Original research article

The psychology of participation and interest in smart energy systems: Comparing the value-belief-norm theory and the value-identity-personal norm model

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ABSTRACT

Environmental problems can be reduced if people would participate in smart energy systems. Little is known about which factors motivate people to actually participate in smart energy systems. We tested the factors that influence individuals' interest and actual participation in smart energy systems. We compared the predictive power of the value-belief-norm theory with a novel model to explain pro-environmental actions: the value-identity-personal norm model. Both focus on normative considerations in explaining behaviour, but the VIP model focuses on general rather than behaviour-specific antecedents. Our results show that both models explained a similar amount of variance in interest and actual participation in smart energy systems. This suggests that the value-identity-personal norm model is a promising model to explain and promote pro-environmental actions such as participation in smart grids. Further, it is more parsimonious than the value-belief-norm theory and focuses on general factors that are likely to predict other environmental behaviours as well. The value-identity-personal norm model is therefore a particularly promising model in promoting a range of environmental behaviours.

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1. Introduction

Environmental problems are among the biggest challenges we are currently facing. Global warming is a growing issue, as the world population increases, as well as fossil energy consumption per capita [13]. In Europe, households are responsible for 27% of the total energy consumption and 30% of the total electricity consumption [5]. Smart grids can potentially contribute to reduce environmental problems by enabling households to balance supply and demand of energy, save energy and increase energy efficiency [12,3,18]. In the current project, a smart energy system is an energy system in which renewable energy production, smart meters, and smart plug devices are integrated and coordinated through energy services, active users and enabling technologies. Smart energy systems often involve a decentralized production of renewable energy, for example the adoption of solar panels by households. Decentralized production of renewable energy can lead to uneven supply of energy (for example, more energy is available when the sun is shining) which requires supplement from fossil fuels. However, if

households change their energy demand to match supply of energy, efficient use of renewables can be increased and reliance on fossil fuels can be reduced. This can be realized by switching one's energy consumption to times when renewable energy is widely available (e.g., when the sun is shining; [19]). That way, smart energy systems can reduce the use of fossil fuels, thereby contributing to the reduction of environmental problems. Smart energy systems can only realize their true potential if households are willing to actively participate in such systems. Individual behaviour is thus crucial in promoting a transition to smart energy systems [30,9,45,43,26]. What influences individuals' interest in and their actual participation in smart energy systems?

Studies have shown that people are not always primarily motivated by financial costs and benefits. For example, people are willing to pay extra for more sustainable sources of energy [44]. Indeed, normative considerations play a key role in explaining environmental behaviour, including sustainable energy use [34]. An important theory explaining environmental behaviour that focuses on normative considerations is the value-belief-norm (VBN) theory (see Fig. 1; [38,37]). VBN theory proposes that relatively stable and general factors, namely values and environmental concern, affect behaviour specific variables (i.e., problem awareness, outcome efficacy and personal norm), which in turn influence behaviour. According to the VBN theory, people are likely to engage in pro-

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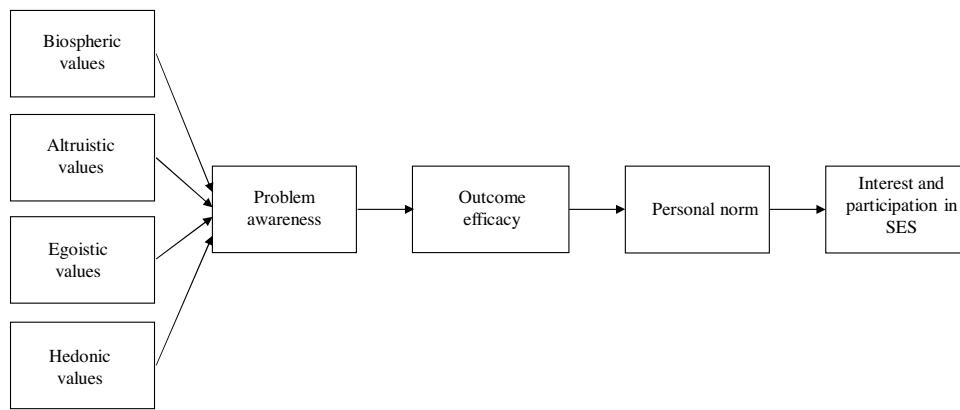*E-mail address:* ellen.van.der.werff@rug.nl (E. van der Werff).

