03	.03	−.98	856	−.09; .03
Environmental values, β_{62}	.04	.04	.97	856	−.04; .12
For Nuclear slope, π_7					
Intercept 2, β_{70}	−1.00	.39	−2.54*	856	−1.77; −.23
Energy-security values, β_{71}	.23	.04	5.87***	856	.15; .31
Environmental values, β_{72}	−.12	.05	−2.55*	856	−.20; −.03
For Gas slope, π_8					
Intercept 2, β_{80}	−1.44	.29	−5.01***	856	−2.00; −.88
Energy-security values, β_{81}	.04	.03	1.41	856	−.02; .10
Environmental values, β_{82}	.03	.04	.71	856	−.05; .10
For Wind slope, π_9					
Intercept 2, β_{90}	−.99	.31	−3.20***	856	−1.60; −.38
Energy-security values, β_{91}	−.02	.03	−.71	856	−.08; .04
Environmental values, β_{92}	−.01	.04	−.28	856	−.09; .07
For Solar*Perceived benefits slope, π_{10}, Intercept 2, β_{100}	−.19	.04	−4.54***	4270	−.27; −.11
For Solar*Perceived costs slope, π_{11}, Intercept 2, β_{110}	.05	.04	1.28	4270	−.03; .13
For Solar*Trust slope, π_{12}, Intercept 2, β_{120}	.05	.03	1.46	4270	−.02; .12
For Solar*Positive emotions slope, π_{13}, Intercept 2, β_{130}	.02	.03	.67	4270	−.04; .09
For Solar*Negative emotions slope, π_{14}, Intercept 2, β_{140}	−.14	.06	−2.53*	4270	−.25; −.03
For Nuclear*Perceived benefits slope, π_{15}, Intercept 2, β_{150}	.00	.05	.00	4270	−.09; .09
For Nuclear*Perceived costs slope, π_{16}, Intercept 2, β_{160}	.10	.05	2.01*	4270	.00; .19
For Nuclear*Trust slope, π_{17}, Intercept 2, β_{170}	.01	.04	.13	4270	−.08; .09
For Nuclear*Positive emotions slope, π_{18}, Intercept 2, β_{180}	.01	.04	.14	4270	−.07; .08
For Nuclear*Negative emotions slope, π_{19}, Intercept 2, β_{190}	.01	.05	.21	4270	−.08; .10
For Gas*Perceived benefits slope, π_{20}, Intercept 2, β_{200}	.11	.05	2.30*	4270	.02; .19
For Gas*Perceived costs slope, π_{21}, Intercept 2, β_{210}	.03	.04	.77	4270	−.04; .10
For Gas*Trust slope, π_{22}, Intercept 2, β_{220}	.09	.04	2.35*	4270	.01; .17
For Gas*Positive emotions slope, π_{23}, Intercept 2, β_{230}	.07	.04	1.86	4270	.00; .14
For Gas*Negative emotions slope, π_{24}, Intercept 2, β_{240}	−.03	.04	−.73	4270	−.10; .05
For Wind*Perceived benefits slope, π_{25}, Intercept 2, β_{250}	.02	.04	.53	4270	−.06; .11
For Wind*Perceived costs slope, π_{26}, Intercept 2, β_{260}	.03	.04	.77	4270	−.04; .10
For Wind*Trust slope, π_{27}, Intercept 2, β_{270}	.05	.04	1.32	4270	−.02; .12
For Wind*Positive emotions slope, π_{28}, Intercept 2, β_{280}	.08	.03	2.69*	4270	.02; .14
For Wind*Negative emotions slope, π_{29}, Intercept 2, β_{290}	−.03	.05	−.57	4270	−.12; .06

Note. All continuous independent variables were centralized.
$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.
[a] Solar, nuclear, gas and wind power were dummy variables: the category hydro-power was the reference group.

In this final model, the perception items had all their expected effects: perceived benefits, trust and positive emotions significantly increased the acceptance of an energy resource whereas perceived costs and negative emotions significantly decreased the acceptance of an energy resource (see Table 3 for the coefficients, *SE*s, *t*-ratios and 95% CIs). Perceived benefits still showed the strongest relation with acceptance. Energy-security values generally decreased acceptance while environmental values increased acceptance. In the next section, we discuss whether the perception variables and values had different relations with the acceptance of different energy resources.

4.3. Comparing predictors between acceptance models for the five energy resources

We compared the relations between acceptance and the predictors using the *95% CIs* around the unstandardized coefficients of the predictors. Several differences between the predictors were found. We recall that hydro-power was the reference group for the predictors that included an energy resource. For example, the interaction effect between solar power and perceived benefits on acceptance should be viewed with respect to the relation between perceived benefits for hydro-power on acceptance.

Perceived benefits had a stronger impact on the acceptance of gas power ($\beta_{10} + \beta_{230} = .45 + .11 = .56$) than on the acceptance of hydro-power ($\beta_{10} = .45$), see Table 3) and of nuclear and wind power (see non-significant *95% CIs* for β_{150} and β_{250} in Table 3). Conversely, the relation between acceptance and perceived benefits was less strong for solar power ($\beta_{10} + \beta_{100} = .45 - .19 = .26$) than for hydro-power ($\beta_{10} = .45$) and for nuclear and wind power. Nevertheless, perceived benefits remained the strongest predictor of the acceptance of solar power.

There was also a significant positive interaction effect between nuclear power and perceived costs on acceptance (see Table 3). Because the initial relation between perceived costs and the acceptance of hydro-power was negative, an additional positive relation between perceived costs and the acceptance of nuclear power meant that perceived costs were less strongly related to acceptance in the

Table 4
Results for the random effects in Step 4 of the HLM analyses on acceptance of hydro-solar, nuclear, gas-fired and wind power.

