

## Article

# Does Participation Foster Transformation Processes towards Sustainable Energy Systems? A Case Study of the German Energy Transformation

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**Abstract:** Sustainable energy transformation depends on learning processes, which allow us to cope with constantly changing environmental and social systems. Participation processes are viewed as a means of fostering social learning. In this paper, social learning is applied as an analytical concept to investigate the cognitive effects of participation such as knowledge acquisition, changes of perspective, and knowledge dissemination. Previous studies have indicated that certain characteristics of the participation process foster social learning. However, empirical evidence is still inconclusive, which is why this paper investigates which factors foster social learning. An empirical analysis was conducted on the basis of a quantitative online survey (N = 516), which questioned people who are in some way involved in the German energy transformation (*Energiewende*). The results show that social learning can be enhanced through participation. In particular, moderated processes—which foster a productive exchange, encourage the building of trust among participants, and allow easy access to relevant information—are likely to provide the appropriate conditions for social learning. Personal characteristics such as an individual’s degree of knowledge might have a greater influence on why people change their perspectives than the intensity of participation.

**Keywords:** participation; social learning; Energiewende; sustainable transformation; energy; Germany

## 1. Introduction

Societies must absorb new concepts and ideas to promote transformation processes towards sustainable energy systems [1]. It is for this reason that integrating different knowledge types and creating spaces to critically reflect on information, interests, and norms is crucial to the shift towards sustainable energy systems. A society trained to cope with constant change, uncertainty, and complexity is one that will be able to manage major problems such as climate change. Reißig [2] argues that transformation processes must also be understood as learning processes. van de Kerkhof and Wiczorek [3] emphasize that system change requires knowledge not only about the possibilities for political action, but especially about changes in values, norms, objectives, and other aspects that influence the decision-making process. The development of design-oriented and reflexive abilities in science as well as in society as a whole is viewed as essential in dealing with transformation processes [4]. This is a major challenge in shaping the transformation process. However, merely understanding the problems is not enough; processes of change are also necessary. The concept of “transformative literacy”, which is defined as “the ability to read and utilize information about societal transformation processes, to appropriately interpret and get involved in these processes” is therefore crucial (Ibid. p. 83). Transformations towards sustainability are also understood here as learning processes, which can be enhanced through participation. Learning and empowerment are core aims of transformation processes [5], since the transformation towards a sustainable energy system is an

unprecedented, complex, interrelated, and uncertain process, which requires fundamental change and cannot be governed by traditional mechanisms [6].

In addition, political science literature has identified learning as a key element to understanding public policy processes [7]. In order to understand policy change over time, policy-oriented learning analyses are applied, indicating why belief systems, for example, are being altered [8]. Dialog and deliberation are seen as essential mechanisms to facilitate, trigger, or activate learning processes [7]. The concept of social learning applied here therefore focuses on communicative or dialogic learning theories, emphasizing the process by which learning takes place through interaction with others (The concept of social learning is not commonly defined. For an in-depth discussion about “social learning”, see Muro and Jeffrey [9] and Reed, et al. [10]). In addition, the concept of social learning concentrates on individuals, not organizations or wider social units, and on how comprehension and perspectives of individuals change in the context of participation. It is assumed that due to the acquisition of new information and experiences, a cognitive process is initiated, which leads to the assimilation or accommodation of values, belief systems, and mental models [11]. A social learning process can be divided into different elements [12–14], which also describe the form and intensity of learning:

- acquiring information and increasing knowledge
- cognitive, relational, and technical change
- knowledge transfer to organizations or peer group

Social learning is understood here as a multi-dimensional and dynamic process [14], which occurs through participation. The concept of social learning complements the widely applied concepts of acceptance in energy research, since it focuses on the cognitive process that forms perceptions and attitudes but does not necessarily explain behavior. Social learning processes are viewed as a means of initiating changes in cognitive patterns, but also generating stronger collective action [11]. Furthermore, social learning is central to sustainability, as it represents a format that can deal with complexity, uncertainty, and vested interests [15]. However, the contributions of social learning processes to sustainable transformations are yet to be fully understood [16,17].

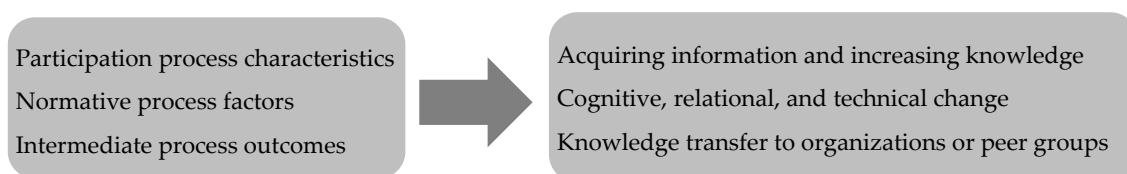
Participation is viewed as a prerequisite for sustainable development [18,19] and, specifically, for stimulating social learning [12,14,15,20–24]. Whether participation improves environmental decision making depends on careful prior planning, adequate resources, and organizational commitment and how the design of participation processes address contextual factors which might cause challenges [25]. Participation is defined here as actors gaining influence over the output and outcome of the decision-making process [26]. In contrast to traditional, sovereign decision-making approaches, the actors involved are not just politicians and state/government representatives, but also experts, laypersons, and organizations that are not legally responsible for making socially relevant decisions [27]. Simple voting procedures such as elections and plebiscites are not considered as a form of participation in this study. Hisschemöller and Cuppen [21] argue that dialog is the ideal way to facilitate learning: It can help (re-)establish trust between different societal groups and (re-)configure their relationships by improving the understanding of each other’s beliefs and actions. Similarly, Lave and Wenger [28] suggest that social engagement, and as such participation processes, provide a proper context to enable learning. However, scholars argue that whether participation facilitates learning or not depends on the design and perception of the participation process [11,29,30]. van der Wal, et al. [31] summarize significant conditions which social learning might depend on, such as the convergence of interests, mutually felt positive interdependence and trust, a balance of power among stakeholders, effective leadership or facilitation, and space for reflection. These conditions more or less describe all face-to-face interactions. However, Vickers [32] concept of appreciation stresses the notion of becoming aware of one’s own position and perception by simply translating “what we suppose to have been awaiting” into concrete words and sharing it with someone else. This means that one-way communication processes, and thus less intensive participation processes, might also facilitate social learning. Furthermore,

Webler, et al. [33] identify social learning as an important outcome of participation, but it has yet to be empirically proven whether a fair and inclusive process facilitates social learning.

A research gap exists between the theoretically derived assumption that participation processes stimulate social learning—and thus foster sustainable energy transformations—and empirically derived findings. Therefore, this paper investigates which specific factors of the participation process foster social learning. The German energy transformation (*Energiewende*) was chosen as a case study because there are a variety of participation processes that play a fundamental role in its implementation. This study of social learning as an outcome of participation processes contributes to research in several key areas. It will provide us with a better understanding of participation outcomes related to energy transformations. In addition, the findings will lead to recommendations that can be practically implemented by policy makers, facilitators of participatory processes, public authorities, NGOs etc. The performed analysis offers the possibility of a standardized assessment of participation processes and provides the necessary information for specific participation processes to be improved further [34].

## 2. Theory and Background

The concept of social learning has already been applied and researched in the field of environmental science. Based on a narrative literature review [35], participatory context factors that influence social learning were identified. These factors are clustered into three general categories: participation process characteristics, normative process factors, and intermediate process outcomes. They influence how or whether participants experience the different elements of social learning: acquisition of information and increasing knowledge; cognitive change (e.g., change of perspectives), relational change (e.g., improved sense of community), and technical change (e.g., awareness of alternative action); and knowledge transfer to organizations or peer groups. Participatory context factors and how they influence social learning are defined in more detail in the following (Figure 1).



**Figure 1.** Factors influencing social learning.

### 2.1. Participation Process Characteristics

Process characteristics are factors such as participation format, access to information, facilitation, participant diversity, context, and participant characteristics. Existing research has found that participation formats which are dialogic—people interact with each other face-to-face—promote social learning more than less intensive participation processes [14]. However, this is disputed, since less intensive participation processes have also led to cognitive change. Independent facilitation can also lead to increased trust and legitimacy [36,37], which in turn foster social learning. The type and number of participants influence social learning [38], but a balanced stakeholder selection is often recommended for successful participation processes [3]. Besides participant characteristics such as gender and age [23], an individual's degree of knowledge might also influence social learning outcomes. Furthermore, the context of the process, such as topic, pre-existing institutions etc., has an impact on social learning processes [39,40].

### 2.2. Normative Process Factors

Normative process factors combine the factors which describe the desirable perceptions of the process. Normative target values have been stressed within research by Fiorino [41], Renn, et al. [42], and Rowe and Frewer [26], who are commonly referred to for empirical analysis. The evaluation criteria identified by these three references describe a well-organized participation process characterized by

opportunities for everyone to participate as equals in face-to-face meetings. These concepts emphasize the importance of fairness and of having an actual influence on the decision. Furthermore, processes which offer process control to the participants are seen as legitimately fostering social learning [14,29]. Faith in one's own ability to engage is a driver for participation and thus also for social learning [22,33]. If someone does not believe his or her actions make a difference, this person will hardly participate at all or view the process as meaningful. An effective and efficient participation process is seen as important when determining successful participation. However, the factors of effectiveness, efficiency, and satisfaction have yet to be investigated in relation to social learning [35].