Fig. 1. The Value-Belief-Norm theory.

environmental behaviour when they feel morally obliged to do so. Feelings of moral obligation are stronger when people are aware of environmental problems caused by their behaviour (problem awareness), and when they feel they can do something about these problems (outcome efficacy). Problem awareness is higher, the higher one's environmental concern. Finally, environmental concern is influenced by people's values. Generally, strong biospheric values, reflecting that one strongly cares about nature and the environment, are positively related to environmental concern, and VBN variables further down the chain. Altruistic values, reflecting the extent to which people care about others, are also positively related to environmental concern and other VBN variables, but to a lesser extent. Egoistic values on the other hand, reflecting whether people care about money and power, are generally negatively related to environmental concern and the variables further down the chain. Hedonic values reflect to what extent people care about comfort and pleasure. Hedonic values have been found to be important predictors of environmental behaviour, however they have not been studied with regard to the VBN theory yet [35]. However, research has suggested that environmental concern could be excluded from the VBN theory, as values appeared to be a better predictor of VBN variables than environmental concern [32]. Therefore, we tested the VBN theory excluding environmental concern, resulting in a more parsimonious model without reducing the predictive power of the model much.

Research has shown that the VBN theory, or key variables from the VBN theory, predict a wide range of environmental behaviours and perceptions, including consumer behaviour and willingness to sacrifice (i.e., pay higher prices and reduce one's standard of living to protect the environment; [38]), the acceptability of energy policies [33], pro-environmental behaviours [25], recycling, refraining from driving, and environmental citizenship [27], ecological risk perception [31], the intention to use green devices [7], conservation behaviour [16], sustainable transport mode choice [14,22], and the adoption of alternative fuel vehicles [15]. However, VBN theory does not predict demonstrating for an environmental cause [38] and sustainability behaviours in an organization very well [2]. It has been suggested that the predictive power of the VBN theory is weaker when the behaviour is rather costly or effortful [37]. We will test if the VBN theory also explains behaviour in a new domain, namely participation in smart energy systems.

The VBN theory mainly includes behaviour-specific factors, notably problem awareness, outcome efficacy and personal norm. Behaviour specific predictors are believed to be strongly related to the relevant behaviour [1], which implies that the VBN theory may be strongly predictive of specific environmental behaviours. Yet, from a practical point of view, it would be advantageous to identify general antecedents of environmental actions, that are likely to affect many environmental behaviours [39]. Targeting such general factors may increase the likelihood that people engage in many pro-environmental actions, which would have a more significant impact on environmental quality. Therefore, we propose a model focusing on general antecedents of environmental actions, namely the Value Identity Personal norm (VIP) model (see Fig. 2). Similar to the VBN theory, the VIP model proposes that environmental behaviour is influenced by feelings of moral obligation to engage in environmental behaviour (personal norms). The VIP model further proposes that personal norm is in turn influenced by one's environmental self-identity, which reflects the extent to which one sees oneself as a pro-environmental person [40]. Environmental self-identity is in turn influenced by biospheric values: stronger biospheric values result in a stronger environmental self-identity. The VIP model differs from the VBN theory in two important ways. First, the VIP model is more parsimonious than the VBN theory. Second, the VIP model focuses on general predictors of environmental actions, notably values and environmental self-identity, while personal norm is a behaviour specific variable. Previous studies provide empirical support for parts of the VIP model. More specifically, environmental self-identity has been found to mediate the relationship between biospheric values, and the intention to use green energy, energy behaviours, preferences for sustainable products, recycling, buying fair trade products and refraining from flying [8,40]. Furthermore, personal norm was found to mediate the relationship between environmental self-identity and the intention to use renewable energy as well as product preferences [41]. Recently, the VIP model has been found to predict environmental behaviour at work [28].

In the current study we aim to compare the predictive power of the VBN theory and the VIP model in explaining participation in a smart energy system. We will test to what extent the VIP model, focusing on general antecedents, is predictive of specific pro-environmental actions such as participation in smart grids, and how well the VIP model explains this behaviour compared to the VBN theory. We will include two indicators of participation in smart energy systems, interest in smart energy systems, and actual participation in smart energy systems. Interest in smart energy systems may not always translate into actual participation in smart energy systems, and may thus be related to different variables (cf. Refs. [24,29]). Therefore we also include, in contrast to most studies, whether people actually participate in the smart energy system project. We will test if the VBN theory, as it includes more behaviour specific variables than the VIP model, is more predictive of these different indicators of adoption of smart energy systems than the VIP model.