# Social Acceptance and Its Role for Planning Technology Infrastructure

## *A Position Paper, Taking Wind Power Plants as an Example*

Barbara S. Zaunbrecher and Martina Ziefle
*Human-Computer Interaction Center, RWTH Aachen University, Campus-Boulevard 57, 52074 Aachen, Germany*

Keywords: Social Acceptance, Energy Infrastructure, Renewable Energies, Planning Procedure, Energy Policy.

Abstract: It will be argued that there are major social gaps in the planning of complex energy infrastructure for public spaces: the first "gap" concerns the question if social acceptance can be reliably measured. The second "gap" refers to the lack of an integration of results from acceptance research into current planning procedures. Taking wind farm planning as an example, both social gaps are discussed and an integrative planning procedure is advocated. Finally, requirements for a user-centered planning process are formulated.



# 1 INTRODUCTION

Social acceptance of novel technologies has been a popular research topic for more than a quarter of a century. While former research concentrated mostly on technological artefacts in the work context (e.g. Davis, 1989), today, large technologies in the context of energy supply are of utmost importance with respect to sustainable technology diffusion. Especially in the light of the turn towards renewable energies, social acceptance of the associated infra-structure such as wind power (WP) plants (on-/offshore), (Devine-Wright, 2005; Zaunbrecher et al., 2014), geothermal energy (Dowd et al., 2011, Kowalewski et al., 2014) as well as transmission lines (Devine-Wright and Batel, 2013, Atkinson et al., 2004, Soini et al., 2011) received attention. For infrastructures, e.g. WP plants or transmission lines, the knowledge about technology acceptance is rich; for others, e.g. storage technologies, detailed analyses about perceived benefits or barriers are still lacking. Though, what is mostly missing is a specific call to action how to finally put these results from social acceptance research into practice.

WP plants are chosen in this paper for two main reasons: (1) For WP plants, a sound research basis exists, providing a rich pool of acceptance-relevant factors. (2) Wind farms currently being planned still face considerable public resistance, showing that the planning process can still be improved.

By conducting a literature review, the major factors influencing the acceptance of a WP plant project were summarized (cf. Appendix). Not only is known how the physical appearance of WP plants influences acceptance (size, color, distance), but also how the relation between investors and operators and the local community can help to foster public perception. Further findings refer, e.g., to effects on nature and the particular landscape in which the WP plant is sited and how this can create support or opposition towards the wind park.

Concerning the role of the public in the technology acceptance discussion, two contradicting positions are generally clashing. One is the public's wish to be integrated into the planning process, arguing that residents are the ones that "suffer" from the infrastructure in the end, therefore requesting participation as an inherent "right". The other traditional expert position is that lay peoples' knowledge is too restricted to make reasonable or reliable decisions. Also, it is often assumed that public opinions are fuzzy so that they can neither be patterned nor predicted. In addition, it is naturally alleged that the more room for discussion is given to the citizens in early stages of the developmental process, the more space for developing a contradictory position will be created (if you ask for problems, you will receive them).

It will be pointed out that for the integration of acceptance-relevant factors in the planning process, two types of -what we term - "social gaps" are to be addressed: (1) It is to be clarified what is under-stood by the notion of "acceptance", and how and if


S. Zaunbrecher B. and Ziefle M..
Social Acceptance and Its Role for Planning Technology Infrastructure - A Position Paper, Taking Wind Power Plants as an Example.
DOI: 10.5220/0005480600600065
In *Proceedings of the 4th International Conference on Smart Cities and Green ICT Systems* (SMARTGREENS-2015), pages 60-65
ISBN: 978-989-758-105-2

it can be reliably measured, or even predicted (Social Gap I). (2) It is to be addressed at which stage in the planning process social acceptance should be integrated (Social Gap II). These questions will be discussed against the background of wind farm planning and acceptance thereof, so as to give concrete examples of acceptance-relevant factors and milestones of the planning process.