Random effect	*SD*	*Variance component*	*df*	χ^2
Intercept 1, r_0	.36	.13	856	1128.41***
Solar slope, r_6	.32	.11	856	966.75**
Nuclear slope, r_7	.78	.61	856	1493.15***
Gas slope, r_8	.37	.14	856	999.52***
Wind slope, r_9	.39	.15	856	1015.22***
Level-1, *e*	.65	.42		

*$p < .05$, **$p < .01$, ***$p < .001$.

case of nuclear power ($\beta_{20} + \beta_{160} = -.18 + .10 = .08$) compared to hydro-power ($\beta_{20} = -.18$) and solar, gas-fired and wind power (see *95% CIs* in Table 3).

Trust was a relatively stronger predictor of the acceptance of gas-fired power ($\beta_{50} + \beta_{220} = .11 + .09 = .20$) than of hydro-power ($\beta_{50} = .11$, see Table 3) and of solar, nuclear and wind power (see *95% CIs* in Table 3). Positive emotions were more strongly related to the acceptance of wind power ($\beta_{30} + \beta_{280} = .12 + .08 = .20$) than to the acceptance of hydro-power ($\beta_{30} = .13$) and that of solar, nuclear and gas-fired power (see *95% CIs* in Table 3). Last, we noticed that negative emotions had a stronger relation with the acceptance of solar power ($\beta_{40} + \beta_{140} = -.11 – .14 = -.25$) than with the acceptance of hydro-power ($\beta_{40} = -.11$) and that of nuclear, wind and gas-fired power (see Table 3).

Energy-security values had a positive impact on the acceptance of nuclear power ($\beta_{03} + \beta_{73} = -.07 + .23 = .16$) whereas they had a minor negative impact on the acceptance of hydro-power ($\beta_{03} = -07$), as was the relation between energy-security values and acceptance of solar, gas-fired and wind power (see *95% CIs* in Table 3). Similarly, environmental values only had a significant interaction with nuclear power on acceptance (see Table 3). After adding the negative coefficient of this interaction to the overall coefficient for environmental values, it became clear that environmental values actually had a smaller relation with the acceptance of nuclear power ($\beta_{04} + \beta_{74} = .07 – .12 = -.05$) than with that of hydro-power ($\beta_{04} = .07$) and the other energy resources (see Table 3). However, because the coefficients of environmental values were rather low, we should not place too much weight on the differences.

4.4. *Impact of protected values*

We then extended our model to explain the acceptance of nuclear power, hydro-power, gas-fired power and wind power even further by including protected values and their interactions with each energy resource as fixed effects in a next step to predict the acceptance of an energy resource, again with centralized values as predictors. The addition of protected values significantly improved the model fit and increased the explained variances, $\Delta\chi^2(4) = 2361.39$, $p < .001$, $PVE = .05$ (see Step 2, Table 5). Moreover, the inclusion of random slopes for the energy resources significantly improved the model fit, $\Delta\chi^2(9) = 106.89$, $p < .001$, $PVE = .86$ (see Tables 5–7). Protected values appeared to significantly reduce the acceptance of an energy resource ($\beta_{60} = -.22$, *95% CI* [$-.28$; $-.16$]). They did not significantly interact with any of the energy technologies (see Table 6), and were thus not differently related to the acceptance of different energy resources. The other variables (i.e. perceived benefits, perceived costs, trust, positive emotions, negative emotions, energy-security and environmental values) had similar relations with acceptance as before protected values were included (see Table 6). The only difference between the HLM without protected values (see Table 3) and the latter analysis was that the interaction between nuclear power and perceived costs was no longer significant in the HLM which included protected values ($\beta_{110} = .08$, *95% CI* [-.01; .17], see Table 6).

5. Discussion

Relatively few studies have investigated the public's perception of various energy resources in a comparative setting with the use of a comprehensive explanatory model. Moreover, little was known about the role of protected values in the public's acceptance of an energy resource. We conducted a mail survey to investigate the Swiss public's perception of solar, nuclear, hydro, gas-fired and wind power. Moreover, we investigated the impact of a broad range of psychosocial factors on the acceptance of these five energy resources, including values, emotions, trust, perceived costs, perceived benefits and protected values in relation to the energy technology.

In what follows, we discuss the differences in the acceptance levels of the five energy technologies, evaluate our comprehensive model to explain the acceptance of different energy technologies and justify why protected values are important considerations in explaining the acceptance of an energy technology. We then critically evaluate our own study and make suggestions for future research.

5.1. *Positive perceptions of hydro-power and rather negative perceptions of gas-fired power*

Our results showed that similar to previous studies (e.g. Ertör-Akyazı et al., 2012; Spence et al., 2010; Tampakis et al., 2013; Truelove, 2012), the renewable energy resources of solar, wind and hydro-power received the highest levels of acceptance. In particular, the expansion of hydro-power plants was positively evaluated by our respondents. Compared to the other two renewable energy sources, hydro-power was associated with the highest benefits and lowest costs, and their operators were seen as most trustworthy. Hydro-power plants are omnipresent and produce most of Switzerland's electricity. Swiss people are therefore familiar with such plants and experience them as reliable energy sources, which probably explains the very positive evaluation of hydro-power. On the other hand, the 'new' renewables are less familiar among the Swiss public, which may explain their lower trust ratings compared to hydro-power. Moreover, the lower perceived benefits of solar power and the higher perceived costs of wind power in our study imply that people perceive solar power as a less reliable energy supply than hydro-power and that wind power is associated with a higher local environmental impact than hydro-power.