### 2.3. Intermediate Process Outcomes

Intermediate process outcomes are factors which are developed within the participation process but do not define its final product. Trust, conflict resolution, and network building are discussed in the existing literature as important factors triggering social learning. Trustworthy relationships lead to an open exchange of knowledge and a positive debate [43], which is necessary for acquiring new information or reconsidering one's own position. Trust has multiple dimensions [44]. For this study, trust building, interpersonal trust (trust between the participants), and organizational trust (individuals' trust in organizational decision makers) [45] are investigated and summarized here with the term "trust". The integration of multiple interests, which is important for social learning, is fostered by network building [46]. Whilst disagreement is important for social learning [47], a consensus needs to be reached to make a valid decision [38]. Conflict resolution therefore appears to be an important factor that influences social learning.

## 3. Materials and Methods

A retrospective, self-reporting survey was conducted in December 2017 to investigate which factors influence social learning in the case of participation processes related to the *Energiewende*. A retrospective self-reporting method was applied, since the aim of the investigation was to measure the degree of learning, not the level of knowledge. The *Energiewende* was initiated in the 1960s and has evolved ever since [48]. The main objectives of the *Energiewende* are to decarbonize the energy supply by switching to renewable sources, and to reduce energy demand by using energy more efficiently. This involves phasing out nuclear energy by 2022 and increasing renewables' share of gross final energy consumption to 60 percent by 2050 [49]. The phasing out of coal-fired power plants is currently a much debated and highly controversial topic in Germany. Other key issues include expanding the grid and guaranteeing competitiveness and security of supply.

Participation has been, and still is, an essential element of the *Energiewende* [50]. It occurs at different stages of planning and decision-making processes. Formal participation processes are mandatory at different levels of decision-making processes related to the *Energiewende*. For instance, the German Federal Building Code stipulates public consultation processes during spatial and urban planning to construct, for example, wind farms. This often provides the public with opportunities to submit written statements to draft plans and sometimes information meetings are organized by the local municipality. The exact arrangement and intensity of these public participation processes depend on the local organizer. The organization of site visits or round tables is optional and rests on the willingness and resources of the actors responsible. In addition, the planning to extend the grid system is accompanied by many participation processes. The public can comment on the scenario framework, grid development plans, and environmental report before it passes through federal parliament. This participation process is organized by the German Federal Network Agency. Furthermore, companies, such as the transmission system operators, organize informal events, or mediation processes between conflicting parties are held. Various formats of participation processes related to different topics are therefore implemented all over Germany. This makes the *Energiewende* an interesting case study.

However, no data exist providing information on the exact sample frame: demographic information about the average participant of decision-making processes related to the *Energiewende* and the number of participation processes. A number of studies [51–53] provide general indications regarding the characteristics of people who are more likely to participate in the *Energiewende*, but there is still a lack of profound empirical data. It is therefore difficult to contact participants directly. In contrast, contact data from organizers, policy makers, or representatives of companies and civil society groups can be easily researched. The study aims to cover all sorts of participation formats and topics related to the *Energiewende*, which is necessary when investigating the different values of factors that influence social learning. Due to the difficulty of reaching out to the average participant, an existing online access panel was chosen to distribute the survey. A survey institute was tasked with converting the survey into an online platform and sending an individual access link to the people registered in the access panel. The panel participants were representative of the German public. The survey was representative in terms of the criteria age, gender, regional distribution (State) as well as education, which were in accordance with the distribution in the German population. Participants throughout Germany were invited to take part in the survey without any form of preselection, such as characteristics, which are seen as indicating active participation.

A total of 8087 people were contacted. In order to select people who had participated in a planning and/or decision-making process related to the *Energiewende*, some selection requirements were defined beforehand and operationalized in the first four questions. The first two questions asked whether and how individuals were involved in a participation process related to the *Energiewende*. A total of 6538 respondents (80.2 percent) answered that they had never been engaged in a participation project related to the *Energiewende*, thus bringing the survey to an end for them. Furthermore, the participation process had to have been finalized in order to make a judgement about the whole process. The third selection question therefore asked whether the participation process was finalized. In total, 416 respondents (5.1 percent) said that the participation process had not yet been finalized. Due to the retrospective nature of the survey, the participation process should have ended no earlier than 2014 to ensure that participants could still reflect on the process. A total of 95 respondents (1.2 percent) indicated that they had engaged in a process that was finalized before 2014. Altogether, 7014 (86.7 percent) of the individuals contacted were rejected because they did not match the survey's target group. A further 557 respondents (6.9 percent) were excluded because of the following criteria: they did not complete the survey (351); they incorrectly answered the test question, checking whether someone was randomly clicking through the survey (53); the interview length was too short, response behaviour was implausible, or share of "no information" was too high (132); they did not relate to energy topics (9); they referred to participation processes such as plebiscites, which are not included in the definition of participation applied in this study (3); or they did not answer any of the questions indicating how they had participated (9). This selection process resulted in 516 valid responses, which represents a response rate of about 6.4 percent.

The survey consisted of 65 questions, of which six were open-ended and 59 closed-ended questions (for full survey, see Appendix A). The survey sought information regarding the participation format (e.g., duration, intensity); context (e.g., topic, pre-existing conflict); individual characteristics of the participant (e.g., age, gender); facilitation of the process; diversity of participants; access to information; perception of the participation process as fair, legitimate, effective, and efficient; and satisfaction regarding the respondent's own engagement. Additional questions were asked concerning trust, conflict resolution, and network building. Thirteen questions measured the different elements of social learning. The survey was constructed on the basis of questions from previous research into social learning and the evaluation of participation processes [11,22,23,29,54,55]. These questions were adjusted and complemented by new questions regarding the specific topic and aims of the study. Not all questions required an answer from each respondent. Depending on how previous questions were answered, some questions were not asked or asked differently. For example, only respondents who indicated that they had taken part in a participation format including face-to-face interaction were



questioned about how they perceived other participants (questions 40–44). This procedure was chosen to prevent respondents from feeling frustrated that they were unable to answer these questions.

The obtained data was first analyzed through descriptive statistics followed by a regression analysis, using IBM SPSS software version 19. Social learning is a multi-dimensional, dynamic process characterized by different elements, which evolve over the course of the participation process [14] but are not commonly defined by the literature [56]. The dependent variable of social learning is therefore differentiated in two composite variables:

1. Acquisition of information and knowledge (“Acquisition”)
2. Cognitive change (e.g., change of perspectives), relational change (e.g., improved sense of community), technical change (e.g., awareness of alternative action), and knowledge transfer to organizations or peer groups (“Change and Dissemination”).

A reliability check was conducted for all dependent variables and Cronbach’s alpha was calculated to determine which variables to include in the composite variables. The dependent variables of “Acquisition” have a Cronbach’s alpha of 0.890 and the dependent variables of “Change and Dissemination” have a Cronbach’s alpha of 0.764. Table 1 presents the items included in the two dependent variables.

**Table 1.** Items of the dependent variables.

	Question
<b>Acquisition</b>	Due to the participation process, I have gained a better understanding about ...
	... the topic
	... different interests
	... economic consequences
	... social consequences
	... impacts on the environment
<b>Change and Dissemination</b>	Through the participation process, my views and attitudes have changed about important questions and problems related to the German energy transformation. (Change of perspectives)
	My views and attitudes were disproved by the participation process. (Perceptions were disproved)
	I have spoken with colleagues, friends, or acquaintances about the results and experiences I have gained during the participation process. (Talked to peer group)
	The participation process has made me aware of alternative actions or solutions. (Alternative solutions)
	As a result of the participation process, I feel more strongly to be part of a community working together towards solving common problems. (Strength of community)

## 4. Results

To understand how the identified factors summarized in the three general categories of “participation process characteristics”, “normative process factors”, and “intermediate process outcomes” influence social learning processes, a clear description of each variable is necessary. The univariate results of each variable are therefore presented, which help in understanding the results of the multivariate analysis in the second part.

### 4.1. Participation Process Characteristics: Participant Characteristics

Characteristics of the individual participant are considered to be important features that influence the learning outcome [23,57]. As expected, more men responded than women: 60.5 percent of the 516 respondents were male and 39.5 percent were female. The age of respondents varied between the minimum of 18 years and the maximum of 78 years, with a mean of 44.89 (SD = 15) years. Most of the respondents (70.4 percent) (The numbers in percentages presented in the following univariate

evaluation were rounded to one decimal place. Due to this rounding, the results do not always add up to 100 percent)) worked either part- or full-time, while 13.2 percent were retired, 9.9 percent were pupils, students, or trainees, 2.9 percent were unemployed, 1.9 percent were on parental leave, and 1.7 percent were “incapable of working” during the participation process. The education level of the respondents was rather high, with 39.7 percent holding a university degree, 37.6 percent having finished school (sum of all three school forms in Germany), 16.1 percent having completed an apprenticeship, 6.2 percent having a master craftsman’s qualification or similar, and 0.4 percent having no school degree. In addition, the individual degree of knowledge of the respective topic before the participation process was estimated by each respondent. In response to the statement “Before the participation process, I knew nothing about the topic”, 45.9 percent gave one of the following responses: completely not true, not true, or rather not true.