## 2 SOCIAL GAP I: IS ACCEPTANCE OF COMPLEX INFRASTRUCTURE MEASURABLE?

Acceptance deals with the approval, positive reception and sustainable implementation of technology. Acceptance research thus explores the relation of usage motives and perceived barriers as well as the attitudes toward the respective technology, and the technological impact assessment. Especially large-scale technologies are viewed critical or at least ambivalent by the public (Renn, 1998). They often escape from perceived comprehensibility and controllability of people, which in turn produces insecurity, fear or even adverse aloofness (Siegrist et al., 2006, Ziefle and Schaar, 2011). It has been shown that the perceived risk of a novel technology and the probability of the disapproval are negatively correlated with the familiarity, the knowledge, and information depth about a technology (Kowalewski et al., 2013, Arning et al., 2013). Also, it was found that individual factors (age, gender, technology generation, personality) have a considerable impact on risk perceptions and acceptance of large scale technologies (Arning et al., 2013, Zaunbrecher et al., 2014). Thus, social acceptance must be modelled as a "product" of usage motives that militate in favour of and against technology as well as situation-specific evaluations, driven by individual needs and demands. In short: Acceptance research has to reflect the fragile trade-off between benefits and barriers ascribed to a technology.

The question if this complex acceptance "product" on the human side can be empirically identified and reliably measured at all, can be clearly answered with yes. This, however, requires a holistic and integrative empirical methodology that allows for a direct and practically oriented transfer of acceptance research into early stages of the development of a technology (Kowalewski et al., 2013). Here, a combination of qualitative and quantitative procedures is essential. While traditional social science methods (focus groups, stakeholder interviews on-site) properly reflect users' implicit and explicit knowledge as well as generic attitudes, the determination of the decisive trade-offs between conflicting motives and the individual cognitive or affective weighing of factors can be adequately captured by conjoint analyses (Arning et al., 2013). In conjoint tasks, respondents evaluate product profiles or scenarios, in order to simulate decision-processes and to decompose the preference of a product or scenario as a combined set of attributes. Conjoint analyses thus show which attribute influences the respondents' choice the most and which level of an attribute is valued the highest. Thus, acceptance of large-scale technologies can indeed be modelled and the decisive acceptance "function" (balance between positive and negative influencing factors) can be reliably determined.

## 3 SOCIAL GAP II: HOW TO INTEGRATE ACCEPTANCE IN TECHNOLOGICAL PLANNING

The Social Gap II refers to the missing link between insights from social science research (relevant factors, acceptance modeling and decision simulation) and the planning of siting of renewable energy technologies. In the following, the existing guidelines for planning WP plants are analyzed, paying particular attention to the way in which social acceptance and citizen participation are represented.

The latest decree on planning and permit of WP plants in in the federal state of North Rhine-Westphalia (Germany) will be discussed as an example for a framework for planning.

It is evident from these guidelines that the choice of a location of a WP plant is solely based on technical, legal, environmental, or economic factors such as regulations on distance to housing and streets, or the protection of natural reservoirs. Acceptance of wind farms by the public is a topic that is only considered in a very generic manner within these guidelines, in the sense of "which measures can be taken to increase acceptance" (Decree on Wind Power from 11th July 2011). However, these measures do not focus on factors that might be valuable for the citizens: the way of the planning process or the design of the WP plant. Rather, they make a point of creating added value for the local community.

Measures to increase acceptance include designing wind farms as "citizen wind farms", in which local residents can take part and also become shareholders, the support of local social, cultural or ecological projects by the operators, and the introduction of reduced electricity prices. Citizen participation is mentioned in the approach, but it is only vaguely mentioned how this should be put into practice ("Citizens should be included in the planning and usage of wind power plants at an early stage. This includes open discussions and information events by the operators", Section 2, Decree on Wind Power from 11th July 2011).

In the literature, several models for the evaluation of WP parks are presented. Wimmler et al. (2015) provide an overview of multi-criteria decision support methods for renewable energies, some of which include "social acceptability" as an evaluation criterion when it comes to the selection of the type of energy. If social acceptability is included at all, it is treated as a "stand alone" factor separated from other factors such as visibility or costs. To explain the shortcomings of such a model, the evaluation criteria proposed by Cavallaro and Ciraolo (2005) will be referred to. In their model, WP plants are assessed according to different criteria such as investment costs, fuel savings and realization time. In addition, "social acceptability" is introduced next to these objective criteria. Acceptance is treated as a qualitative variable, ranging from "bad" to "moderate". Although the importance of social acceptance and an early integration of the public are basically acknowledged, it remains unclear on which (data) basis the acceptability of the example projects is determined. By treating social acceptability separately, it is implied that it is independent from other factors, although research proved the close interrelationship between acceptance and e.g. costs (cf. Appendix). Recapitulating, social acceptance in WP planning is either

a. represented in the fuzzy concept of "information and communication", running parallel, but separated from the planning phase (Figure 1), or
b. used as "black box" evaluation for possible scenarios, without a common understanding what contributes to acceptance (Figure 2).