Contrary to most previous studies, we found that gas-fired power plants were rated more negatively than nuclear power plants (Ansolabehere & Konisky, 2009; Ertör-Akyazı et al., 2012; Greenberg, 2009a; Spence et al., 2010; Truelove, 2012). The perception of nuclear power was not as negative as may be expected since the Swiss government has decided to phase out nuclear power in the next years. For example, the acceptance and perceived benefits ratings of nuclear power were around the midpoint of their scales.

The negative evaluation of gas-fired power plants may be the result of three factors. First, as mentioned above, it may have to do with Swiss people's low familiarity with this type of energy resource since there are currently no gas-fired power plants in the country. A second explanation may be that this type of energy resource emits CO_2. Currently, Swiss electricity production is CO_2 neutral. This prospective change may result in low perceived climate benefits and high perceived environmental costs. Third,

Table 5
Model statistics of HLM to explain acceptance of hydro-, nuclear, gas-fired and wind power, including protected values as predictor, per step.

Model	-2LL ML	Nr. of parameters	$\Delta\chi^2$	df	σ^2	PVE
Step 1: All fixed effects and interactions at Level 1 and Level 2	10,630.12	34			.62	
Step 2: Fixed effect of protected values and interactions protected values* energy resources added	8268.73	38	2361.39***	4	.59	.05
Step 3: Random slopes added	8161.84	47	106.89***	9	.08	.86

Note. $-2LL\ ML = -2$ log likelihood of maximum likelihood, $\Delta\chi^2$ = difference between $-2LL\ ML$ of current model and $-2LL\ ML$ of previous model, σ^2 = residual variance; *PVE* = Proportion Variance Explained compared to previous step = $(\sigma^2_{model\ 1} - \sigma^2_{model\ 2})/\sigma^2_{model\ 1}$. ***$p < .001$.

gas-fired power plants would make Switzerland more dependent on other countries for its gas supply. In short, if gas-fired power plants were currently introduced in Switzerland, the public would very likely oppose them. More research is needed to determine the extent to which familiarity or environmental and energy-security beliefs affect people's perception of an unknown energy technology.

5.2. A comprehensive model explaining acceptance of different energy resources

The second aim of our study was to investigate whether a general model can be used to explain the acceptance of different energy technologies. Overall, our findings showed that one comprehensive model was able to explain a considerable part of the acceptance of specific energy resources. In line with *Hypothesis 1*, each of the perception variables was significantly related to the acceptance of an energy resource. Moreover, *Hypothesis 2* was also confirmed as perceived benefits related most strongly of all variables to the acceptance of each of the five energy technologies. The impact of trust, emotions and values on acceptance was significant but relatively low compared to the perception variables. It may be that the relations between trust and acceptance, and between affect and acceptance, are moderated by perceived risks and benefits and therefore appeared smaller when all variables were considered in the same model. The indirect relations between trust and acceptance and affect and acceptance were also revealed in a study on the acceptance of nuclear power (Visschers et al., 2011).

Table 6
Final estimations of fixed effects (with robust *SE*s) in Step 3 of the hierarchical linear mixed model analyses on acceptance of hydro- (reference group), nuclear, gas-fired and wind power, including protected values.

Fixed effects[a]	*Coefficient*	*SE*	*t-ratio*	*Approx. df*	*95% CI*
For Intercept 1, π_0					
Intercept 2, β_{00}	5.27	.15	34.07***	856	4.96; 5.57
Energy-security values, β_{01}	−.05	.02	−2.25*	856	−.09; −.01
Environmental values, β_{02}	.08	.03	2.98**	856	.03; .13
For Perceived benefits slope, π_1, Intercept 2, β_{10}	.41	.03	13.70***	3412	.35; .47
For Perceived costs slope, π_2, Intercept 2, β_{20}	−.14	.02	−5.95***	3412	−.19; −.10
For Positive emotions slope, π_3, Intercept 2, β_{30}	.12	.02	5.78***	3412	.08; .16
For Negative emotions slope, π_4, Intercept 2, β_{40}	−.06	.03	−1.91	3412	−.13; .00
For Trust slope, π_5, Intercept 2, β_{50}	.09	.03	3.62***	3412	.04; .14
For Protected values slope,, π_6, Intercept 2, β_{60}	−.22	.03	−7.29***	3412	−.28; −.16
For Nuclear slope, π_7					
Intercept 2, β_{70}	−.50	.40	−1.28	856	−1.28; .27
Energy-security values, β_{71}	.22	.04	6.05***	856	.15; .29
Environmental values, β_{72}	−.10	.04	−2.27*	856	−.18; −.01
For Gas slope, π_8					
Intercept 2, β_{80}	−1.42	.30	−4.72***	856	−2.02; −.83
Energy-security values, β_{81}	.04	.03	1.50	856	−.01; .10
Environmental values, β_{82}	−.01	.04	−.15	856	−.08; .07
For Wind slope, π_9					
Intercept 2, β_{90}	−1.04	.32	−3.26***	856	−1.67; −.41
Energy-security values, β_{91}	−.02	.03	−.49	856	−.08; .05
Environmental values, β_{92}	−.03	.04	−.86	856	−.10; .04
For Nuclear*Perceived benefits slope, π_{10}, Intercept 2, β_{100}	−.04	.05	−.93	3412	−.13; .05
For Nuclear*Perceived costs slope, π_{11}, Intercept 2, β_{110}	.08	.05	1.78	3412	−.01; .17
For Nuclear*Trust slope, π_{12}, Intercept 2, β_{120}	.01	.04	.25	3412	−.07; .09
For Nuclear*Positive emotions slope, π_{13}, Intercept 2, β_{130}	−.01	.04	−.36	3412	−.09; .06
For Nuclear*Negative emotions slope, π_{14}, Intercept 2, β_{140}	.02	.05	.42	3412	−.07; .11
For Nuclear*Protected values slope, π_{15}, Intercept 2, β_{150}	−.03	.04	−.78	3412	−.11; .05
For Gas*Perceived benefits slope, π_{16}, Intercept 2, β_{160}	.11	.05	2.37*	3412	.02; .20
For Gas*Perceived costs slope, π_{17}, Intercept 2, β_{170}	.05	.04	1.21	3412	−.03; .12
For Gas*Trust slope, π_{18}, Intercept 2, β_{180}	.07	.04	2.00*	3412	.00; .14
For Gas*Positive emotions slope, π_{19}, Intercept 2, β_{190}	.04	.03	1.15	3412	−.03; .11
For Gas*Negative emotions slope, π_{20}, Intercept 2, β_{200}	−.03	.04	−.74	3412	−.10; .05
For Gas*Protected values slope, π_{21}, Intercept 2, β_{210}	.03	.04	.88	3412	−.04; .10
For Wind*Perceived benefits slope, π_{22}, Intercept 2, β_{220}	.03	.04	.63	3412	−.06; .11
For Wind*Perceived costs slope, π_{23}, Intercept 2, β_{230}	.04	.04	1.18	3412	−.03; .11
For Wind*Trust slope, π_{24}, Intercept 2, β_{240}	.03	.04	.96	3412	−.04; .10
For Wind*Positive emotions slope, π_{25}, Intercept 2, β_{250}	.09	.03	3.00**	3412	.03; .15
For Wind*Negative emotions slope, π_{26}, Intercept 2, β_{260}	−.03	.05	−.67	3412	−.13; .06
For Wind*Protected values slope, π_{27}, Intercept 2, β_{270}	.02	.04	.43	3412	−.06; .10