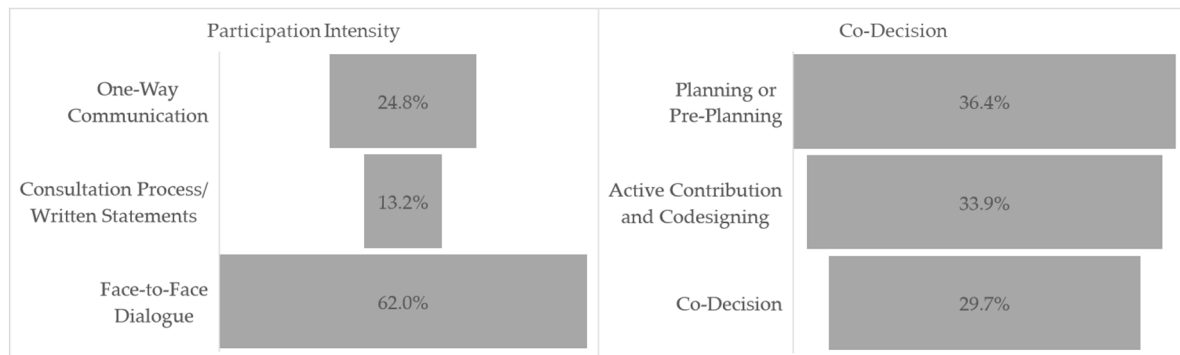
#### 4.2. Participation Process Characteristics: Context

One prerequisite for the survey was that the process must have ended in the past three years (2014–2017). Most of the respondents referred to a participation process that ended in 2016 (46.9 percent). Meanwhile, 28.1 percent referred to a process finalized in 2017, 17.3 percent in 2015, and 7.8 percent in 2014. The processes were spread throughout Germany, located in each federal state. The respondents were asked to name the topic of the process in an open-ended question format. The answers were summarized into 20 categories: wind energy; solar energy; biogas; hydropower; renewable energy; energy supply; electricity and heat transport; nuclear power plant; coal power plant; lignite mining; mobility; urban/neighborhood planning; energy-efficient buildings; energy efficiency; other energy transition projects; nuclear waste storage; gas production (inorganic); other power plants; geothermal and spatial planning. Most respondents (42.3 percent) cited “wind energy” as a topic. The topics “spatial planning”, “solar energy”, and “renewable energy” were each cited by about 10 percent of the respondents. The topics “other energy transition projects” and “electricity and heat transport” were cited by about 5 percent of the respondents. “Energy supply” and “energy efficiency” were each cited by about 2 percent of the respondents. Each of the other categories was referred to by less than 2 percent of the respondents. These results show how throughout Germany, wind turbines are being built and, due to spatial planning regulations, participation processes are mandatory when deciding where they are located. This is therefore the most common context by far with regard to participation in *Energiewende* projects. Furthermore, the respondents were asked whether a conflict about this topic existed before the participation process: 43 percent stated that a conflict existed, 34.5 percent said that none existed, and 22.5 percent either did not know or did not provide an answer.

#### 4.3. Participation Process Characteristics: Participation Format

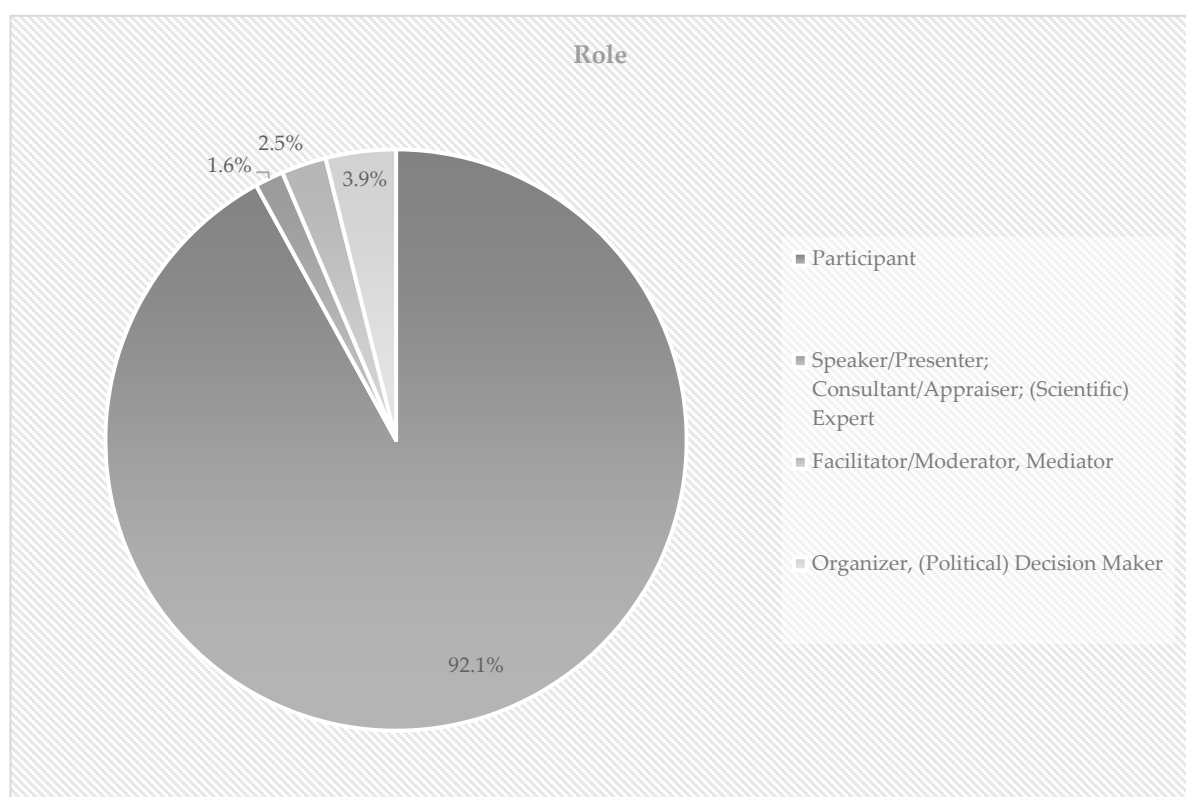
The intensity and duration of the participation of each respondent were documented through several questions. First of all, it was determined how each respondent had participated. Respondents could tick corresponding categories but were also able to add missing descriptions in an open-ended question. These answers were summarized into three categories. Figure 2 shows that 24.8 percent of the respondents participated exclusively in the form of one-way communication: they gathered information themselves and went to information meetings. A figure of 13.2 percent of the respondents took part in consultation processes and submitted comments or statements, which also included online participation. However, most of the respondents (62 percent) engaged in face-to-face dialog. In separate questions, the co-decision ability was captured and answers were also summarized into three categories. In the planning or pre-planning process 33.5 percent of the respondents took part and their statements were considered. Of the respondents 31.2 percent were able to shape the decision in the sense that they were able to engage also during later stages of the decision-making process as well as being able to co-design alternatives and the solution. However, the final decision was still made by a specific actor such as policy makers or government. A number of 27.3 percent stated that the

decision was made by everyone engaged in the process while 7.9 percent of the respondents did not know or did not respond to any of the questions about the degree of co-decision. This sample size therefore provides data from people who have participated to varying degrees.



**Figure 2.** Participation intensity (N = 516) and co-decision (N = 475).

Another aspect providing information about the degree of participation is the role respondents played in the participation process. The respondents could tick up to eight categories; multiple answers were possible and are summarized in four categories in Figure 3: The majority of respondents indicated that they were solely engaged as participants (92.1 percent), 3.9 percent of the respondents had the role of organizer and/or decision maker, 2.5 percent moderated or mediated the process, and 1.6 percent took part either as an expert, consultant, and/or presenter. This shows that the results mainly refer to the experiences of average participants in decision-making processes related to the *Energiewende*.

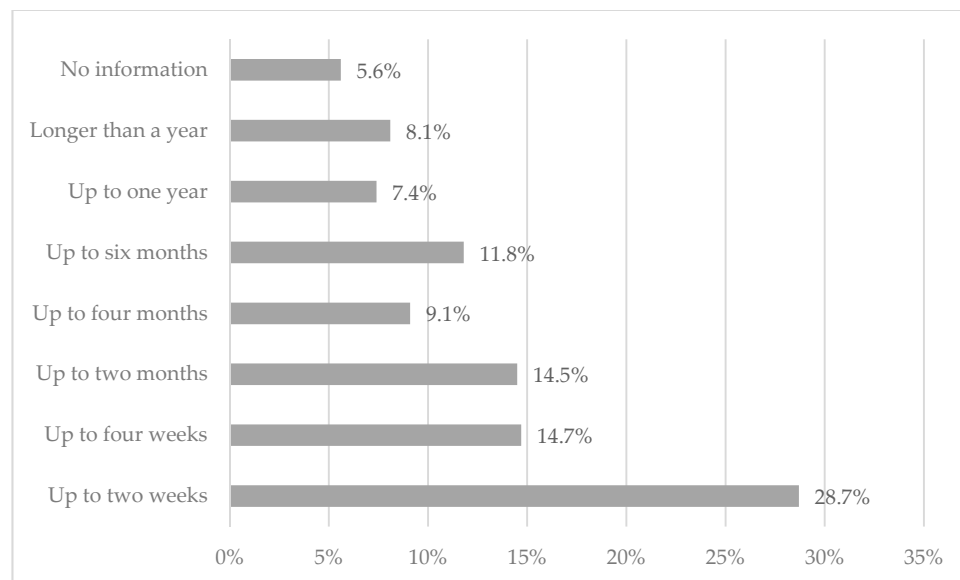


**Figure 3.** Role of participants (N = 516).

In addition, the respondents were asked whether and how often they participated in a meeting or event. Figures of 45.9 percent had participated in one meeting, 33.3 percent in two or three



meetings, 9.3 percent in four or more meetings, and 11.4 percent had not participated in any meeting. Furthermore, the duration of individual participation was quite diverse, as shown in Figure 4.