Both procedures have conceptual disadvantages. In the planning procedure (Figure 1), information on the planning is given to the public, but the planning is not influenced by acceptance issues raised, because these are not scheduled as possible factors to determine e.g. the plant's location.

Leaving no room for alterations in the planning may even lead to frustration because the public might feel they have no real impact to influence decisions that are more or less imposed in a top-down manner. A process like this might look like an "alibi public consultation" that seeks to gain agreement to already fixed plans rather than openly discussing options.

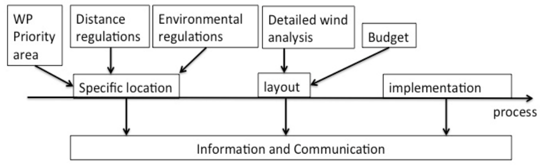


Figure 1: Planning procedure according to the German Federal Association of Wind Power (www.wind-energie.de/themen/planung-und-repowering/planung).

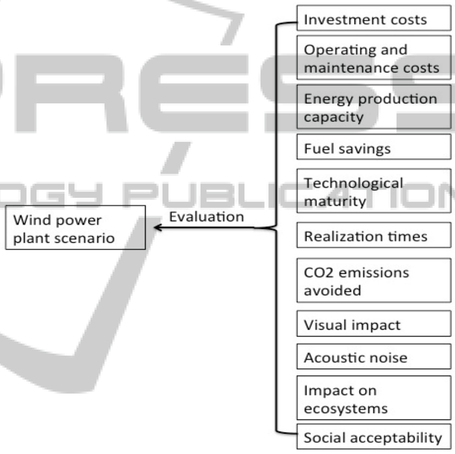


Figure 2: Example set of criteria to assess WP plant scenarios (Cavallaro and Ciraolo, 2005).

In the second model (Figure 2), social acceptability is treated separately from other factors (investment costs, visual impact etc.). However, because many of these factors influence acceptance (cf. Appendix), it makes no sense to treat social acceptance as a stand-alone factor next to the other factors.

It has become obvious that social acceptance of wind parks from a planning point of view is mainly characterized by an ex-post perspective in combination with a mandatory need to "inform" citizens. If acceptance is considered at all in today's planning of technology infrastructure, it is at the very end of the process when plans are more or less fixed. Any amendments to the final plan are costly, lead to delays and can only be realized in a very limited way. What is lacking is the integration of acceptance factors as early as in the design and planning phase of the project. In order to have sustainable planning solutions, we advocate a planning model which integrates citizens, and, this way, knowledge from acceptance studies already in early stages of an iterative planning process.

The idea of integrating social acceptance, demands, and wishes early in the development process has already been proposed for cell towers in mobile communication development (Kowalewski et al., 2013). Rather than treating acceptance as a separate factor, we propose instead to integrate social acceptance studies in the planning phase for location and layout of WP plants by using the model of a feedback loop (Figure 3). By integrating a communicative feedback loop in the planning, potential pitfalls (e.g. in choosing a location) can be avoided. Next to distance and environmental regulations, results from social acceptance studies on WP plant locations can be taken into account in the very beginning of the process. If planners know early enough about locally important issues, main argumentation lines for and against the infrastructure as well as possible compensations, they can timely adapt plans, rather than being confronted with citizen protests when the precise plans are decided upon. Because the literature analysis has shown that acceptance is a complex phenomenon, and that some factors can be operationalized qualitatively, others quantitatively, the types of factors determine where and how they can be integrated in the development process. The acceptance-relevant factors were thus grouped in thematic categories and in two categories defining the type of factor (cf. Appendix). Examples for thematic categories are "physical appearance", which refers to the outward appearance of a WP plant or "environment", taking into account those factors that deal with the effect of the WP plant on its natural surroundings. At this stage, acceptance as a whole cannot be adequately represented in a model or a simulation for the siting of wind farms as a single "value" that ranges between two predefined poles, e.g. 0 and 1. To come closer to a solution for the integration, the factors were grouped into two categories, "physical" and "latent". *Physical* refers to factors that, considered on their own, can be represented by a numerical value, because they are observable and can thus be quantified. Example factors are the size of a wind farm, the distance to it, financial benefits to the local community, the effect on property values etc. *Latent* refers to factors such as "perceived health risks", "place attachment" or "local network of support" that cannot be represented by a numerical value because of their qualitative nature.