Note. All continuous independent variables were centralized.
*$p < .05$, **$p < .01$, ***$p < .001$.
[a] Nuclear, gas and wind power were dummy variables; hydro-power was the reference group.

Table 7
Results for the random effects in Step 3 of the HLM analyses on acceptance of hydropower, nuclear, gas-fired and wind power, including protected values.

Random effect	*SD*	*Variance component*	*df*	χ^2
Intercept 1, r_0	.65	.42	856	5213.92***
Nuclear slope, r_7	1.07	1.14	856	6817.87***
Gas slope, r_8	.87	.75	856	4812.45***
Wind slope, r_9	.88	.77	856	4881.64***
Level-1, *e*	.29	.08		

*$p < .05$, **$p < .01$, ***$p < .001$.

Environmental and energy-security values are rather general constructs and not specifically related to the energy resource under investigation. Therefore, they may have had small impacts on acceptance because their impact on acceptance was moderated by the perception variables. However, to prove this assumption, further research and analyses are needed, for example, using structural equation modelling, which unfortunately went beyond the scope of this article.

In addition to the good fit of the general model, we found some differences between the impacts of the same predictors on the acceptance of different energy technologies, thereby confirming *Hypothesis 3*. Perceived benefits was more strongly related to the acceptance of gas-fired power than to acceptance of the other energy sources, This relation was also smaller for solar power than for the other energy resources. We believe that these findings reflect the level of agreement among people regarding the perceived benefits of energy technologies; more agreement implies less variance between people and thus less opportunity for perceived benefits to explain differences between people regarding their acceptance. Studies in which affective images for different energy resources were investigated are in line with this assumption: people's associations with renewable energy resources are rather alike and very positive (Truelove, 2012). Similarly, the relation between perceived costs and the acceptance of nuclear power was significantly smaller than for the other energy resources. It is probable that most people are aware of the costs of nuclear power because of the negative media attention around this energy resource.

The relations between values and acceptance also differed between the energy resources. Stronger energy-security values increased the acceptance of nuclear power whereas they slightly decreased the acceptance of the other energy resources. Environmental values, on the other hand, slightly reduced the acceptance of nuclear power but slightly increased it for solar, hydro- gas-fired and wind power, which corresponds to the findings of Hobman and Ashworth (2013). The differing impacts of values show that people have various underlying motivations to support different energy resources.

5.3. The role of protected values

The extent to which respondents held protected values with respect to specific energy technologies seemed to significantly reduce the acceptance of all five energy technologies. This finding confirmed *Hypothesis 4*. The finding that protected values also reduced the acceptance of renewable energy resources may come as a surprise since one would expect that people would not hold protected values in relation to these resources. The relatively low mean scores for this construct confirmed this (see Table 2). The result may imply that if, for some reason, an energy technology project violates people's core values, this can considerably reduce its level of acceptance. Moreover, protected values were related to acceptance despite the fact that our models already included factors that may have been related to protected values, such as perceived costs, perceived benefits and negative and positive emotions. Protected values thus seem to be a unique predictor of the acceptance of any energy source.

5.4. Critical remarks and suggestions for further research

Three limitations of our study should be discussed. First, Switzerland has a very specific energy portfolio; there are currently no fossil fuel plants in operation. As the comparison between our findings and those of studies in countries with running fossil fuel plants showed, this complicates generalizing our results regarding the perception of the different energy technologies to countries with different energy portfolios. On the other hand, our findings revealed that with the introduction of an unknown energy technology in a country, one should not expect the public to have the same perception of this resource as in other countries; this issue should be examined in detail. Nevertheless, since information processing and attitudes formation are universal human characteristics, we expect that the relations between the perception variables and values on the one hand and the acceptance of an energy resource on the other will be the same in other countries.