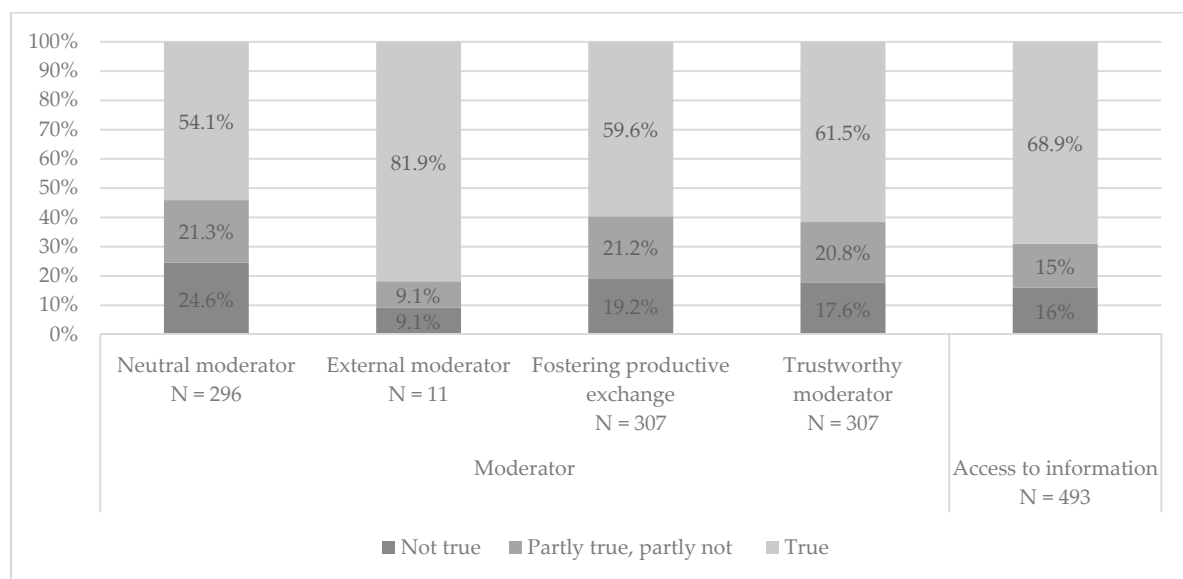


**Figure 4.** Duration of individual participation (N = 516).

Most of the processes were rather inclusive in the sense that 73.1 percent of the processes were open for everyone to attend. Of the respondents 18.4 percent stated that the participants had been chosen and invited to participate while 8.5 percent of the respondents indicated that they did not know who was able to participate. Furthermore, the diversity of participants was measured by asking whether the respondents felt that all affected parties were represented in the process: 60.2 percent found this to be “true”.

#### 4.4. Participation Process Characteristics: Moderation

Respondents who did not indicate if they had participated as a moderator or facilitator were asked whether the participation process was moderated. Of all respondents 59.5 percent indicated that the process was moderated, and 38.4 percent indicated that the process was not moderated. (The remaining respondents (2.1 percent) indicated earlier in the survey that they had participated as a moderator, which is why this question and the follow-up questions about moderation were not included in their survey). The respondents who said that the process was moderated were surveyed on their perception of the moderation. Moderation should be neutral [3,40], i.e., whether the facilitation was independent of the organizer. Respondents who indicated that they had participated as an organizer or decision maker were therefore asked whether an external participant had moderated the process. A large majority (81.9 percent) of these respondents indicated that an external person had moderated the process. The other respondents were asked whether the moderation was neutral, which more than half indicated to be “true” (54.1 percent). (For better comprehension of the seven-point Likert scale, the answers are summarized as follows: the three answer categories “rather true (5), true (6), or completely true (7)” are summarized as “true”; and the three answer categories “not true at all (1), not true (2), and rather not true (3)” are summarized as “not true”). Many processes were therefore moderated by a neutral moderator. Furthermore, most respondents tended to agree that the moderation fostered a productive exchange (mean of 4.9, SD = 1.6) and was trustworthy (mean of 5, SD = 1.6). (For more details, see Figure 5)



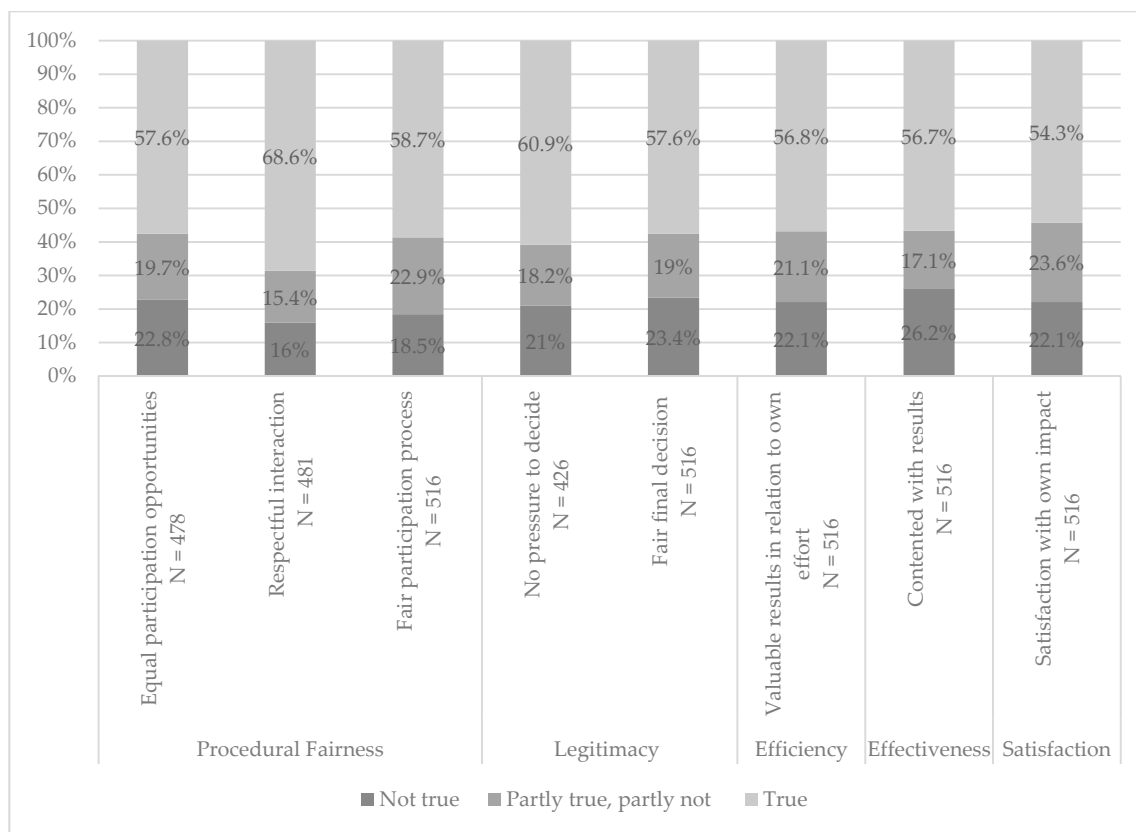
**Figure 5.** Participation process characteristics (seven-point Likert scale answers summarized in three categories).

#### 4.5. Participation Process Characteristics: Access to Information

Of respondents 68.9 percent agreed that information on the topic had been provided and was easily accessible.

#### 4.6. Normative Process Factors: Procedural Fairness, Legitimacy, Effectiveness, Efficiency, and Satisfaction

Respondents were also asked to evaluate the participation process based on the previously defined normative process factors (see Section 2). In general, most respondents viewed the overall process as fair, legitimate, effective, and efficient, and were satisfied with their own engagement (see Figure 6). Between 54.3 percent and 68.6 percent of the respondents gave the response “true” to questions about normative process factors. The processes were mainly seen as respectful (mean 5.22, SD = 1.6) and without any decision-making pressures (mean 4.89, SD = 1.8).



**Figure 6.** Normative process factors (seven-point Likert scale answers summarized in three categories).

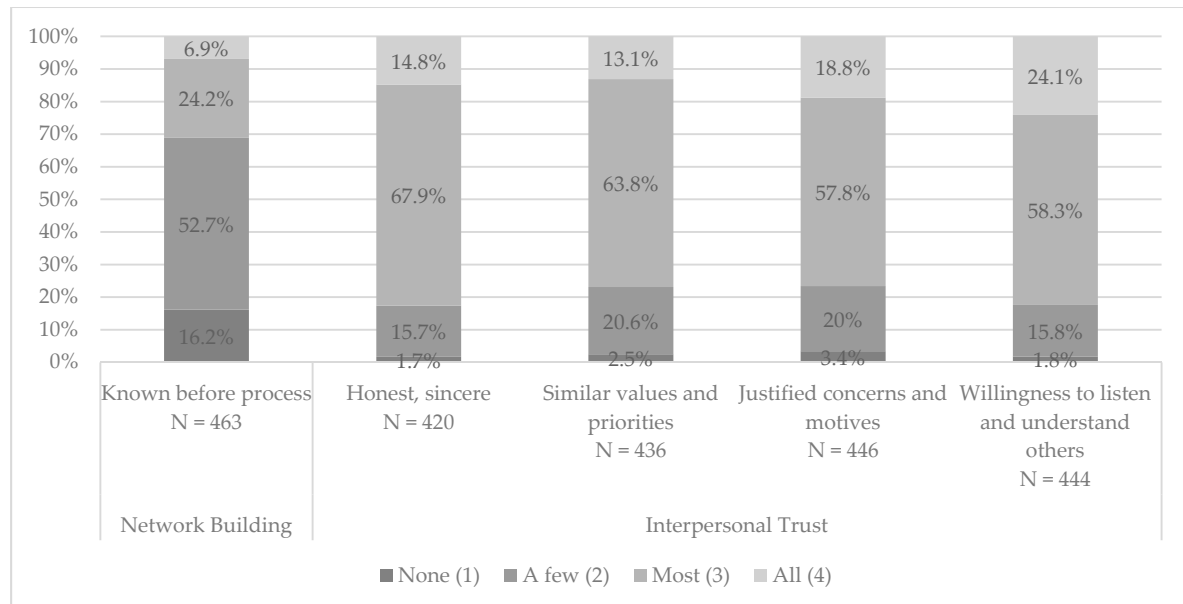
#### 4.7. Intermediate Process Outcomes: Trust, Network Building, and Conflict Resolution

The variables trust, conflict resolution, and network building were measured by means of several questions. The first five questions differed in their answer scheme to the other retro-perspective evaluation questions. A four-point rating scale was applied to measure interpersonal trust and network building (see Figure 7). The first question in this set of variables asked respondents about how many other participants they knew before the process. A number of 52.7 percent answered that they were familiar with a few other participants. These results suggest that most respondents made new acquaintances during the process.