Simulations, e.g. for the siting of WP plants, work with numerical variables such as potential analysis, square meters of suitable surfaces etc. An integration of latent, qualitative factors is thus difficult should the model remain limited to numerical variables. Nonetheless, acceptance factors play an equally, if not more, important role and should thus be considered in planning. What is therefore needed is a model allowing for the integration of qualitative next to quantitative factors.

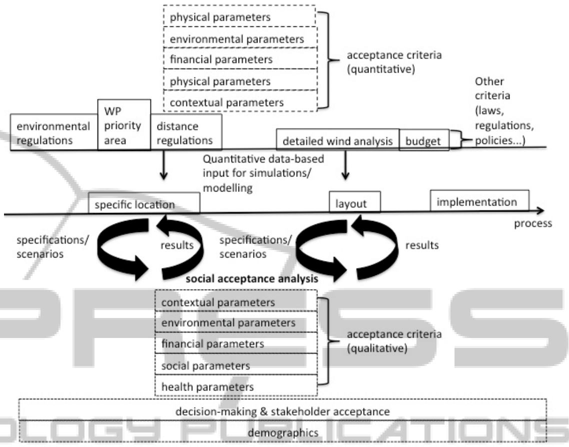


Figure 3: Proposed framework for WP planning.

As shown in Figure 3, we propose to integrate quantitatively measurable acceptance criteria at the same stage as decision criteria which are based on laws and regulations (distance to housing etc.). Together, this data based input can be used for simulations and planning scenarios. The added value lies in the fact that certain siting and layout scenarios, which would meet environmental and other criteria set by laws, but not acceptance criteria, would be ruled out from the very beginning. This would result in scenarios which fulfill basic acceptance criteria and in which acceptance is given the same value over environmental and feasibility criteria. In a next step, the proposed scenarios should then be discussed with a representative group of citizens, so public perception and acceptance factors can be taken into account and fed back into the scenario building. It is likely that the results will have to pass this cycle iteratively in order to come to a solution that is feasible and agreed upon.

## 4 CONCLUSIONS

A new process model for wind farm planning was discussed to improve the integration of acceptance-relevant factors. This process will require openness from the side of the planners, not only to acknowledge the importance of social acceptance, but also to give room to suggestions and amendments to the scenarios. Besides, a thoroughly planned communication and information concept is needed, so that citizens can gain information and competences to contribute to the decision-process.

# REFERENCES


Álvarez-Farizo, B., Hanley, N., 2002. Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain. *Energy Policy* 30, 107–116.

Arning, K., Kowalewski, S., Ziefle, M., 2014. Health Concerns vs. Mobile Data Needs: Conjoint Measurement of Preferences for Mobile Communication Network Scenarios. *Hum. Ecol. Risk Assess. Int. J.* 20, 1359-1384.

Atkinson, G., Day, B., Mourato, S., Palmer, C., 2004. "Amenity" or "eyesore"? Negative willingness to pay for options to replace electricity transmission towers. *Appl. Econ. Lett.* 11, 203–208.

Baxter, J., Morzaria, R., Hirsch, R., 2013. A case-control study of support/opposition to wind turbines: Perceptions of health risk, economic benefits, and community conflict. *Energy Policy* 61, 931–943.

Bishop, I.D., Miller, D.R., 2007. Visual assessment of off-shore wind turbines: The influence of distance, contrast, movement and social variables. *Renew. Energy* 32, 814–831.

Cavallaro, F., Ciraolo, L., 2005. A multicriteria approach to evaluate wind energy plants on an Italian island. *Energy Policy* 33, 235–244.

Cowell, R., Bristow, G., Munday, M., 2011. Acceptance, acceptability and environmental justice: the role of community benefits in wind energy development. *J. Environ. Plan. Manag.* 54, 539–557.