Second, although we based the choice of predictors included in our acceptance models on existing frameworks and previous studies, we had to select amongst them. Hence, we may not have included certain factors that would have been highly relevant in explaining the acceptance of an energy source, such as knowledge or social norms (Huijts et al., 2012). The high explained variances of our models, however, imply that we did not miss any essential factors. We also had to make a trade-off between the correspondence of the items between the different energy resources and their suitability for each energy resource. We therefore had to include a few items that were slightly different between the five energy resources (e.g. the second item of the perceived costs construct, see Appendix II, Table A). Moreover, we had to form scales with suboptimal internal reliabilities for some energy sources.

Future research should therefore investigate the perception of various energy sources in different countries to confirm our comprehensive model and to test the validity of the items and scales used. In addition, it would be useful to examine the kinds of values that are violated by the construction or expansion of different energy production facilities; are these mainly environmental values, or can such a prospect also affect energy-security and economic values? Future research should also investigate the impact of protected values on actual decisions concerning energy resources. For example, to what extent are consumers with protected values in relation to a particular energy resource not willing to make trade-offs between portfolios that include this energy source? This would be especially relevant to facilitating communication with people who hold strong protected values.

6. Conclusions and implications

This study shows that it is appropriate to use one comprehensive model to investigate people's acceptance of different energy sources. Such a model should include emotions and trust and, more importantly, perceived benefits and costs.

We discovered only small differences between the same predictors to explain the public's acceptance of different energy resources. To garner support for the relatively unknown and unpopular resource of gas-fired power, it appeared even more important to highlight the benefits and the trustworthiness of the responsible authorities and to induce positive emotions.

Since one and the same model can explain the acceptance of different energy resources, we suggest that similar approaches can be used to change people's acceptance of different energy sources. One should mainly focus on the resource's advantages, for example, by promoting them, as the acceptance of an energy source is mostly determined by the perceived benefits. Emotions and trust in responsible authorities may indirectly change people's opinion of an energy technology and should therefore also be addressed in communications with the public and when investigating the feasibility of an energy technology project. Moreover, we recommend taking protected values into account in efforts to explain people's acceptance of energy sources and in developing a communications plan for a local energy project. Protected values should not only be considered with respect to controversial energy resources, such as nuclear power, but also for energy resources that have a more positive image, such as wind power. In short, we can conclude that with respect to the acceptance of various energy resources, one model fits all.

Appendix I

Information about the five energy resources given to the respondents in the questionnaire

(Please note that respondents answered several questions about each energy resource before reading the next scenario).

Introduction

Switzerland faces big changes in its electricity production if its current nuclear power plants are not replaced after they reached the end of their operating times. Even if electricity consumption can be significantly reduced due to more energy efficiency, Switzerland will also need new power plants to fill the gap in electricity production, which will be caused by the nuclear phase out. We are therefore interested in your opinion about several energy resources.

In this questionnaire, five energy resources are described in scenarios. We would like to ask you to answer several questions for each scenario. Please imagine for each scenario that it applies to Switzerland and that all factors that are not described in the scenario will remain as they currently are.

Solar power

Current situation: *More than 10,000 solar power sites are installed on Swiss roofs and facades.*
Output 2011: *0.24% of the total electricity production in Switzerland.*
Future: *After the nuclear phase out, the aim is that solar panels produce about 3% of the total electricity production in 2035. This implies an expansion of solar panels to a surface of about 23 km^2.*
Advantages: - *Solar panels do not produce any greenhouse gasses (CO_2 neutral).*
- The sun is an unlimited resource.
Disadvantages: - *The amount of output of solar panels depends on the amount of sunshine. Therefore, so-called combined heat and power pumps (CHPP) should also be built to ensure the electricity production.*
- The costs of producing solar power are currently higher than the market price and are therefore being subsidized.

Nuclear power

Current situation: *4 nuclear power plants (NPPs) with 5 nuclear reactors are currently operating.*
Output 2011: *41% of the total electricity production.*
Future: *The current NPPs will reach the end of their operating time from 2020 onwards and should be replaced by the newest generation of NPPs to guarantee their current electricity production.*
Advantages:- *No greenhouse gasses are emitted during electricity production (CO_2 neutral).*
- NPPS ensure the electricity supply.
Disadvantages: *- NPPs produce radioactive waste, which should be disposed in a secure way.*
- Radioactivity can be released when an accident happens in a NPP. The probability of an accident is however very small.

Hydro-power

Current situation: *566 large-scale hydro-power plants (large HPPs) and more than 1000 small HPPs are currently operating in Switzerland.*
Output 2011: *They produce 54% of the total electricity.*
Future: *Calculations show that 26% more hydro-power can be produced in 2035 compared to now. This corresponds to the construction of 21 large HPPs, as well as the expansion and reconstruction of several large HPPs, and the reconstruction of several small HPPs.*
Advantages: - *HPPs do not emit any greenhouse gasses (CO_2 neutral).*
- HPPs ensure the electricity supply.
Disadvantages: *HPPs can locally damage the environment, nature, fishery, tourism, agriculture, flood control measures and drinking water supply.*

Gas-fired power

Current situation: *There are currently no combined cycle gas turbines (CCGTs) in Switzerland.*
Output 2011: *0% of the total electricity production.*
Future: *Calculations show that in 2035 about 36% of the electricity should be produced by CCGTs if Switzerland phases out nuclear power. This corresponds to the construction of 9 CCGTs.*
Advantages: - *The price of gas-fired power is low.*
- CCGTs are flexible: they can be turned on and off on a short notice.
Disadvantages: -*Switzerland will be more dependent on other countries for the supply of natural gas.*
- CCGTs will increase the CO_2 emissions from power plants tenfold (up to 11 million tons per year). The emissions could be reduced significantly when the CO_2 is captured directly at the plant and stored in the subsurface (the so-called Carbon Capture and Storage (CCS) technology).