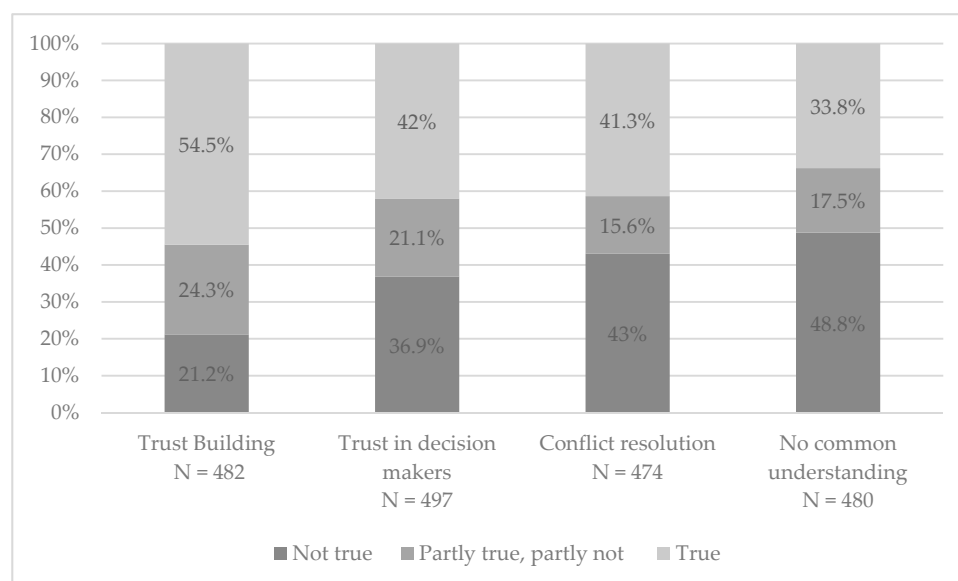
Interpersonal trust, i.e., trust in other participants' ability to communicate honestly and negotiate in good faith, might foster social learning [23]. The results given in Figure 7 indicate that a large majority of respondents felt that their fellow participants were mostly honest, sincere, and willing to listen as well as genuinely trying to understand each other's points of view. Similar priorities were obtained for questions about whether other participants shared the same values and priorities and reasonable concerns and motives. These results suggest that interpersonal trust was generally quite high between the participants, which helps participants to open up and share insights and information.

Questions about trust building, organizational trust (trust in decision makers), and conflict resolution were asked using a seven-point Likert scale (see Figure 8). Half of respondents (54.5 percent) indicated that they had an increased trust of other participants. However, data regarding the variable organizational trust was less distinctive. Only 42 percent of respondents answered "true" to the statement "I trust the persons responsible to make the right decision". Fellow participants were viewed as trustworthy, but the decision-making competencies of organizers and policy makers, for example, were regarded as neutral overall. Furthermore, the conflict resolution capacity of the participation process was assessed less positively. With 41.3 percent citing as "true" the fact that conflicts arose which went unresolved, the results provide no clear indication as to whether or not participation processes help in overcoming conflicts. Of the respondents 48.8 percent indicated that a common

understanding was established. However, 33.8 percent said that no common understanding was reached. The results thus provide further indication that participation processes can lead to conflict resolution, but that conflicts and disagreements can also emerge and remain unresolved.



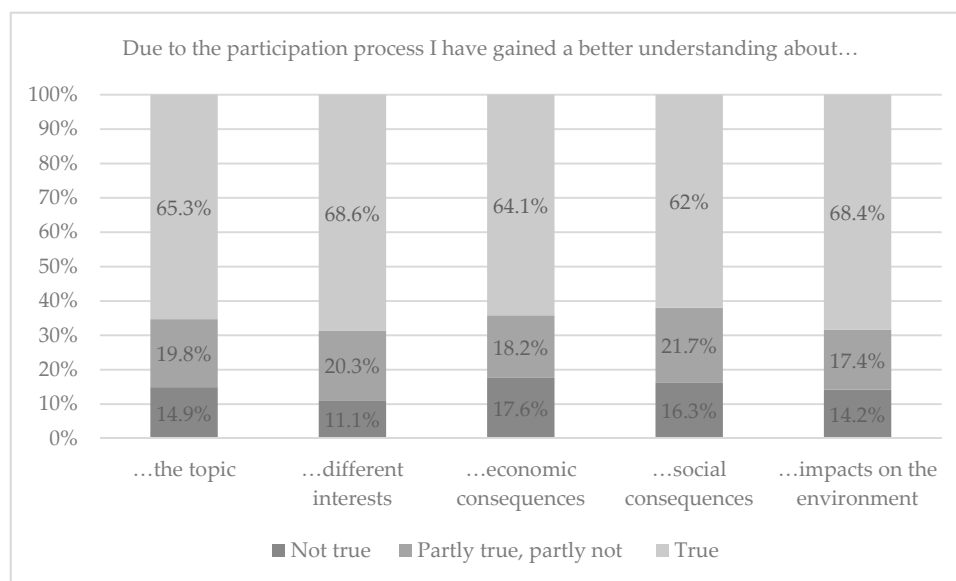
**Figure 7.** Intermediate process outcomes 1 (four-point scale).



**Figure 8.** Intermediate process outcomes 2 (seven-point Likert scale answers summarized in three categories).

#### 4.8. Social Learning

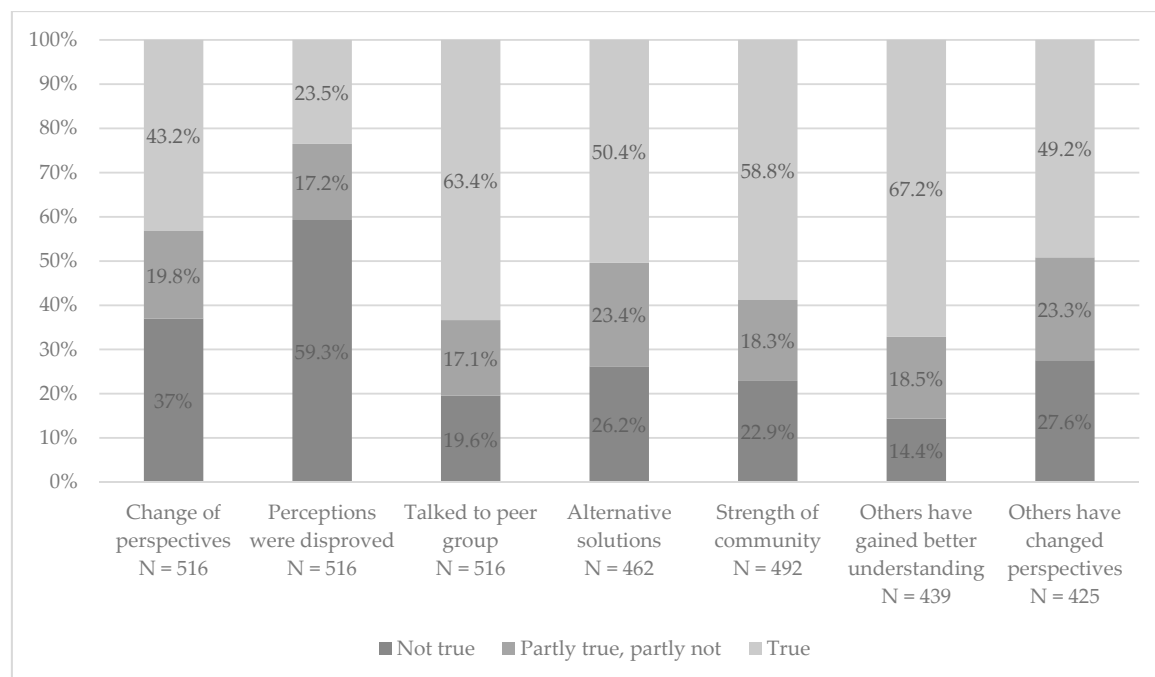
The dependent variable of social learning was assessed by means of 12 questions and measured different elements of learning. The acquisition element of social learning (acquisition of facts, information, and knowledge) was measured using a set of five questions. The results displayed in Figure 9 show that the majority of respondents gained a better understanding of different aspects of issues related to the *Energiewende*.



**Figure 9.** Acquisition element of social learning (seven-point Likert scale answers summarized in three categories).

The change and dissemination element of social learning was reported less often by the respondents than acquisition of knowledge (see Figure 10). More respondents tend to agree that their perspective changed (43.2 percent) than disagree (37 percent). However, 59.3 percent disagreed that their perceptions were disproved, indicating that they felt validated in their opinions and attitudes. This suggests that the questioning of personal values was rarely fostered by the participation process. Knowledge transfer to the respective peer group or organization the respondent is involved in, occurs quite frequently (63.4 percent) and the sense of community was strengthened by 58.8 percent of the respondents. Two questions, regarding the acquisition of knowledge and change of perspectives by other participants, were asked to examine whether there was a distinction between self-perception and external perception. A comparison of these two questions, with the results for the self-reported degree of learning, shows that the self-perception and perception of other learning degrees differ somewhat. The degree of knowledge acquisition is also higher than the degree for changing perspectives. Self-perception thus differs from the perception of other learning degrees, but the overall tendency of the results is similar.





**Figure 10.** Change and dissemination element of social learning (seven-point Likert scale answers summarized in three categories).