Decree on Windpower from 11th July 2011. [Erlass für die Planung und Genehmigung von Windenergieanlagen und Hinweise für die Zielsetzung und Anwendung (Windenergie-Erlass) Gem. Az. VIII2 - Winderlass, Az. X A 1 – 901.3/202 und Az. III B 4 – 30.55.03.01]

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* 13, 319–340.

Devine-Wright, P., 2005. Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy* 8, 125–139.

Devine-Wright, P., Batel, S., 2013. Explaining public preferences for high voltage pylon designs: An empirical study of perceived fit in a rural landscape. *Land Use Policy* 31, 640–649.

Dimitropoulos, A., Kontoleon, A., 2009. Assessing the determinants of local acceptability of wind-farm investment: A choice experiment in the Greek Aegean Islands. *Energy Policy* 37, 1842–1854.

Dowd, A.-M., Boughen, N., Ashworth, P., Carr-Cornish, S., 2011. Geothermal technology in Australia: Investigating social acceptance. *Energy Policy* 39, 6301–6307.

Ek, K., 2005. Public and private attitudes towards "green" electricity: the case of Swedish wind power. *Energy Policy* 33, 1677–1689.

Graham, J.B., Stephenson, J.R., Smith, I.J., 2009. Public perceptions of wind energy developments: Case studies from New Zealand. *Energy Policy* 37, 3348–3357.

Gross, C., 2007. Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance. *Energy Policy* 35, 2727–2736.

Jobert, A., Laborgne, P., Mimler, S., 2007. Local acceptance of wind energy: Factors of success identified in French and German case studies. *Energy Policy* 35, 2751–2760.

Johansson, M., Laike, T., 2007. Intention to respond to local wind turbines: the role of attitudes and visual perception. *Wind Energy* 10, 435–451.

Kowalewski, S., Arning, K., Minwegen, A., Ziefle, M., Ascheid, G., 2013. Extending the Engineering Trade-Off Analysis by Integrating User Preferences in Conjoint Analysis. *Expert Syst. Appl.* 40, 2947–2955.

Kowalewski, S., Borg, A., Kluge, J., Himmel, S., Trevisan, B., Eraßme, D., Ziefle, M., Jakobs, E.-M., 2014. Modeling the Influence of Human Factors on the Perception of Renewable Energies. Taking Geothermics as Example. In: *Advances in Human Factors, Software and System Engineering*, 155-162.

Krohn, S., Damborg, S., 1999. On public attitudes towards wind power. *Renew. Energy* 16, 954–960.

McLaren Loring, J., 2007. Wind energy planning in England, Wales and Denmark: Factors influencing project success. *Energy Policy* 35, 2648–2660.

Pasqualetti, M.J., 2000. Morality, Space, and the Power of Wind-Energy Landscapes. *Geogr. Rev.* 90, 381–394.

Pedersen, E., van den Berg, F., Bakker, R., Bouma, J., 2009. Response to noise from modern wind farms in The Netherlands. *J. Acoust. Soc. Am.* 126, 634-643.

Renn, O., 1998. Three decades of risk research: accomplishments and new challenges. *J. Risk Res.* 1, 49–71.

Siegrist, M., Keller, C., Cousin, M.-E., 2006. Implicit Attitudes Toward Nuclear Power and Mobile Phone Base Stations: Support for the Affect Heuristic. *Risk Anal.* 26, 1021–1029.

Soini, K., Pouta, E., Salmiovirta, M., Uusitalo, M., Kivinen, T., 2011. Local residents' perceptions of energy landscape: the case of transmission lines. *Land Use Policy* 28, 294–305.

Songsore, E., Buzzelli, M., 2014. Social responses to wind energy development in Ontario: The influence of health risk perceptions and associated concerns. *Energy Policy* 69, 285–296.

Sustainable Energy Ireland, 2003. Attitudes towards the Development of wind farms in Ireland. URL: http://www.sei.ie/uploadedfiles/RenewableEnergy/Attitudestowardswind.pdf

Swofford, J., Slattery, M., 2010. Public attitudes of wind energy in Texas: Local communities in close proximity to wind farms and their effect on decision-making. *Energy Policy* 38, 2508–2519.

Vorkinn, M., Riese, H., 2001. Environmental Concern in a Local Context The Significance of Place Attachment. *Environ. Behav*. 33, 249–263.