Wind power

Current situation: *there are currently 30 wind turbines (WTs) operated at 9 locations in Switzerland.*
Output 2011: *0.11% of the total electricity production.*
Future: *After the nuclear phase out, the aim is that about 1.5% of the electricity production comes from WTs. This corresponds to the construction of 280 new WTs.*
Advantages: *- WTs do not emit any greenhouse gasses (CO_2 neutral).*
- The wind is an unlimited resource.
Disadvantages: - *WTs require a large area, which can only be used in a limited way.*
- The output of WTs depends on the amount of wind. To ensure the electricity production, so-called combined heat and power pumps (CHPP) should also be built

Appendix II

Table A
Items per construct, including mean values, standard deviations, corrected item-total correlation (r_{pbis}), and their scale's Cronbach's α, per energy technology

	Solar power			Nuclear power			Hydro-power			Gas-fired power			Wind power		
Items per construct	*M*	*SD*	r_{pbis}	*M*	*SD*	r_{pbis}	*M*	*SD*	r_{pbis}	*M*	*SD*	r_{pbis}	*M*	*SD*	r_{pbis}
Protected values				$\alpha = .63$			$\alpha = .54$			$\alpha = .78$			$\alpha = .73$		
1 The expansion of [ ][c] is not acceptable for me, regardless of the size of the benefits.	*n/a*			4.03	2.33	.51	2.00	1.48	.42	4.65	2.02	.66	2.42	1.87	.60
2 I consider the construction of one [ ] plant just as bad as the construction of ten[h] [ ] plants.	*n/a*			4.20	2.44	.50	2.01	1.54	.41	4.23	2.26	.67	2.24	1.81	.63
3 The construction of [ ] plants concerns values that are untouchable.	*n/a*			3.70	1.99	.32	3.16	1.86	.26	4.16	1.97	.55	3.01	1.88	.45
Positive emotions[a]	$\alpha = .82$			$\alpha = .86$			$\alpha = .85$			$\alpha = .87$			$\alpha = .91$		
1 Pride	3.86	2.01	.63	2.08	1.51	.76	4.56	1.97	.70	1.84	1.25	.72	3.73	2.12	.78
2 Satisfaction	4.89	1.75	.69	2.72	1.72	.73	5.01	1.69	.72	2.19	1.42	.76	4.23	2.02	.85
3 Enthusiasm	5.05	1.78	.72	2.24	1.60	.74	4.72	1.77	.74	2.03	1.38	.79	4.27	2.01	.84
Negative emotions[a]	$\alpha = .81$			$\alpha = .90$			$\alpha = .82$			$\alpha = .88$			$\alpha = .89$		
1 Fear	1.45	1.05	.61	4.38	2.02	.79	2.03	1.32	.71	3.40	2.02	.75	1.59	1.15	.79
2 Anger	1.33	.94	.58	3.15	2.09	.74	1.48	1.06	.58	2.87	2.05	.73	1.55	1.18	.74
3 Nervousness	1.47	1.09	.66	3.61	2.03	.82	1.72	1.18	.69	2.97	1.91	.78	1.63	1.21	.70
4 Threat	1.39	1.00	.64	4.37	2.12	.79	2.04	1.32	.61	3.39	2.02	.74	1.65	1.23	.80
Acceptance	$\alpha = .79$			$\alpha = .65$			$\alpha = .76$			$\alpha = .79$			$\alpha = .83$		
1 I accept the expansion[b] of [ ] in Switzerland.	6.05	1.45	.68	3.97	2.30	.39	5.89	1.41	.65	2.99	1.86	.72	5.47	1.84	.73
2 Switzerland can renounce [ ] without any problems.[d]	5.92	1.59	.58	4.75	2.03	.52	5.99	1.45	.54	3.44	1.95	.57	4.90	2.00	.65
3 The production of [ ] power is sustainable.	5.82	1.48	.64	3.23	2.03	.50	5.85	1.43	.58	2.72	1.67	.62	5.33	1.80	.67
Perceived benefits	$\alpha = .77$			$\alpha = .72$			$\alpha = .60$			$\alpha = .68$			$\alpha = .67$		
1 [ ] help us to mitigate climate change.	5.08	1.89	.53	3.85	2.00	.46	5.26	1.81	.37	2.09	1.46	.34	5.31	1.82	.42
2 Even when [ ] are not expanded, Switzerland would have a secure energy supply.[d] [e]	3.94	1.88	.68	4.54	2.02	.46	5.60	1.54	.38	3.42	1.89	.47	4.30	1.97	.49
3 The electricity price would become too high if [ ] are not expanded.[f]	4.31	1.74	.42	4.21	1.87	.51	4.52	1.79	.30	3.25	1.73	.49	4.73	1.69	.36
4 Thanks to the expansion of [ ], the energy supply will be secured in the long term.	3.80	1.88	.68	4.28	2.07	.59	5.28	1.52	.51	2.95	1.64	.55	3.98	1.96	.51
Perceived costs	$\alpha = .52$			$\alpha = .69$			$\alpha = .70$			$\alpha = .72$			$\alpha = .61$		
1 I am very concerned about the consequences of [ ] in Switzerland.	2.47	1.64	.35	4.64	1.96	.52	2.64	1.66	.54	4.76	1.84	.58	2.63	1.75	.44
2 [ ] destroy the sights of cities and villages.[g]	2.82	1.78	.35	4.25	1.91	.52	3.23	1.73	.54	5.71	1.51	.58	4.08	2.00	.44
Trust															
I fully trust the operators[i] of Swiss [ ].	4.90	1.76	*n/a*	3.14	1.99	*n/a*	5.16	1.58	*n/a*	2.72	1.64	*n/a*	4.93	1.82	*n/a*