#### 4.9. Multivariate Analysis

Multivariate statistical analyses were conducted in order to investigate the relationships between the factors summarized in the general categories (“participation process characteristics”, “normative process factors”, and “intermediate outcomes”) and social learning. The category “participation process characteristics” consists of 17 independent variables (Including three variables about moderation. The items neutral moderator and external moderator were combined to a new variable “neutral and external Moderation.”); “normative process factors” and “intermediate outcomes” both comprise eight variables, which were checked for multicollinearity. The dependent variable “social learning” was divided into two composite variables: “acquisition” and “change and dissemination” (see “Materials and Methods” section for more details).

#### 4.10. Factors Influencing Social Learning: Participation Process Characteristics

The descriptive statistics showed that 307 of the 516 respondents experienced a moderated participation process. For this reason, 40.5 percent of the respondents could not be represented in a regression model including questions about moderation. Two models, which differ with regard to case selection and number of independent variables, were therefore run for each analysis with the category “participation process characteristics”. The following first two models represent a regression model based on the answers of respondents who experienced a non-moderated participation process, meaning the model does not include the three variables of moderation. The other two regression analyses investigating the relationship between participation process characteristics and social learning represent the respondents who have experienced a moderated participation process, with these models including the three variables of moderation.

A linear regression model (N = 158) of how participation process characteristics (without moderation) influence the acquisition element of social learning resulted in an effect size of  $R^2 = 0.265$ . This means that the variables included in the model explain 26.5 percent of the variation of social learning, which is acceptable for a regression model that investigates social relationships. Table 2 shows that of the 14 independent variables tested, only three have a significant relationship with the dependent variable “acquisition”. The independent variable with the strongest influence in this

model is “access to information”, with Beta = 0.292 on acquisition of knowledge. In addition, the two independent variables describing participant diversity—“all affected interests included” and “inclusiveness”—are also significant, but are only loosely related to the acquisition element of social learning. This suggests that easy access to relevant information and an inclusive participation process, which enable all parties affected to participate, provide participation characteristics that make it more likely for people to acquire information and knowledge. Interestingly, the variables representing participant characteristics, participation format, and context have no statistically significant influence on the acquisition of knowledge or information.

The second regression model representing non-moderated participation processes that investigate the relationship between participation process characteristics and “Change and Dissemination” resulted in  $R^2 = 0.247$ . In contrast to the first model, four of the 14 variables tested show a significant relationship to the dependent variable. The variables “knowledge before the process”, “topic”, “all affected interests included”, and “participation duration” are statistically significant. The strongest relationship to the dependent variable in this model is the variable “knowledge before the process” at Beta = 0.268. The variables “topic”, “all affected interests included”, and “participation duration” are significant but only at the 5 percent level. A comparison of these two models indicates that the two elements of social learning—“acquisition” and “change and dissemination”—are influenced by different factors. Although both models showed a significant relationship between “all affected interests included” and the dependent variable, the Beta values are rather low at 0.185 and 0.188, respectively. The social learning element of “acquisition” demonstrated the strongest relationship to “access to information” and the social learning element of “change and dissemination” to “knowledge before the process”. This indicates that individual characteristics such as “knowledge before the process” have a much greater influence on “change and dissemination” than the acquisition of knowledge. In contrast, participant diversity and easy access to information appear to influence whether participants acquire new information or knowledge.

**Table 2.** Linear regression model of how participation process characteristics (without moderation) influence social learning (significant predictors highlighted in grey).

	Acquisition				Change and Dissemination			
	R <sup>2</sup> = 0.265 N = 158				R <sup>2</sup> = 0.247 N = 158			
	Unstandardized Coefficients		Standardized Coefficients	Sig.	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta		B	Std. Error	Beta	
<i>Participant Characteristics</i>								
Gender	−0.025	0.193	−0.010	0.896	−0.126	0.197	−0.050	0.524
Age	0.010	0.006	0.130	0.088	0.002	0.006	0.030	0.693
Educational attainment	−0.062	0.042	−0.108	0.147	−0.081	0.043	−0.140	0.064
Knowledge before process	0.098	0.059	0.128	0.097	0.206	0.060	0.268	0.001
<i>Context</i>								
Topic	−0.005	0.015	−0.028	0.716	−0.030	0.015	−0.156	0.048
History of conflicts	−0.001	0.002	−0.022	0.784	−0.002	0.002	−0.052	0.527
<i>Participation Format</i>								
Role	−0.022	0.156	−0.011	0.887	0.089	0.160	0.044	0.577
Participation intensity	0.100	0.114	0.070	0.381	0.061	0.117	0.042	0.602
Co-decision	−0.007	0.004	−0.142	0.061	−0.006	0.004	−0.113	0.140
Participation frequency	−0.008	0.102	−0.006	0.938	0.221	0.104	0.179	0.035
Participation duration	−0.004	0.004	−0.082	0.272	−0.001	0.004	−0.028	0.708
<i>Participant Diversity</i>								
All affected interests included	0.141	0.067	0.185	0.038	0.146	0.069	0.188	0.037
Inclusiveness	0.414	0.195	0.158	0.035	−0.138	0.199	−0.052	0.489
<i>Access to Information</i>								
Access to information	0.229	0.066	0.292	0.001	0.001	0.068	0.002	0.985

The two regression models investigating the relationship between moderated participation processes and social learning resulted in four statistically significant relationships to the dependent variable “acquisition”. The strongest relationship (Beta = 0.252) is between the variable “fostering productive exchange” and “acquisition”. Furthermore, “participation intensity” (Beta = 0.176) is highly significant with respect to the acquisition of knowledge. The two variables “knowledge before the process” and “access to information” are also significant predictors.

The model investigating the relationship between moderated participation and the social learning element “change and dissemination” explains the variation of the dependent variable to within around 36 percent. Six of the 17 participation process characteristics included have a statistically significant relationship with “change and dissemination”. “Knowledge before the process” and “fostering a productive exchange” are highly significant in terms of the dependent variable. The two variables “age” and “participation duration” both have a significantly negative relation to “change and dissemination”. The negative relationship between age and “change and dissemination” indicates that younger participants are more likely to change their perspectives and share lessons they have learned with their peer group. Meanwhile, the negative relationship between “participation duration” and “change and dissemination” suggests that the longer someone is engaged, the less likely this person will change or reconsider his or her position. In addition, the variable “all affected interests included” appears to have a significant influence on the dependent variable, but the relationship is weaker than between the dependent variable and both independent variables “knowledge before process” and “fostering productive exchange”. In contrast to the model investigating non-moderated participation, the significant factors explaining “change and dissemination” are different, with the exception of “knowledge before the process” and “all affected interests included”, which are significant in both models. The two models investigating moderated participation indicate that different factors influence the two social learning elements. Participant characteristics such as age and an individual’s knowledge before the process appear to have a much stronger influence on the social learning element of “change and dissemination” than “acquisition”. Furthermore, the independent variable “fostering productive exchange” shows a stronger relationship to “change and dissemination” (Beta = 0.316) than to “acquisition” (Beta = 0.252). Similar to the models investigating non-moderated participation, the factor “access to information” has a significant relationship to “acquisition”. Therefore, the factor “access to information” seems to be a substantial impact factor for the acquisition of information and knowledge.

The models including the moderation variables resulted in higher  $R^2 = 0.393$  and  $R^2 = 0.358$  (see Table 3) than the two models representing non-moderated participation. Models which include moderation variables thus appear to be better suited to explaining the variance in social learning than models without those variables. This finding suggests that moderation is an important factor influencing social learning.

**Table 3.** Linear regression models of how participation process characteristics (including moderation) influence social learning (significant predictors highlighted in grey).

	Acquisition				Change and Dissemination			
	R <sup>2</sup> = 0.393 N = 266				R <sup>2</sup> = 0.358 N = 266			
	Unstandardized Coefficients		Standardized Coefficients	Sig.	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta		B	Std. Error	Beta	
<i>Participant Characteristics</i>								
Gender	0.026	0.135	0.011	0.846	0.166	0.143	0.064	0.248
Age	−0.004	0.004	−0.050	0.339	−0.014	0.005	−0.162	0.003
Educational attainment	0.005	0.031	0.009	0.858	−0.040	0.033	−0.066	0.216
Knowledge before process	0.085	0.037	0.123	0.022	0.193	0.039	0.271	0.000
<i>Context</i>								
Topic	−0.006	0.009	−0.031	0.540	0.006	0.010	0.031	0.546
History of conflicts	0.001	0.002	0.042	0.435	0.001	0.002	0.016	0.765
<i>Participation Format</i>								
Role	−0.035	0.099	−0.018	0.724	0.043	0.105	0.022	0.681
Participation intensity	0.260	0.079	0.176	0.001	0.268	0.084	0.175	0.002
Co-decision	0.002	0.003	0.028	0.599	0.001	0.004	0.012	0.820
Participation frequency	0.041	0.069	0.032	0.553	0.096	0.074	0.073	0.195
Participation duration	−0.006	0.004	−0.066	0.200	−0.012	0.005	−0.142	0.008
<i>Moderation</i>								
Neutral and external moderation	0.018	0.058	0.026	0.760	−0.016	0.061	−0.023	0.791
Fostering productive exchange	0.195	0.070	0.252	0.006	0.252	0.075	0.316	0.001
Trustworthy moderator	0.079	0.074	0.106	0.288	0.029	0.079	0.037	0.715
<i>Participant Diversity</i>								
All affected interests included	0.069	0.059	0.089	0.245	0.130	0.063	0.161	0.041
Inclusiveness	−0.036	0.141	−0.013	0.798	−0.065	0.150	−0.023	0.663
<i>Further Participation Process Characteristics</i>								
Access to information	0.165	0.065	0.205	0.011	0.010	0.069	0.012	0.882

In summary, these results indicate that different elements of social learning are fostered by different factors of the participation process. However, the results suggest that the variables “all affected interests” and “knowledge before the process”, which both showed significant relationships in three of the four models, are generally important impact factors in terms of social learning. Interestingly, the participation format and the context had either no or only moderate influence on social learning within non-moderated participation processes. However, the independent variable “topic” is not normally distributed, meaning a significant influence between topic and social learning might still be possible. The models representing moderated participation showed that the participation format had a significant influence, whilst context factors had no influence. The results of the models representing moderated participation indicated that moderation, which is perceived to foster a productive exchange, is one of the most relevant impact factors explaining social learning.