Wimmler, C., Hejazi, G., de Oliveira Fernandes, E., Moreira, C., Connors, S., 2015. Multi-Criteria Decision Support Methods for Renewable Energy Systems on Islands. *J. Clean Energy Technol.* 3, 185-195.

Wolsink, M., 2000. Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. *Renew. Energy* 21, 49–64.

Zaunbrecher, B.S., Kowalewski, S., Ziefle, M., 2014. The Willingness to Adopt Technologies: A Cross-Sectional Study on the Influence of Technical Self-efficacy on Acceptance, in: *Human-Computer Interaction. Applications and Services*. SPRINGER*,* 764–775.

Ziefle, M., Schaar, A.K., 2011. Gender differences in acceptance and attitudes towards an invasive medical stent. *Electron. J. Health Inform.* 6, e13.

# APPENDIX

Table 1: Acceptance factors in wind power plants (based on Devine-Wright, 2005 and Graham et al., 2009, extended).

| Thematic area | Type | Specification | Examplary sources |
|---|---|---|---|
| Physical appearance | physical | number of WP plants and height | Dimitropoulos and Kontoleon (2009) |
| | physical | movement | Bishop and Miller (2007) |
| | physical | color | Lee (1989) |
| | physical | farm size and shape | Sustainable Energy Ireland (2003) |
| Context and landscape | physical | location | Ek (2005) |
| | physical | distance | Bishop and Miller (2007), Swofford and Slattery (2010), Sustainable Energy Ireland (2003) |
| | physical | cumulative effects (neighboring projects), proximity to important features | Graham et al. (2009) |
| | latent | local impact of construction (building site) | Graham et al. (2009) |
| | latent | fit in landscape, former use and perception of site | Jobert et al. (2007) |
| | physical | visibility | Jobert et al. (2007), Johansson and Laike (2007) |
| | physical | ownership of territory (communal/ private) | Jobert et al. (2007) |
| | latent | local experience with wind power | Krohn and Damborg (1999) |
| Environment | physical | loss of landscape, habitat and fauna | Álvarez-Farizo and Hanley (2002) |
| | latent | impact on specific location (cliffs) | Álvarez-Farizo and Hanley (2002) |
| | latent | environmental characteristics of siting area | Dimitropoulos and Kontoleon (2009) |
| | physical | effects on local environment | Graham et al. (2009) |
| Economic reasons | physical | costs | Álvarez-Farizo and Hanley (2002) |
| | physical | economic benefits | Baxter et al. (2013), Dimitropoulos and Kontoleon (2009), Graham et al. (2009), Jobert et al. (2007) |
| | latent | economic fairness | Baxter et al. (2013) |
| | physical | effect on property values | Graham et al. (2009) |
| | latent | effect on tourism | Jobert et al. (2007) |
| | physical | ownership of the park, financial participation | Jobert et al. (2007), Sustainable Energy Ireland (2003) |
| Health | latent | health risks | Baxter et al. (2013), Songsore and Buzzelli (2014) |
| | latent | sound | Pedersen et al. (2009) |
| Social reasons | latent | intra-community conflict | Baxter et al. (2013), Graham et al. (2009) |
| | latent | community benefits | Cowell et al. (2011) |
| | latent | effect on personal daily quality of life | Johansson and Laike (2007) |
| | latent | place attachment | Vorkinn and Riese (2001) |
| Decision-making and stakeholders | latent | Patterns, in which decision-making and planning processes are carried out | Dimitropoulos and Kontoleon (2009) |
| | latent | fairness of the process and outcome | Gross (2007), Songsore and Buzzelli (2014) |
| | latent | information and participation | Jobert et al. (2007), McLaren Loring (2007) |
| | latent | energy policy support | Wolsink (2000) |
| | latent | local integration of the developers and network of support from local actors | Jobert et al. (2007) |
| | latent | perception of developer | Graham et al. (2009) |
| Demographics | physical | age, income | Ek (2005) |
| | latent | interest in environmental issues | Ek (2005) |
| | latent | attitude towards wind power in general | Graham et al. (2009) |
| Ethics and Values | latent | national good/ security of supply | Graham et al. (2009) |
| Symbolism | latent | representation of wind turbines | Pasqualetti (2000) |