[a] Items were preceded by the question: "To what extent do the following responses spontaneously arise in you when you think of [ ]?"
[b] "Expansion" was replaced by "rebuilding" the case of nuclear power and by "construction" in the case of gas-fired power.
[c] One of the five energy sources should be included between the square brackets.
[d] Item was reverse coded.
[e] For solar power: "Thanks to the expansion of [ ], Switzerland has a secured energy supply", which was not reverse coded.
[f] For solar power and wind power: "Due to the expansion of [ ], the electricity price will become too high in Switzerland".
[g] For nuclear power: "The current and future nuclear power plants are safe". For hydro-power: "Hydro-power plants have large negative consequences on the local environment". For gas-fired power: "The CO_2 emissions by gas-fired power plants is dangerous for the environment". For wind power: "Wind turbines destroy the sight of the landscape".
[h] For nuclear power: "three nuclear power plants".
[i] For solar power: "owners".

Appendix III

Table B
Items used to assess energy-security values and environmental values, including their mean values, standard deviations, corrected item-total correlation (r_{pbis}), and their scale's Cronbach's α.

Items per construct	*M*	*SD*	r_{pbis}
Energy-security values[a]	$\alpha = .68$		
…electricity is available to a low price for all Swiss people.	5.40	1.72	.51
…the electricity supply is guaranteed, whoever produces the electricity.	4.71	1.87	.39
…our selection of future energy resources does not influence our quality of life.	4.55	1.74	.78
…there will be no experimenting with our energy supply.	4.69	1.91	.32
…that the electricity supply in Switzerland is independent of other countries.	5.60	1.53	.38
Environmental values[a]	$\alpha = .78$		
…environmental protection stands over economic progress.	5.31	1.52	.58
…energy technologies are adapted to nature.	5.87	1.26	.69
…future generations are not burdened with the consequences of our current energy resources.	6.10	1.29	.60
…energy technologies are safe for humans and the environment.	6.48	.87	.55

[a] Items were proceeded by the question: "How important is it for you that …".

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211.

Ansolabehere, S., & Konisky, D. M. (2009). Public attitudes toward construction of new power plants. *Public Opinion Quarterly, 73*, 566–577.

Baron, J., & Leshner, S. (2000). How serious are expressions of protected values? *Journal of Experimental Psychology: Applied, 6*, 183–194.

Baron, J., & Spranca, M. (1997). Protected values. *Organizational Behavior and Human Decision Processes, 70*, 1–16.

Bronfman, N. C., Jiménez, R. B., Arévalo, P. C., & Cifuentes, L. A. (2012). Understanding social acceptance of electricity generation sources. *Energy Policy, 46*, 246–252.

Burstein, P. (2003). The impact of public opinion on public policy: A review and an agenda. *Political Research Quarterly, 56*, 29–40.

Cooper, M. (2011). The implications of Fukushima: The US perspective. *Bulletin of the Atomic Scientists, 67*, 8–13.

Davidson, R. J., & Freudenburg, W. R. (1996). Gender and environmental risk concerns: A review and analysis of available research. *Environment and Behavior, 28*, 302–339.

de Groot, J. I. M., Steg, L., & Poortinga, W. (2013). Values, perceived risks and benefits, and acceptability of nuclear energy. *Risk Analysis, 33*, 307–317.

Demski, C., Poortinga, W., & Pidgeon, N. (2014). Exploring public perceptions of energy security risks in the UK. *Energy Policy, 66*, 369–378.

Ertör-Akyazı, P., Adaman, F., Özkaynak, B., & Zenginobuz, Ü. (2012). Citizens' preferences on nuclear and renewable energy sources: Evidence from Turkey. *Energy Policy, 47*, 309–320.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making, 13*, 1–17.

Greenberg, M. (2009a). Energy sources, public policy, and public preferences: Analysis of US national and site-specific data. *Energy Policy, 37*, 3242–3249.

Greenberg, M., & Truelove, H. B. (2011). Energy choices and risk beliefs: Is it just global warming and fear of a nuclear power plant accident? *Risk Analysis, 31*, 819–831.

Greenberg, M. R. (2009b). NIMBY, CLAMP, and the location of new nuclear-related facilities: U.S. national and 11 site-specific surveys. *Risk Analysis, 29*, 1242–1254.

Hanselmann, M., & Tanner, C. (2008). Taboos and conflicts in decision making: Sacred values, decision difficulty, and emotions. *Judgement and Decision Making, 3*, 51–63.

Heung Chang, S. (2011). The implications of Fukushima: The South Korean perspective. *Bulletin of the Atomic Scientists, 67*, 18–22.

Hobman, E. V., & Ashworth, P. (2013). Public support for energy sources and related technologies: The impact of simple information provision. *Energy Policy, 63*, 862–869.

Huijts, N. M. A., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews, 16*, 525–531.

IBM Corp. (2011). *IBM SPSS Statistics Version 20.0*. Armonk, NY: IBM Corp.

Jones, C. R., & Eiser, J. R. (2009). Identifying predictors of attitudes towards local onshore wind development with reference to an English case study. *Energy Policy, 37*, 4604–4614.

Jorant, C. (2011). The implications of Fukushima: The European perspective. *Bulletin of the Atomic Scientists, 67*, 14–17.

Kanellakis, M., Martinopoulos, G., & Zachariadis, T. (2013). European energy policy—A review. *Energy Policy, 62*, 1020–1030.