#### 4.11. Factors Influencing Social Learning: Normative Process Factors

The regression model investigating the relationship between the generic category of normative process factors and the dependent variable acquisition (N = 435) resulted in an effect size of  $R^2 = 0.315$ . The results presented in Table 4 indicate that “equal participation opportunities” (Beta = 0.142) and “respectful interaction” (Beta = 0.164) are positively and significantly related to “acquisition”. However, the relationship is rather weak, with significance at the 5 percent level. The overall perception of the participation process as being fair appears to have no influence on social learning. Furthermore, the results suggest that perceptions of effectiveness, efficiency, and the satisfaction of participants with respect to their own impact and legitimacy are not related to social learning. However, the model accounts for 31 percent of social learning, which is contrary to the low level of significance or non-statistical significance of the single variables included in the model. These factors might therefore be of importance in terms of influencing social learning. The second model investigating the

relationship between normative process factors and the dependent variable “change and dissemination” resulted in a much lower  $R^2 = 0.204$  and none of the independent variables show a statistically significant influence. The models indicate a weak linear relationship between normative process factors and social learning, although there might still be a significant relationship. These results further prove that different social learning elements are impacted by different factors of the participation process, but that further investigation is required with respect to how normative process factors influence social learning.

**Table 4.** Linear regression models of how normative process factors influence social learning (N = 435, significant predictors highlighted in grey).

	Acquisition				Change and Dissemination			
	R <sup>2</sup> = 0.315				R <sup>2</sup> = 0.204			
	Unstandardized Coefficients		Standardized Coefficients	Sig.	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta		B	Std. Error	Beta	
<i>Procedural Fairness</i>								
Equal participation opportunities	0.099	0.039	0.142	0.012	0.061	0.042	0.087	0.150
Respectful interaction	0.127	0.042	0.164	0.003	0.031	0.046	0.039	0.539
Fair participation process	0.053	0.052	0.067	0.312	0.028	0.056	0.036	0.613
Efficiency	0.002	0.056	0.002	0.974	−0.036	0.061	−0.046	0.552
Effectiveness	−0.007	0.057	−0.010	0.898	0.036	0.061	0.051	0.552
Satisfaction	0.091	0.050	0.115	0.071	0.094	0.054	0.119	0.081
<i>Legitimacy</i>								
No decision pressures	0.066	0.041	0.096	0.106	0.085	0.044	0.123	0.056
Fair final decision	0.103	0.055	0.134	0.061	0.115	0.059	0.150	0.052

#### 4.12. Factors Influencing Social Learning: Network Building, Trust, and Conflict Resolution

Table 5 provides the results of the regression models, which analyze the relationship between social learning and the intermediate process outcomes of trust, network building, and conflict resolution. An effect size of  $R^2 = 0.351$  was measured for the model, explaining the social learning element “acquisition”. The strongest significant relationship was measured between the variable “trust building” and “acquisition” at Beta = 0.340. Furthermore, the variable “trust in decision makers” was significantly related to the dependent variable. The results show that network building has a low and negative impact on “acquisition”, thus indicating that the fewer people someone knows before the process, the more knowledge he or she acquires.

The eight tested variables summarized as intermediated outcomes explain the social learning element of “change and dissemination” to within about 38 percent. The variables “known before process”, “trust building”, “trust in decision makers”, and “conflict resolution” are significantly related to “change and dissemination”. Trust building (Beta = 0.309) and “trust in decision makers” (Beta = 0.298) have the strongest relation to “change and dissemination”. It can therefore be assumed that if people trust the responsible decision makers, organizers etc., they are more likely to change their perspectives and feel more part of a community. The most prominent result to emerge from the data is that while conflict resolution does not have a significant impact on the acquisition of knowledge and information, it is still highly significant for “change and dissemination”. This is because unresolved conflicts hinder the strengthening of a sense of community. Furthermore, participants who are familiar with each other enhance the questioning of values or strengthen the sense of community, but the level of significance is only at 5 percent.

The degree of trust building with respect to other participants is highly significant and positively related to the dependent variables “acquisition” and “change and dissemination”. In addition, trust in decision makers has an impact on social learning, but it is more significant for “change and dissemination” than the acquisition of information and knowledge. The evidence therefore suggests



that trust building and organizational trust (individuals' trust in organizational decision makers) have an important impact on social learning, whilst interpersonal trust (trust between participants) seems to have no substantial influence on social learning. Interestingly, whether people made new acquaintances has a negative significance in relation to the acquisition of information and knowledge, and a positive significance in terms of "change and dissemination". These results further indicate that the different elements of social learning are influenced by different factors of the participation process.

**Table 5.** Linear regression model of how trust, network building, and conflict resolution influence social learning (N = 361, significant predictors highlighted in grey).

	Acquisition				Change and Dissemination			
	R <sup>2</sup> = 0.351				R <sup>2</sup> = 0.377			
	Unstandardized Coefficients		Standardized Coefficients	Sig.	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta		B	Std. Error	Beta	
<i>Network Building</i>								
Known before process	−0.171	0.074	−0.107	0.021	0.147	0.072	0.092	0.042
<i>Trust</i>								
Honest, sincere	0.197	0.114	0.098	0.085	−0.042	0.111	−0.021	0.708
Similar values and priorities	0.198	0.108	0.102	0.067	0.127	0.105	0.066	0.229
Justified concerns and motives	0.136	0.082	0.080	0.097	0.115	0.080	0.068	0.149
Willingness to listen to and understand others	0.184	0.101	0.103	0.069	0.067	0.098	0.038	0.492
Trust building	0.279	0.047	0.340	0.000	0.252	0.046	0.309	0.000
Trust in decision makers	0.094	0.042	0.123	0.025	0.228	0.041	0.298	0.000
<i>Conflict Resolution</i>								
Conflict resolution	0.019	0.030	0.028	0.529	0.116	0.029	0.178	0.000

In summary, these results show that social learning resulted from participation processes related to the *Energiewende*. However, the regression models demonstrated that a few individual factors of the participation process have a high statistically significant impact on social learning. Furthermore, the social learning elements "acquisition" and "change and dissemination" are affected by different variables. The most interesting aspect of the results is that trust building and organizational trust have a very significant impact on social learning, while aspects such as effectiveness, efficiency, satisfaction, and individuals' ability to co-decide have no statistically significant impact on social learning. Instead, participation process characteristics such as whether all affected interests are included or the degree of knowledge about the respective topic before the process have an influence on social learning processes. Furthermore, the processes which are moderated showed that social learning is enhanced by moderation which fosters productive exchange.

## 5. Discussion

The purpose of this article is to investigate how participation processes related to the *Energiewende* foster social learning. Univariate analysis of the data showed that social learning took place. However, the results indicate that the social learning elements of the acquisition of facts, methods, and skills are more common than the social learning elements of "change and dissemination". In addition, regression analyses demonstrated that the elements of social learning are explained by different independent variables.

Similar to the findings of Leach, Weible, Vince, Siddiki and Calanni [23], the results demonstrate that some aspects of trust and procedural fairness have a statistically significant influence on social learning. In contrast to their findings, however, the statistical analysis above showed that procedural fairness has a significant influence on the acquisition of knowledge and information but not on "change and dissemination". Age, meanwhile, only impacts the social learning elements of "change and dissemination". The younger the person, the more this person questioned his or her opinions

or felt like being part of a community, while gender and education do not have a significant impact (see Tables 2 and 3). The findings of de Vries, et al. [58] suggest that a trustworthy relationship between the participants and a participation process, which is perceived as being a respectful one, are more important drivers for social learning than participation formats. Similar conclusions can be drawn from the analyzed data. “Trust building” has a very significant relationship to the tested elements of social learning, which implies that an increase in trust between the participating actors also increases social learning. Whilst participation intensity showed a significant influence, the Beta values are moderate. Therefore, the occurrence of a face-to-face dialog or the engaging of participants in one-way communication processes only appears to have a marginal impact on social learning. Furthermore, the models indicate that moderation which fosters productive exchange and individuals’ knowledge before the process has a greater impact on social learning than the specific participation format.

Moderation can be assumed to have a greater impact on the acquisition of information and knowledge than on “change and dissemination” (see Table 3). In addition, the inclusiveness of the process or representation of all affected interests in the process did not have a significant impact on the social learning of respondents who experienced a moderated participation process. This might be explained by the fact that moderation, which fosters productive exchange, should enable a differentiated dialog that takes different perspectives and interests into account, even if they are not particularly present.

Previous assessments of social learning in environmental governance have considered the personal characteristics of the participant, such as gender, age, and education [57]. However, these aspects were often not analyzed thoroughly enough or the sample size was too small to generate definitive conclusions [23]. One aspect which was hardly considered in previous studies was an individual’s knowledge of the respective topic before the start of the participation process. The results (see Tables 2 and 3) show that if someone did not know much about the topic before the process, he or she is more likely to acquire more information and knowledge and change his or her perception. This aspect should be investigated more thoroughly by future research to gain a better understanding of its effects on social learning processes.

There is still much debate as to what participation format best fosters social learning [35]. A number of scholars found that participants learned more if they went to several meetings [23,33,40,59] or were involved at an early stage [60]. The results of this study (Tables 2 and 3), however, suggest that frequency (i.e., number of meetings attended) is hardly significant and the timing and degree of co-decision is not at all statistically significant. Surprisingly, the duration of participation was found to have a significantly negative impact on the social learning element “change and dissemination”. This suggests that the longer someone is involved in a participation process, the less he or she has a change or reconsideration of perspective. Such a relationship initially seems implausible, since the longer someone is engaged, the more information and knowledge should be acquired and the better someone should get to know the interests and perspectives of others. However, the longer the process lasts, the more familiar participants become with the topic and other participants, experts, and decision makers. It can thus be assumed that participants initially have to process a lot of new information and experiences, but that the amount of new insights will probably decrease the longer the process continues. It can also be assumed that the learning curve reaches saturation at a certain point. This finding could also be attributed to the biased recollection of respondents: the longer someone is engaged in a process, the more he or she forgets how much knowledge was acquired at the beginning. This suggests that on the basis of these results, there needs to be a reconsideration of the assumption that longer processes foster social learning.

Whilst some of the independent variables tested did not show a significant relationship, they still may be important impact factors. The applied models of the multivariate analysis are based on linear regression that only looks at the linear relationships between dependent and independent variables and which is sensitive to residuals. The relationship might not be linear, but factors such as the legitimacy

of the process might still impact social learning. Regression models favor independent variables that are close to the dependent variable, which could further narrow down some of the results.

The results can be narrowed down further by the survey mode, since this retro-perspective analysis depends highly on the proper recollection of each respondent. It could be argued that the degree of social learning resulted from social desirability bias. However, there was a variation in the results of single variables measuring social learning. Furthermore, in terms of whether perceptions were disproved due to the participation process, it was shown that participants paid close attention to the wording of questions and made a distinction between acquiring knowledge and questioning values. However, Leach, Weible, Vince, Siddiki and Calanni [23] found in their study that respondents might tend to underestimate the effect of social learning because their qualitative interviews revealed that respondents must have an opinion or be conscious about their preconceived notion beforehand in order to experience a change in perception. This could explain why respondents generally indicated that they acquired knowledge and talked to their peer group, but also questioned their values less often. The combination of qualitative and quantitative methods to investigate social learning would therefore be valuable to further improving the understanding of such social phenomena in energy research [61].

## 6. Conclusions

The results demonstrate that participation related to the *Energiewende* can foster the acquisition of facts, methods, and skills; knowledge transfer to organizations or peer groups; the questioning of values; and an awareness of alternative action—which are all important aspects in the shift towards sustainability. Therefore, processes for the transformation towards sustainable energy systems can be enhanced through participation. Previous studies found that the facilitation of learning through participation is dependent on the design and perception of the participation process [11,29,30]. This paper therefore investigated how different factors influence social learning within participation processes related to the *Energiewende*. The results indicate that trust building and an individual's level of knowledge about a respective topic have a greater impact on social learning than the intensity of participation processes.

This is a remarkable finding, since most scholars have so far argued for intensive participation to ensure successful decision-making [41,62–64]. However, the implications of this study for actors responsible for participation processes in the context of the *Energiewende* are that the participation format should be chosen to best fit the contextual conditions. The results indicate that less intensive participation also leads to social learning. Although more than half of respondents perceived the participation processes to be fair, legitimate, effective, and efficient, only 42 percent trust the respective decision makers to make the “right” decision. Therefore, facilitators and decision makers must increase their efforts to build up trust and demonstrate that all affected interests and perspectives are taken into account. This seems especially important because trust building and organizational trust (individuals' trust in organizational decision-makers) significantly relates to social learning, which includes aspects such as a heightened sense of belonging to a community. This could help in also accepting negative consequences of the transformation from a fossil-fuel-dependent to a renewable-based energy system.

On average, survey respondents moderately agree that the participation processes were fair and legitimate, whilst they also acquired new knowledge. However, the univariate analyses demonstrate that respondents experienced the social learning element of acquisition more than they reported to have experienced cognitive change processes. These results might stem from the chosen self-assessment method of the survey design or might be due to people generally underestimating their degree of learning. Social learning is a complex process that is difficult to measure with single variables, with composite variables also seemingly limited in terms of accuracy. Further research is therefore needed for a closer investigation of the single elements of social learning and how they are linked to the participatory context. The results have already demonstrated how the acquisition of knowledge as well as change and dissemination are caused by different variables. This quantitative analysis provides

a general overview of the factors influencing social learning. However, the interconnections and interdependencies of the identified relationships should be investigated more closely with different methodological approaches, such as case studies that combine quantitative and qualitative methods or pre- and post-questionnaires.

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## Appendix

	Factor	Question
K1	Screening Question	Did you gather information, make comments, or participate in any other way in the context of an energy project in Germany?
K2	Screening Question	How did you participate in this energy project?
K3	Screening Question	Has the participation process ended already?
K4	Screening Question	In what year did this participation process take place?
1	Context	In what state did the participation process take place?
	Screening Question	With this question, we want to test your attention to the survey. Please choose the answer category 2 on the scale from 1 to 5.
2	Context	What is the name of the place/city/district where the participation process took place?
3	Context	Please describe using keywords what the participation procedure was about.
4	Context	Were there any conflicts about this issue before the participation process?
5	Participation Format	What role did you have in the process?
6	Participation Format	Please describe your role as ... ... political decision-maker ... organizer ... moderator ... mediator ... consultant/appraiser ... (scientific) expert ... speaker
	Please enter in each case whether the form applies to the participation process or not.	
7	Participation Format	Information meetings
8	Participation Format	Written information through Internet, announcements etc.
9	Participation Format	Written or oral statement/response
10	Participation Format	Online participation procedure (this does not mean sending written statements by email)
11	Participation Format	Dialog events during which participants were able to exchange views on the issue
12	Participation Format	Informal (background) talks
13	Participation Format	If other forms of participation characterize the process, please cite them briefly:
	Please enter in each case whether the description applies to the participation process or not.	
14	Participation Format	Discussion of objections
15	Participation Format	It was possible to participate before and during the planning process
16	Participation Format	It was possible to participate at each stage of the planning and decision-making process
17	Participation Format	Participants were able to co-develop alternatives and the preferred solution
18	Participation Format	The final decision was taken jointly by all participants
19	Participation Format	The final decision was taken by a specific actor, such as policy makers, government, parliament, business, etc.
20	Participation Format	If further aspects characterize the participation process, to which you refer here, please mention them briefly:
21	Participation Format	How many events/meetings did you attend during this participation procedure?

22	Participation Format	Over what period of time did you participate?
23	Participant Diversity	Who was able to participate?
24	Participant Diversity	Please explain briefly how the participants were selected for the participation process.
25	Participant Diversity	Who participated?
26	Facilitation	Was the process moderated?
27	Facilitation	The moderation of the process was neutral/The moderation was conducted by an external person
28	Facilitation	The moderation supported a productive exchange of ideas between the participants.
29	Facilitation	The moderation of the process was trustworthy.
30	Access to Information	Information on the process and the relevant facts were provided or could easily be obtained.
31	Participant Diversity	All sectors and interests that are affected by the issue were represented in the participation process.
32	Procedural Fairness	The opportunities to contribute opinions and knowledge to the participation process were the same for everyone
33	Procedural Fairness	The participants (participants, organizers, moderators, experts, etc.) treated each other with respect.
34	Procedural Fairness	The participation process was fair.
35	Efficiency	The results obtained are valuable in relation to my own efforts (e.g., time).
36	Effectiveness	Overall, I am satisfied with the results of the participation process.
37	Satisfaction	I am satisfied with my own contribution to and influence on the process.
38	Legitimacy	The participation process and the decision-making process were free from interference, such as pressure from or requirements of project developers.
39	Legitimacy	The final decision was fair, even for those who have to live with any resulting consequences.
<i>The other participants ...</i>		
40	Network Building	... I knew personally before the start of the process.
41	Trust (Interpersonal)	... were honest, sincere, and kept their word.
42	Trust (Interpersonal)	... had the same values and priorities as me.
43	Trust (Interpersonal)	... had reasonable motives and concerns.
44	Trust (Interpersonal)	... were willing to listen and tried sincerely to understand other points of view.
45	Trust Building	As a result of the participation process, I have built up trust in other participants.
46	(Organizational) Trust	I trust those responsible (i.e., the respective decision makers such as policy makers, administration etc.) to make the right decisions.
47	Participant Characteristics	Before the participation process, I was not familiar with the topic.
Due to the participation process, I have gained a better understanding about ...		
48	Social Learning ( <i>Acquisition</i> )	... the topic.
49	Social Learning ( <i>Acquisition</i> )	... different interests.
50	Social Learning ( <i>Acquisition</i> )	... economic consequences.
51	Social Learning ( <i>Acquisition</i> )	... social consequences.
52	Social Learning ( <i>Acquisition</i> )	... impacts on the environment.
53	Social Learning (Change)	As a result of the participation process, my views and attitudes have changed about important questions and problems related to the <i>Energiewende</i> .
54	Social Learning (Change)	My views and attitudes were disproved by the participation process.
55	Social Learning (Dissemination)	I have spoken with colleagues, friends, or acquaintances about the results and experiences I have gained during the participation process.
56	Social Learning (Change)	The participation process has made me aware of alternative actions or solutions.
57	Social Learning (external perception)	In my estimation, the other participants have acquired new information through the participation process and thus gained a better understanding.
58	Social Learning (external perception)	In my estimation, the other participants have changed their attitudes or positions as a result of the participation process.
59	Social Learning (Change)	As a result of the participation process, I feel more strongly to be part of a community working together to solve common problems.



60	Conflict Resolution	No common understanding has been developed over the course of the participation process.
61	Conflict Resolution	Conflicts have arisen within the participation process, which were not resolved.
62	Participant Characteristics	Please state your gender
63	Participant Characteristics	Please state your age
64	Participant Characteristics	What was your main professional occupation at the time of the participation process?
65	Participant Characteristics	What is your highest educational qualification?

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