Keller, C., Visschers, V., & Siegrist, M. (2012). Affective imagery and acceptance of replacing nuclear power plants. *Risk Analysis, 32*, 464–477.

Oxford English Dictionary. (2012). *acceptance, n*. Retrieved January 31, 2013, from http://www.oed.com/view/Entry/1011.

Peters, E., & Slovic, P. (1996). The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology, 26*, 1427–1453.

Raudenbush, S. W., & Bryk, A. S. (2002) (2nd ed.). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.), (Vol. 1). Thousand Oakes, CA: Sage Publications.

Raudenbush, S. W., Bryk, A. S., Cheong, A. S., Fai, Y. F., Congdon, R. T., & du Toit, M. (2011). *HLM 7: Hierarchical linear and nonlinear modeling*. Lincolnwood, IL: Scientific Software International.

Reiner, D. (2008). *A looming rhetorical gap: A survey of public communications activities for carbon dioxide capture and storage technologies*. Electricity Policy Research Group Working Papers.

Reiner, D., Curry, T., De Figueiredo, M., Herzog, H., Ansolabehere, S., Itaoka, K., et al. (2006). American exceptionalism? Similarities and differences in national attitudes toward energy policy and global warming. *Environmental Science & Technology, 40*, 2093–2098.

Ritov, I., & Baron, J. (1999). Protected values and omission bias. *Organizational Behavior and Human Decision Processes, 79*, 79–94.

Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis, 20*, 713–720.

Spence, A., Poortinga, W., Pidgeon, N., & Lorenzoni, I. (2010). Public perceptions of energy choices: The influence of beliefs about climate change and the environment. *Energy & Environment, 21*, 385–407.

Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*, 407–424.

Swiss Federal Office of Energy (SFOE). (2013a, July 10). *Energy Strategy 2050*. Retrieved August 30, 2013, from http://www.bfe.admin.ch/themen/00526/00527/index.html?lang=en.

Swiss Federal Office of Energy (SFOE). (2013b). *Schweizerische Elektrizitätsstatistik 2012* [*Swiss electricity statistic 2012*]. Order no.: 805.005.12. Bern: SFOE.

Swiss Statistics. (2012a). *Bevölkerungsstand und -struktur* [*Population size and composition*]. Retrieved September 2, 2013, from http://www.bfs.admin.ch/bfs/portal/de/index/themen/01/02/blank/data/01.html.

Swiss Statistics. (2012b). *Bildungsstand der Wohnbevölkerung nach Alter und Geschlecht* [*Education level of the resident population according to age and gender*]. Retrieved September 2, 2013, from http://www.bfs.admin.ch/bfs/portal/de/index/themen/20/05/blank/key/gleichstellung_und/bildungsstand.html.

Tampakis, S., Tsantopoulos, G., Arabatzis, G., & Rerras, I. (2013). Citizens' views on various forms of energy and their contribution to the environment. *Renewable and Sustainable Energy Reviews, 20*, 473–482.

Tanner, C., & Medin, D. L. (2004). Protected values: No omission bias and no framing effects. *Psychonomic Bulletin & Review, 11*, 185–191.

Tanner, C., Ryf, B., & Hanselmann, M. (2009). Geschützte Werte Skala (GWS) Konstruktion und Validierung eines Messinstrumentes. *Diagnostica, 55*, 174–183.

Tetlock, P. E., Kristel, O. V., Elson, S. B., Green, M. C., & Lerner, J. S. (2000). The psychology of the unthinkable: Taboo trade-offs, forbidden base rates, and heretical counterfactuals. *Journal of Personality and Social Psychology, 78*, 853.

Toth, F. L. (2008). Prospects for nuclear power in the 21st century: A world tour. *International Journal of Global Energy Issues, 30*, 3–27.

Truelove, H. B. (2012). Energy source perceptions and policy support: Image associations, emotional evaluations, and cognitive beliefs. *Energy Policy, 45*, 478–489.

van der Pligt, J. (1985). Public attitudes to nuclear energy: Salience and anxiety. *Journal of Environmental Psychology, 5*, 87–97.

Venables, D., Pidgeon, N. F., Parkhill, K. A., Henwood, K. L., & Simmons, P. (2012). Living with nuclear power: Sense of place, proximity, and risk perceptions in local host communities. *Journal of Environmental Psychology, 32*, 371–383.

Visschers, V. H. M., Keller, C., & Siegrist, M. (2011). Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: Investigating an explanatory model. *Energy Policy, 39*, 3621–3629.

Visschers, V. H. M., & Siegrist, M. (2012). Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. *Energy Policy, 46*, 292–300.

Visschers, V. H. M., & Wallquist, L. (2013). Nuclear power before and after Fukushima: The relations between acceptance, ambivalence and knowledge. *Journal of Environmental Psychology, 36*, 77–86.

Wallquist, L., Visschers, V. H. M., & Siegrist, M. (2010). Impact of knowledge and misconceptions on benefit and risk perception of CCS. *Environmental Science & Technology, 44*, 6557–6562.

West, B. T., Welch, K. B., & Galecki, A. T. (2006a). Linear mixed models. In *Linear mixed models* (pp. 9–49). Boca Raton: Chapman and Hall/CRC.

West, B. T., Welch, K. B., & Galecki, A. T. (2006b). Models for repeated-measures data: The rat brain example. In *Linear mixed models* (pp. 175–217). Boca Raton: Chapman and Hall/CRC.

Whitfield, S. C., Rosa, E. A., Dan, A., & Dietz, T. (2009). The future of nuclear power: Value orientations and risk perception. *Risk Analysis, 29*, 425–437.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*, 151–175.